# Bertrandt*magazine*

The Customer Magazine of the Bertrandt Group
No. 17 | September 2017

## MIXED REALITY AND VIRTUAL REALITY:
3D VISUALISATION IS TRANSFORMING PRODUCT DEVELOPMENT

PORSCHE 919 HYBRID:
DEVELOPING AN INNOVATIVE HEADLIGHT

PEUGEOT 3008:
DEVELOPING COMPLETE SEATS

## EDITORIAL INFORMATION


**Publisher**
Bertrandt AG
Birkensee 1, 71139 Ehningen, Germany
Phone: +49 7034 656-0
Fax: +49 7034 656-4100
Internet: www.bertrandt.com
E-Mail: info@bertrandt.com

**Editorial responsibility**
Gudrun Remmlinger

**Editorial office**
Bertrandt AG, Gudrun Remmlinger
Phone: +49 7034 656-4413
Fax: +49 7034 656-4242
E-Mail: gudrun.remmlinger@de.bertrandt.com

**Contributors to this issue**
Carina Endrijaitis, Nina Gruhs,
Sylvie Fourny, Alisa Hardt, Hartmut Mezger,
Gudrun Remmlinger, Petra Schmidt,
Stefanie Willner

**Layout**
Hartmut Mezger, Bertrandt Technikum GmbH

**Printing**
Druckerei Mack GmbH, Schönaich

**Translation:**
Language Service Paul Willin, Hildesheim




For reasons of simplicity and clarity, the pronoun "he" is used in general references to employees. This is not intended in any way to discriminate against female employees.



# EDITORIAL

Dear readers, the process of developing products is becoming increasingly complex. A key consideration in this respect is the wide variety of technologies available and this is something that is currently affecting all the players on the market. At the same time, development activities are being influenced by a number of different trends, including digitisation, autonomous driving, lightweight design and electric mobility. For engineering service providers such as Bertrandt, the advances in technology are bringing about changes in working conditions. We are taking more responsibility for the development process. In addition, interface, control and project management skills are becoming crucial factors in the successful completion of large-scale packages that involve longer-term projects.

We are pleased to be able to give you a taste of the variety involved in our day-to-day work in this latest issue of the Bertrandtmagazine. One of the forward-looking themes we cover is mixed and virtual reality. We believe that 3D visualisation will lead to fundamental changes in product development. Bertrandt is moving in both directions using the HoloLens mixed reality headset and the Oculus Rift virtual reality equivalent, with the aim of ensuring that we can recommend the best possible visualisation method for each individual customer solution. We are working on electric vehicles in a wide range of areas, including the development of lightweight components. In the field of autonomous driving, we have created a number of innovative interior concepts and in our b.competent project we are involved with taking driver assistance systems to the next level. Our customer projects are also highly varied and range from the development of a headlight for a racing car to complete seats for an SUV.

By focusing on all the current trends, we can provide our customers with support throughout the product development process. We take a number of different approaches, which include internal growth, working with partners and involvement in consortiums. The latest examples include our membership of the "Elektromobilität Süd-West" (electric mobility south-west) cluster and the AUTOSAR consortium, both of which will help us to create future-proof solutions for our customers.

Dietmar Bichler

"The latest major trends in the automotive industry have led to greater complexity in the development process."

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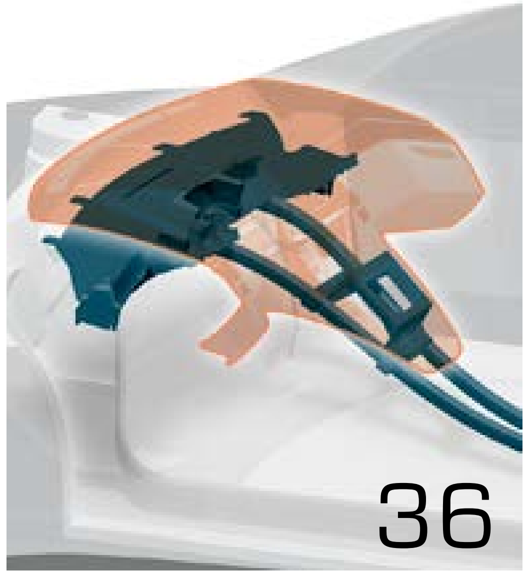
MIXED REALITY AND VIRTUAL REALITY


PEUGEOT 3008


CARBON CARRIER

PAVING THE WAY FOR AUTONOMOUS DRIVING


FROM INDIVIDUAL SYSTEMS TO ONE ALL-EMBRACING PROJECT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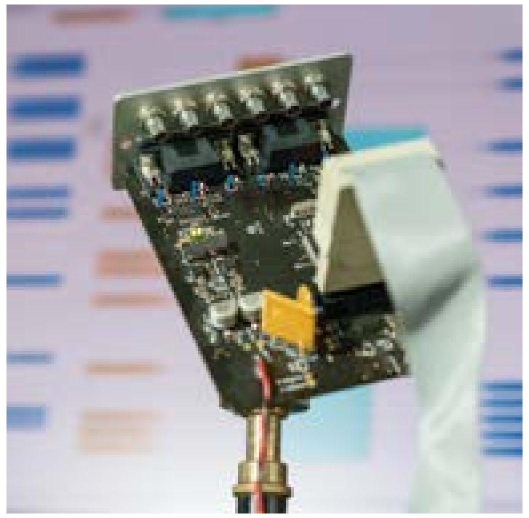
# SPOTLIGHT

Electronics development

## MEMBERSHIP OF AUTOSAR



In March, Bertrandt joined the AUTOSAR (AUTomotive Open System ARchitecture) initiative. Software development is becoming an increasingly important factor in the automotive industry because of the wide range of connected functions in vehicles. In the AUTOSAR development partnership, vehicle manufacturers, suppliers and other companies from the electronics, semiconductor and software industries are working together to establish industry standards that will manage the growing complexity of electronic systems. Bertrandt's extensive knowledge of embedded software and in-depth understanding of the AUTOSAR architecture will allow the company to contribute to improving the development process and increasing its cost-effectiveness. Membership of the AUTOSAR consortium consolidates Bertrandt's commitment to software development and enables it to apply the current relevant standards and tools produced by the consortium's committees to the development of future mobility solutions.

Electronics development

## NEW SERVICES FOR RAIL TRANSPORT

Bertrandt has expanded its range of services for rail vehicles. The electronics department has added to its activities in the fields of integration, testing and function development. It is also focusing on developing bodies, doors and interior fittings, together with simulation. These additions to our rail portfolio have allowed Bertrandt's Berlin and Dresden sites to offer a range of new development services. Trains are an environmentally friendly means of transport and safety as well as reliability are key considerations. Our expertise lies in developing, integrating and validating electronic systems. We test their functionality and install updates, such as maintenance releases. We focus both on comfort features and safety applications, such as the emergency brake functions. In addition, our diagnostics experts can investigate whether control units are transferring commands accurately and whether specific messages displayed on the driver's screen are correct. The same tests can be carried out for passenger information systems. Other important areas for us are the body and interior of rail vehicles. We design panelling and integrate the cable ducting systems that run behind it. Additional services include seat design and arrangement and the development of brake and drive systems. Our simulation services complement the development process, for example, by allowing force ratios to be evaluated.



Medical technology

## TESTING LABORATORY FOR THE PHARMACEUTICAL INDUSTRY

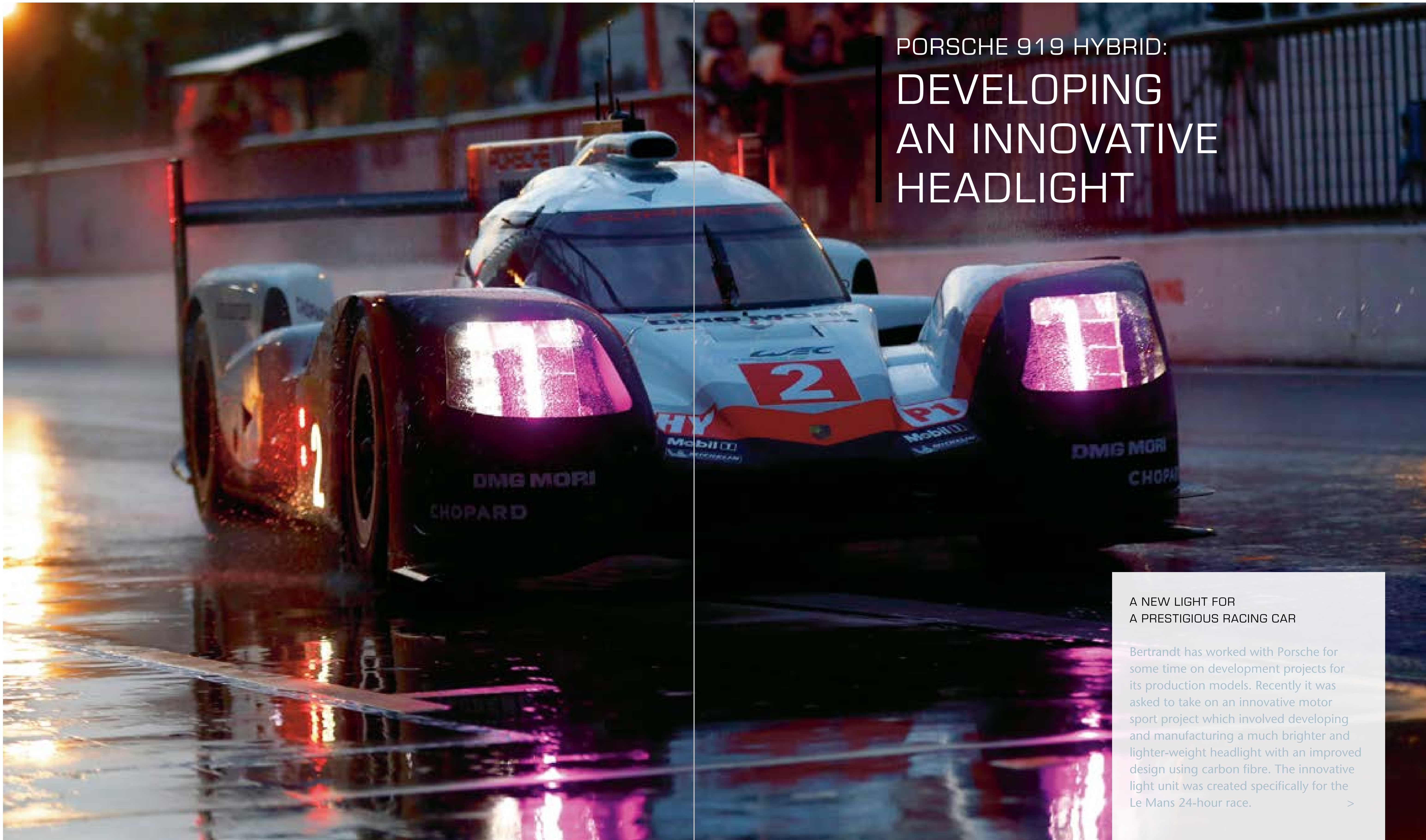
One of the objectives of establishing the Wiesbaden site was to give Bertrandt a location very close to the Frankfurt-Höchst industry park. Our specialists there manage complete testing processes, provide comprehensive design services and respond flexibly to individual customers' requirements. We comply with all the relevant DIN standards and the Good Manufacturing Practice (GMP) quality assurance system of the US Food and Drug Administration (FDA) in order to ensure that we meet the high quality requirements of the pharmaceutical and medical technology industries. The lab at the Wiesbaden site is fitted with state-of-the-art equipment. Its climate chamber is designed for use at temperatures between -40 °C and +150 °C. A micro balance allows materials to be weighed to high levels of precision and a universal testing machine tests the safety of medical devices when they are used incorrectly. Using the lab's new clean bench, Bertrandt can produce its own machine samples for test runs, measurement system analyses and other testing purposes.

Mechanical engineering

## MACHINERY DESIGN

Bertrandt also provides plant and machinery design services. One example is the machines that Kleemann manufactures, which are used to crush stone and other materials in stone quarries and for road building. Our services include developing individual components, such as crushers, sieves, inlet ducts, engines and conveyors, and also supporting the production process for an entire new range of impact crushers. This involves everything from changing a threaded hole to creating new parts for the range and requires our team to work closely with the manager responsible for the machine and with suppliers. GRP housings have recently been created for all the different ranges of impact crushers. Bertrandt was involved in the development of the housings and in the interface management process. These housings are very important, because they protect the machine's drive system.

The biggest challenge was the fitting accuracy of the components. The transport width and height of the mobile machine are particularly important. The space available is very limited and the moving parts need enough leeway. Complying with tolerances is essential, particularly in relation to the costly processes of manufacturing moulds and tools. If the transport dimensions were exceeded, an expensive special transport solution would be needed.

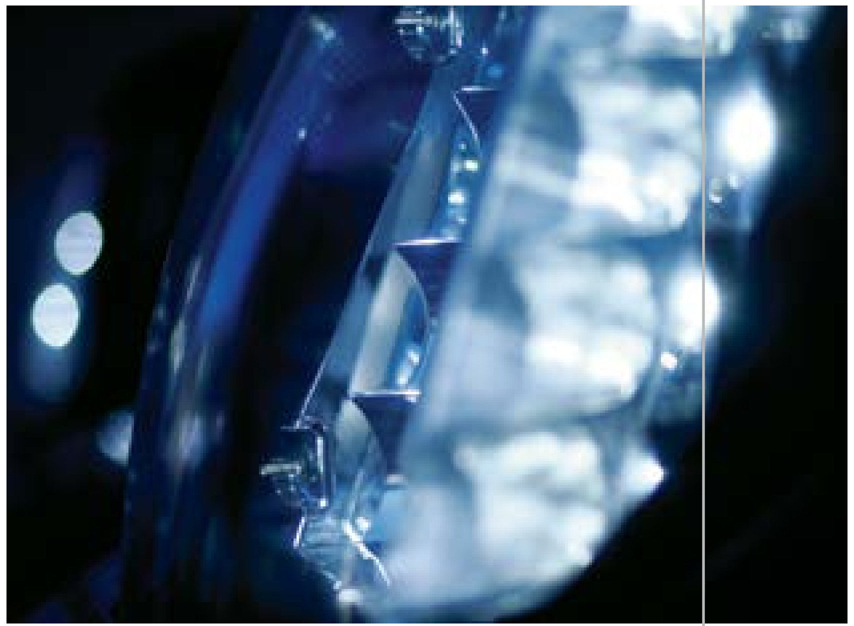



# PORSCHE 919 HYBRID: DEVELOPING AN INNOVATIVE HEADLIGHT

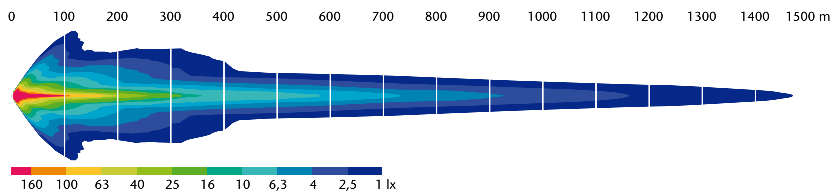
## A NEW LIGHT FOR A PRESTIGIOUS RACING CAR

Bertrandt has worked with Porsche for some time on development projects for its production models. Recently it was asked to take on an innovative motor sport project which involved developing and manufacturing a much brighter and lighter-weight headlight with an improved design using carbon fibre. The innovative light unit was created specifically for the Le Mans 24-hour race. >

Each headlight has twelve pairs of LEDs and reflectors.


The latest hand-picked LEDs in the new lighting unit.


Impressive side lighting and range in the 919 Hybrid.



Range and distribution of the light from the 919 Hybrid headlamp.

Speed was needed to complete the entire development process for the 919 Hybrid, from the initial concept through to the small-scale production of 30 headlight units per year. Bertrandt had only a few months to develop a completely new headlight, including the design specifications, the concept and detailed design, the layout of the lenses, the thermal simulation and testing, followed by the structural and joining systems and ultimately production. In addition, suitable suppliers had to be identified and managed.

## The special requirements of motor sport

The particular requirements for the racing car included a very robust, lightweight design, together with high-performance components. These demands could only be met as a result of Bertrandt's comprehensive expertise and long-term experience of designing lighting systems and lenses, using new materials and creating lightweight components in carbon fibre. Other success factors were Bertrandt's interdisciplinary network of highly motivated specialists from its simulation, testing and prototyping teams, the problem-free internal cooperation and the competent supplier management service, all of which allowed the headlights to be produced quickly and cost-effectively. The early involvement of all the internal and external partners in the project proved to be another beneficial factor. The first headlights were delivered only five months after the project kick-off. The high quality of the products ensured that they functioned perfectly throughout the entire racing season. The main milestones in the development process were the creation of the first sample components and the assembly of the first headlights from individual parts. The excitement reached fever pitch when the headlamp unit was used for the first time during a light test on the Porsche skid pan. With its high-performance lighting, the revolutionary headlamp put every other light in the shade. It also proved to be highly robust, which boded well for the legendary Le Mans race, where the tough conditions mean that materials are exposed to extreme stresses.

## At the limits of what is technically feasible

The revolutionary headlight unit was a huge success in its first endurance race at the Spa-Francorchamps circuit. The luminous flux emitted by each light amounted to 12,000 lm. The maximum light intensity was more than five times that permitted for road vehicles and gave the lights a range of 1.5 km. The system is equipped with the latest LEDs from Osram, which were hand-picked, and has three different functions: pencil beam (ultra-long-distance light), main beam and side beam. Twelve pairs of LEDs and reflectors per headlight unit are split into seven individually controlled strings for long-distance and cornering light. The characteristic Porsche four-spot light design has been retained when the lights are in daylight mode and the control unit is fully integrated into the headlamps. Special features of the new lights included improvements in side lighting and range, an almost 30 percent weight reduction, a simplified assembly process and better cooling functions. Compared to the previous year's version, the number of LEDs was doubled, while the weight of each headlight unit was reduced by 1.1 kilograms. In addition, each headlight has 20 coloured LEDs which allows the two cars to be distinguished from one another. The light unit can be installed and removed quickly because it consists of one robust, easy-to-handle module. The development of the new lighting unit made a significant contribution to Porsche's 18th overall win at the Le Mans 24-hour race and to its victory in the FIA World Endurance Championship (in the team and driver rankings).

## The next GT racing project

After the success of the headlight in the World Endurance Championship, Bertrandt was commissioned to take on another project. A new, robust headlight system has to be developed for the Porsche 911 RSR which will be taking part in a number of different endurance racing series in 2017. ■

*David Maisenbacher, Holger Negele, Mönsheim*

## IN BRIEF

### PORSCHE 919 HYBRID HEADLIGHT

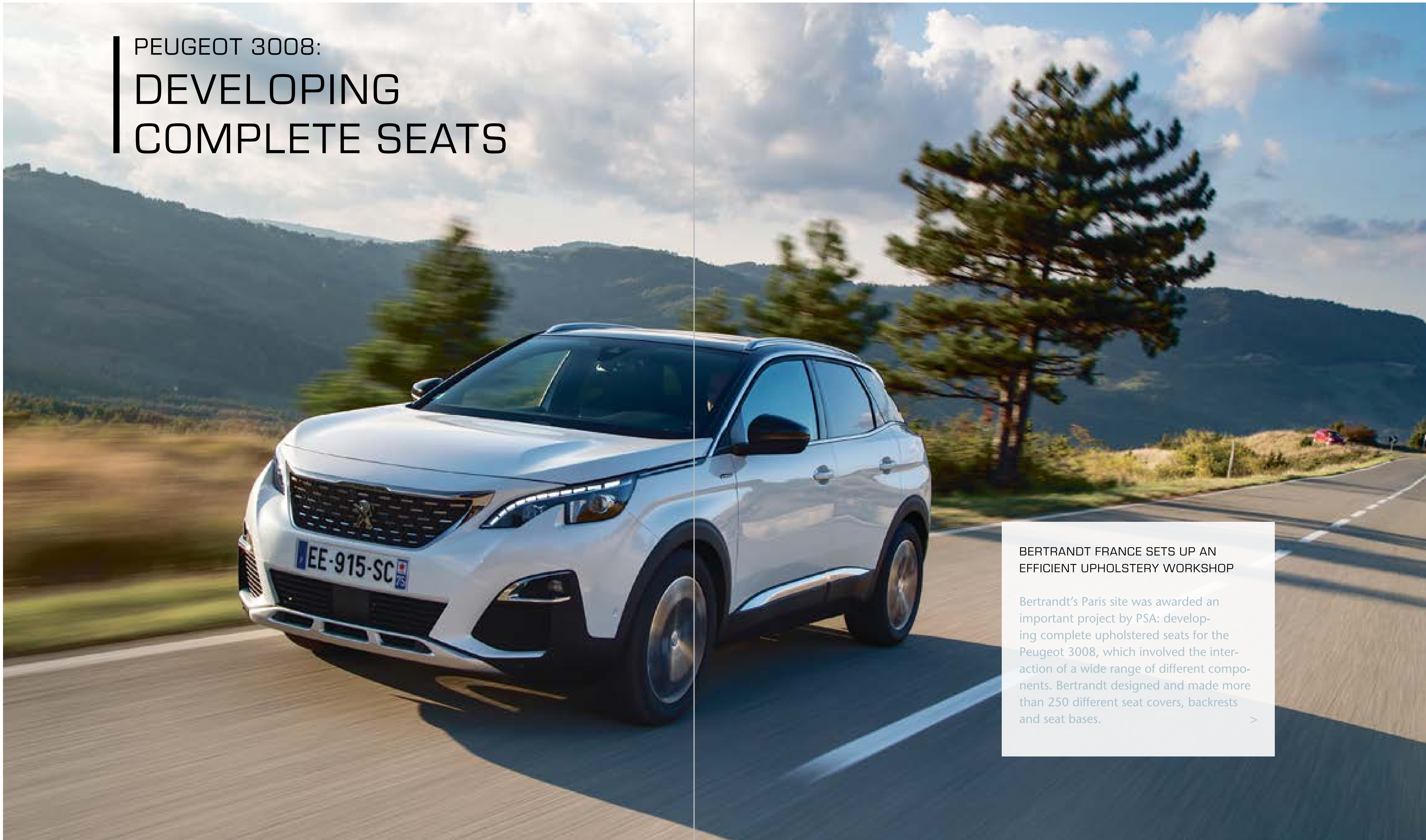
**Lighting technology**
- Analysis of the previous year's headlight, lighting concept, design of individual reflectors, selection of the type of LED, lens simulation, lighting measurements

**Thermal management**
- Cooling concept, thermal simulation, thermal tests

**Design**
- Use of lightweight technologies, CFRP components, design for ease of production, tool design, drawings, assembly documentation

**Prototypes/small-scale production**
- 3D printing, tool making, plastic injection moulding, coating CFRP, joining CFRP components, assembly equipment, final assembly

**Project management**
- Project coordination, supplier management (electronics, CFRP components)




# PEUGEOT 3008: DEVELOPING COMPLETE SEATS

## BERTRANDT FRANCE SETS UP AN EFFICIENT UPHOLSTERY WORKSHOP

Bertrandt's Paris site was awarded an important project by PSA: developing complete upholstered seats for the Peugeot 3008, which involved the interaction of a wide range of different components. Bertrandt designed and made more than 250 different seat covers, backrests and seat bases. >

The Peugeot 3008 –
reinterpreting the SUV.

Individual seat development for vehicles ranging from SUVs to sports cars.

The interior of the Peugeot 3008 has received several design awards.

## IN BRIEF

### THE UPHOLSTERY WORKSHOP AT BERTRANDT FRANCE

- Highly experienced upholsterers
- Comprehensive equipment for an industrial upholstery workshop
- Dedicated CAD tools for a rapid response
- Customised upholstery for individual customers
- Complete development of seat covers for vehicle, train and aircraft manufacturers
- Volume production and process management

The Peugeot P8x project for the creation of complete upholstered seats consisted of two models: the P84 for the Peugeot 3008 and the P87 for the Peugeot 5008. The contract was awarded in a new way. Bertrandt France was given responsibility for the entire development process, including tool making, with the exception of the parts transferred from previous models, the metal seat structures and the plastic slots for the headrest guides. Bertrandt's initial strategy was to collaborate with an external upholstery company.

Because of the pace of work required, the long distance between the two companies and the accompanying costs, this strategy soon proved to be problematic. Therefore, the project team decided to set up an upholstery workshop on the premises of Bertrandt France in order to ensure that the seat covers could be developed and created reliably, right through to industrial production by the supplier.

### Efficient creation of seat covers

Bertrandt SAS also decided to invest in the Lectra software package for the creation and technical definition of the seat covers. The process improvements and efficient change management system provided by this software resulted in the required level of operational excellence. The 3D version of the models used to create the final seat covers was converted into a 2D version using this software tool. After the digital design phase, the upholsterers produced several iterations of the seat covers and resized them on the basis of customer feedback. These phases were referred to as "implementation loops". The goal of the Bertrandt team was to complete the implementation process in a maximum of three loops after the initial presentation of the seat.

### Digitisation using ScanGraph

The digitisation process allowed the models to be scanned and converted into digital form very quickly. In order to record the history of the seat cover implementation process, a reverse engineering approach was used at the end of each phase to document the technical definition. This contained all the relevant data, including the cover design, cardboard models and digital models, and enabled the cutting process for the seat covers to be managed efficiently.

### In a strong position for the future

The French upholstery workshop will be expanded in order to meet the requirements of manufacturers from France and elsewhere in Europe. It is already working closely with Bertrandt's upholstery department in Wolfsburg. The plan is to provide upholstery services for the luxury segments of the aviation and shipping industries, for vintage cars and for special vehicles belonging to collectors. The original challenge faced by Bertrandt France has opened up a variety of new and interesting prospects. ■

*Sylvie Fourny, Loïc Chapon, Paris*

# MIXED REALITY AND VIRTUAL REALITY

3D VISUALISATION IS TRANSFORMING PRODUCT DEVELOPMENT

Mixed reality and virtual reality have opened a new chapter in the history of technology. They give engineers a glimpse into the future and help to make product development processes even more efficient. Almost 20 years ago, Bertrandt presented its first virtual 3D application during the launch of the Bertrandt Competence Car at the Frankfurt Motor Show in 1999. Now our engineers are working with these innovative technologies to improve product development even further and offer our customers the best possible solutions. >

## Making informed decisions long before the availability of models

Bertrandt is taking a number of different approaches. Mixed reality is a useful tool in almost all areas of development. In future our engineers will be able to evaluate different scenarios during package space investigations by putting virtual components into locations in a real car. Virtual reality, the creation of a computer-generated three-dimensional world, has also been in use in development processes for some time. It is the ideal tool for design evaluations. Bertrandt believes that both technologies have a great deal of potential, in particular when teams in different locations and different countries are working together. Development engineers can meet, for example to assess the package space needed by an alternator. This is where the HoloLens, a mixed reality head-mounted display developed by Microsoft, can play a central role by allowing virtual objects to be positioned in three dimensions in a real environment. In the case of the alternator, the engineers can look into the engine compartment of a new car model. The HoloLens projects the hologram into the real-life setting. The engineers can determine how to install the alternator cost-effectively and without complications. This means that they can be sure that enough space is available for the component and that the area where it will be located can be easily accessed. Their gestures control the visualisation. They can select objects, such as the alternator, and move them until they are in the correct position for installation. They use head and body movements to ensure that they always have the best view, which allows them to evaluate how the component can be installed. It would, of course, be possible to carry out the same investigation with a real alternator in the real engine compartment, but only two years later when the first prototypes of the new model have been built. If the developers were to discover at such a late stage that the component could not be installed at all or perhaps only with difficulties, costly and time-consuming modifications would be needed. At the time when the mixed reality evaluation is carried out, the new car model only exists in the form of digital design drawings and three-dimensional representations of them. This is why the team of developers meet in a space where reality and visualisations come together. At a very early stage in the development process, they can see and assess a design solution that in real life they would only be able to assess much later.

Mixed reality combines the real environment with virtual three-dimensional objects. These objects can interact with the real world and demonstrate their physical properties. For example, they can roll across a real table and fall onto the floor. For this reason, the HoloLens does not block the wearer's view of the real world in the same way that a virtual reality headset does. The engineers can see and hear each other. They are not immersed in their own enclosed, three-dimensional world. Instead they are located in the same room, can talk to one another, share ideas, evaluate arguments and ask questions. They can interact and communicate in order to find the best solution. >

Bertrandt engineers assess the engine compartment of a new car model that will only be available in prototype form in a few years' time.

In an IT context, virtual and mixed reality are nothing new, but they are now arriving in the world of work.

Bernhard Zechmann
Head of system services

## Arriving in the world of work

Bernhard Zechmann, head of system services at Bertrandt, sums up the new visualisation technologies as follows: "In an IT context, virtual and mixed reality are nothing new, but they are now arriving in the world of work." He believes that three developments have been responsible for enabling these tools to be used in a work environment. The first is the huge increase in computing power. The HoloLens is a computer with the same processing capacity as the most powerful mobile devices. His prediction is that "when we can give a headset like this the power of a desktop computer, we will be able to take the next big leap forward." Zechmann has in mind the higher resolution that would benefit engineers in future design evaluations and also acoustic improvements.

The third factor is the arrival of artificial intelligence, in the form of apps that can independently collect data relating to questions which have been asked and then answer the questions. Or as Bernhard Zechmann puts it: "Robots are definitely useful tools, but we have to program them. We will have made huge progress when our tools have a higher level of intelligence." However, the most important thing for him is the ease of use. The HoloLens wearer's hands are free and the headset has no cables. The entire visualisation technology is integrated into the HoloLens itself and the set-up times are very short. Even inexperienced users can immerse themselves in the augmented reality environment after only a few minutes and move about in it safely. >

Using the technology that lies behind the HoloLens, Bertrandt can enable its customers to make the best possible use of the space available long before the machines and robots are installed in the factory building.



### Making data usable in mixed reality

The HoloLens can process all the data and properties that can be transformed into 3D models. Bertrandt developers convert CAD data into special 3D models that can be visualised by the HoloLens. The developers' 3D data is animated by apps using a computer gaming engine based on Unity3D. Logic and additional material properties are added to the data. This makes it possible to apply physical forces to 3D models in order to accelerate or deform them or to subject them to the effects of gravity. The objects can also emit or be influenced by light and 3D sounds.

The HoloLens is designed in such a way that the apps it accesses run directly on the headset and not in the background on a separate computer. Only the pre-programmed data is transmitted to the headset via a network or WLAN. The HoloLens does not need a PC to generate the holographic images. It is itself a computer with all the necessary components. The device has a special holographic processor alongside its central and graphics processors which allows it to display the 3D objects immediately. The holographic processor is responsible for processing the data supplied by the headset's comprehensive range of sensors. These include cameras that identify the environment and measure distances, together with position and acceleration sensors.

### Handling sensitive data securely

The ease of use and the newly acquired mobility of the 3D visualisation tools are obvious benefits. However, they also present an additional challenge. The data used in product development must be protected from hackers. According to Bernhard Zechmann, this is a crucial task. “We offer our customers specially designed security strategies. We can also provide them with advice on which tools are secure and which should not be used.”

In this case, he is of the opinion that data security begins with the hardware and with changes to the chip architecture which ensure that the devices encrypt the data. However, this will not be enough. “What happens if a device is lost or stolen?” wonders Bernhard Zechmann. Bertrandt already has a number of solutions available in this area.

### Mixed reality of interest to a number of industries

Technology of this kind is useful in almost all areas of development. The Bertrandt engineers will in future be able to use different scenarios to solve problems. Bertrandt can transfer its expertise to cars, aircraft and factories in order to reduce its customers' costs and save them time. All of this happens long before the component is actually installed or the machines and robots are moved into the factory building. Mixed reality can be used in a multifunctional way to meet customers' specific requirements in a range of industries. >

Mixed reality combines the real world with virtual three-dimensional objects that can interact with their real-life surroundings.

## Virtual reality – complete immersion in virtual worlds

Virtual reality (VR), which takes users into three-dimensional, computer-generated worlds, has also been in use in industry for some time. “We now have practical experience of this,” explains Zechmann. Computer games with realistic 3D animations have been popular for a long period. If you try out the latest VR games for yourself, you will find it hard to resist their appeal. The experience of stepping into a world, taking part in the action and influencing events there with the help of a controller has never been so realistic. Zechmann believes that end consumers can also benefit from what VR has to offer. “The use of VR headsets in car manufacturers’ customer centres will help potential purchasers to gain a 3D impression of the impact of different combinations of colours and materials in the interior of the car and to find out whether they work together. A three-dimensional view of all the equipment options can also be presented to customers in a virtual showroom.” This is why Bertrandt is currently working with VR devices such as the Oculus Rift, the HTC Vive and the Samsung Gear VR.

The HoloLens allows the functionality of products to be evaluated in the early stages of development before the first prototypes are produced.

## Not just a service provider, but also a technology scout

For Bernhard Zechmann, MR and VR projects have become part of Bertrandt’s corporate philosophy. “We have identified new ways of giving our customers even better support in future. Three-dimensional visualisation tools are just the next step in this process. We already have the necessary infrastructure and now we need to adapt the tools and the apps to the requirements of our customers and their industries.” Bertrandt not only has the necessary technical expertise, but, equally importantly, it also has an in-depth knowledge of its customers’ processes as a result of working on projects over a number of years. This allows Bertrandt to offer customised solutions, improve customers’ workflows, save valuable development time and reduce costs. For this reason, Bertrandt is working with both the HoloLens (MR) and the Oculus Rift (VR) so that it can recommend the best visualisation technique in every case.

Virtual reality is one step ahead, as the first devices are already available on the market. However, the Microsoft HoloLens is the first MR visualisation device to be launched globally. The “development edition”, as the initial version of the headset is known, has all the technology needed for mixed reality. It is a wearable, wireless computer with a 3D monitor, loudspeakers, a video camera for recording its surroundings and sensors that identify the spatial coordinates of its wearer. If people need to interact and communicate with one another during the visualisation process, then mixed reality is the ideal solution. However, in situations where one person has to immerse themselves fully in a virtual world, a VR headset is more suitable, because the user’s entire field of vision is screened off from the real environment. >


**We will be happy** to give you a personal presentation of the opportunities that visualisation technology can offer. We can also visit your site with our tech roadshow.

Contact:
**Dr. rer. pol. Markus B. Götzl**
Head of corporate strategic development, marketing, public and investor relations
markus.goetzl@de.bertrandt.com

## Customer reactions are clear

Intervening in established processes always gives rise to new challenges. How will this technology change existing workflows? Bertrandt engineers are providing customers with consultancy specific to their business and their industry and highlighting areas where the efficiency and the speed of processes can be increased and where there is potential for reducing costs. As Zechmann explains: “Anyone who tries out 3D visualisations will experience the wow effect very quickly.” He is also aware of the direct consequences of this. “Our customers want to introduce these new technologies sooner rather than later.” This type of 3D visualisation can bring about fundamental changes in product development and in all the downstream processes. ■

## THE MICROSOFT HOLOLENS ACADEMY

Bertrandt successfully applied to take part in Microsoft’s second Holographic Academy programme. This involves starting and completing an ambitious project in the space of only twelve weeks. Bertrandt made use of expertise from its Ingolstadt, Hamburg, Düsseldorf and Regensburg sites to develop an app for the HoloLens.

After Bertrandt had brought the project to a successful conclusion, the company was recognised by Microsoft on its website as one of the few experts in the development of HoloLens apps anywhere in the world. Microsoft will also recommend Bertrandt when it receives enquiries from other companies. An additional benefit is that Microsoft provides us with contacts who give us a glimpse behind the scenes. They can answer technical questions, offer design hints to the development teams and allow us not only to become involved with the technology but also to gain an in-depth understanding of it quickly and effectively.

We chose a universal use case: the maintenance and repair instructions for an electric-powered light aircraft. We used the HoloLens to illustrate individual aspects of service checks and maintenance procedures, configure the smart tools for each stage of the work and create detailed documentation that complies with aviation regulations. We have taken a generic approach in order to allow the expertise that we have acquired across our various sites to be used in other industries and scenarios.


# SHAPING THE DIGITAL TRANSFORMATION

## THE HOLOLENS AUGMENTS REALITY

The arrival of the fourth industrial revolution has brought about a fundamental change in the mindset of many customers. The increasing importance of data for processes and workflows is presenting us and our customers with new and complex challenges.



Several years ago we introduced new design methods at our Hamburg site, which were more efficient, more stable and easier to modify and represented the first step towards automation. More recently we have taken on projects involving automatic data analysis and processing. By linking these programs together, we have created complete end-to-end solutions that can seamlessly integrate the data from engineering processes into the production process.
As a result of the development of complex software solutions of this kind, Bertrandt is now seen as a competent and efficient partner for technology projects. This has led to an increasing number of enquiries about independent process and technology analyses.
The virtual and augmented reality systems that are currently becoming established on the market offer further opportunities for improving processes. The focus is on augmented reality, which, in contrast to virtual reality technology, superimposes or overlays digital information onto the real world in order to enhance or augment it. This makes it possible to show customers parametric computer models and complete design solutions directly and in real time in the actual location where the component will be installed. Interactive and configurable options of this kind significantly improve the efficiency of the decision-making process both for the end customer and for developers and designers. This makes it possible to obtain valuable feedback from a number of areas at a very early stage, which can then be evaluated and incorporated back into the development process.
Another application of AR in an industrial context is the animation of workflows. This allows animated training material or step-by-step instructions based on existing 3D development data to be superimposed on the real-life component.
As things currently stand, manuals or presentations are generally used to prepare employees for installing or maintaining new components or assemblies. In comparison to this static 2D information, a full-size or scaled-down 3D animation gives an intuitive understanding of the proportions of the component and allows the perspective to be controlled by the observer. Animating the activity and adding text instructions and voice-overs is comparable with an introduction from a trainer and is equally memorable.
To provide help with on-site assembly or maintenance work, all the activities can be accessed step-by-step and displayed in animated form as holograms directly on the real-life component. If problems occur, a video connection can be set up to a service helpdesk that will give support in real-time. This means that wherever you are in the world, all the relevant technical knowledge is available to you when you need it.
Bertrandt has successfully applied to take part in Microsoft's Holographic Academy programme across all its sites, which involved setting up a maintenance and repair scenario of this kind. The experience of doing this will enable us in future to make customers' processes more innovative and efficient using the very latest technologies. ■

You can find out more about Bertrandt's activities in the fields of mixed and virtual reality on our YouTube channel:


# "LIGHTWEIGHT DESIGN CUTS COSTS"

Bertrandt's extensive experience of the development process allows it to offer intelligent and innovative solutions in the field of lightweight design. Its technical departments, including the vehicle body, interior, powertrain, chassis, electronics, simulation and testing teams, work hand-in-hand across the different disciplines involved to overcome all the accompanying challenges. By systemically networking different areas of knowledge and expertise, it is possible to produce future-proof solutions that perfectly meet the individual requirements of customers and the market.



INTERVIEW WITH FRANK PRELLER
Research and technology team leader at Bertrandt Wolfsburg

**/ Some of the key trends in the automotive industry include digitisation, connected vehicles, autonomous driving and electric powertrains. Lightweight design has been an important consideration for several years. What do you believe is the role of lightweight design in relation to these central issues?**

Electric vehicles definitely have an important influence on the lightweight design of components. In other respects, lightweight design has become a discipline that is no longer an end in itself. The latest vehicles have reached a level where a great deal of work is involved in reducing their weight even further and this can quickly become very expensive. However, in electric cars weight reduction plays a key role. Every kilogram we can remove is helpful. Nevertheless, even the smallest improvement in battery performance brings about a much greater increase in the range of the car than reducing the vehicle's weight by one kilogram. Because we have to protect the battery very carefully against high levels of acceleration and against intrusion in the event of a collision, lightweight design is essential in this area.
Lightweight design also plays a central role in digitisation. If you look at one of the latest instrument panels, it consists of a variety of different instruments and controls which offer huge potential for weight reduction. The hardware components of cars are becoming much lighter and less complex and the package space is changing. This allows us to develop new interior concepts.

**/ What challenges is lightweight design facing with regard to reducing the weight of vehicles across all the segments?**

We have neglected the goal of weight reduction across all the segments for some years, particularly when it comes to secondary lightweight design. If we can reduce the weight of bodywork or interior components by 10 percent, this means that on a secondary level we can use a smaller engine. The chassis can also become lighter in weight and downsizing measures can be introduced. We are working very hard on achieving our goals for the interior and the body in order to enable the chassis and engine designers to respond accordingly.
In my view, there are two major challenges facing lightweight design in the automotive industry. The first is weight-optimised cost reduction, where the focus is primarily on the cost, but weight reduction is the actual benefit. The second is integration. The problem is not persuading the developers to make a particular component a few kilograms lighter, but integrating this into the process. Our job is to achieve results using a completely new technology, new materials and different approaches without changing the production methods. A piece of sheet steel can easily be replaced by aluminium, because both of these are deep drawn parts. They can be made in the same press. But as soon as you want to replace sheet steel with a moulded plastic part that is ribbed, the use of the machine is called into question. In the field of lightweight design we are constantly calling something into question >

> We have the potential to put the right material in the right place.

that is currently working: a process, a component, an assembly or a complete vehicle. If you want to change the machinery that is in use, you will need all your powers of persuasion and a good financial plan.

**/ Where do you think the greatest potential lies for lightweight design? What are the driving forces behind the next wave of innovative solutions?**

First of all, we need to make a lot of components from a similar family of materials and join composite components together in a highly disciplined way. There must not be an explosion in the number of different joining methods that we use. We have the potential to put the right material in the right place. We need to call existing components and methods into question, but always from the perspective of bringing a new car onto the market in the shortest possible time at a low cost and with few risks. We must also take into account the fact that manufacturers' approval processes become more complex when components made from a new material have to be integrated, sized correctly and ultimately recycled.
The main driving forces are very interesting. In the case of cars, weight reduction is part of the process of cutting fuel consumption. If the car has an electric drive, its range can also be extended. The situation becomes more complicated when we look at commercial vehicles, because of the loads they carry. If we can reduce the weight of a truck by one kilogram, this allows it to transport an additional kilogram, which brings an immediate benefit for customers. In addition, the vehicle registration criteria and the driving licence categories are based on weight. If you can make a slightly larger vehicle that is lighter than its counterparts, it can be driven by someone with a driving licence in a lower category.

**/ Can Bertrandt's experience of the aviation industry help in this respect?**

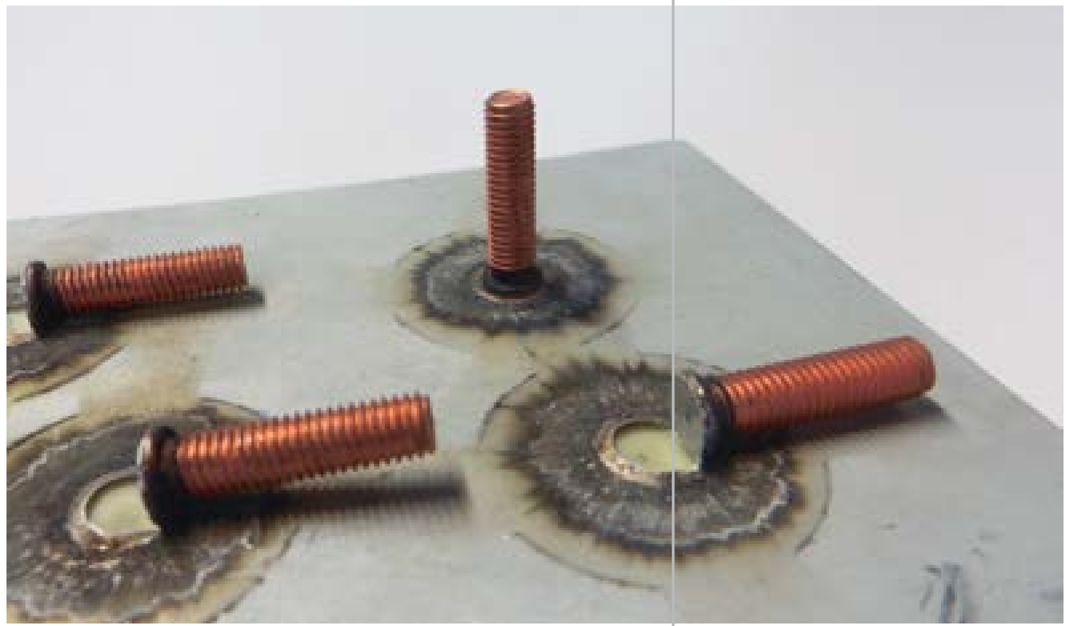
Yes, definitely. We are already making use of the experience of our colleagues in Hamburg and their expertise in the field of composites in our highly innovative projects. Although the technology is not a direct match, we can draw conclusions about what size a component should be and how it can be joined to another part. I will give you an example of an area where this functions very well. One of the latest trends is 3D printing. The aircraft designers have pushed ahead with this because they have realised that they can save time by sending the data via e-mail, printing it out locally and then leaving the 3D printed part in the aircraft. The process is no longer used to make spare parts that are only fitted temporarily. As development service providers, we can learn from this both for the cars themselves and for their production processes, for example when we are making cores for cast tools.

**/ How do you help your customers with this new technology? Many manufacturers are holding off on using CFRP. What concepts do you have to offer?**

We are working with manufacturers and their suppliers on these concepts. We talk about CFRP being a very expensive material, but we have not succeeded in integrating fibreglass components in the past. The move from metals to fibreglass or fibre composites would have represented the first step. Then we could gradually have increased the level of innovation. However, we are still in the process of moving away from bodies made of sheet steel. This makes the shift to carbon fibre more difficult, for example with regard to the coefficient of expansion.
One interesting example of a new approach is the BMW 7 Series, where carbon fibre is used to stiffen areas of very thin steel. The carbon fibre is applied in the form of a patch behind the B pillar to reinforce the steel component. This represents a breakthrough in design engineering which also happens to resolve the cost problem. The load-bearing capacity of the component is increased and ultimately this is good for the price. This also means that the material can be used in other segments. >



> We are still in the process of moving away from bodies made of sheet steel.



How can welded studs be combined with face sheets that are only 0.2 millimetres thick?

Good lightweight design can be easily integrated and also helps to reduce costs.

**/ Is Bertrandt taking part in projects that will enhance its lightweight design skills?**

The latest example is our joint project with SGL, the Carbon Carrier. But from the perspective of complete lightweight vehicles, the InCar and InCar plus concepts, which were developed by ThyssenKrupp with our involvement, play a decisive role. They focus on the entire vehicle and therefore all the opportunities for secondary lightweight design are included in one project. The most interesting consideration is that the manufacturer can integrate the new ideas immediately because the project is based on classic construction methods. Manufacturers and their suppliers can adapt this modular principle to their own individual projects and integrate it fully. At the time, this represented an innovative approach to the conventional production process.

InCar demonstrated how lightweight design using steel can be perfected. Making components from steel is one means of continuing to use existing production machines over a longer period. One example of this was Litecor, a sandwich material which has face sheets generally made from 0.2 mm steel with a variable polymer core between them. Stiffness is the main problem with classic lightweight design and Litecor was the solution to making components stiffer.

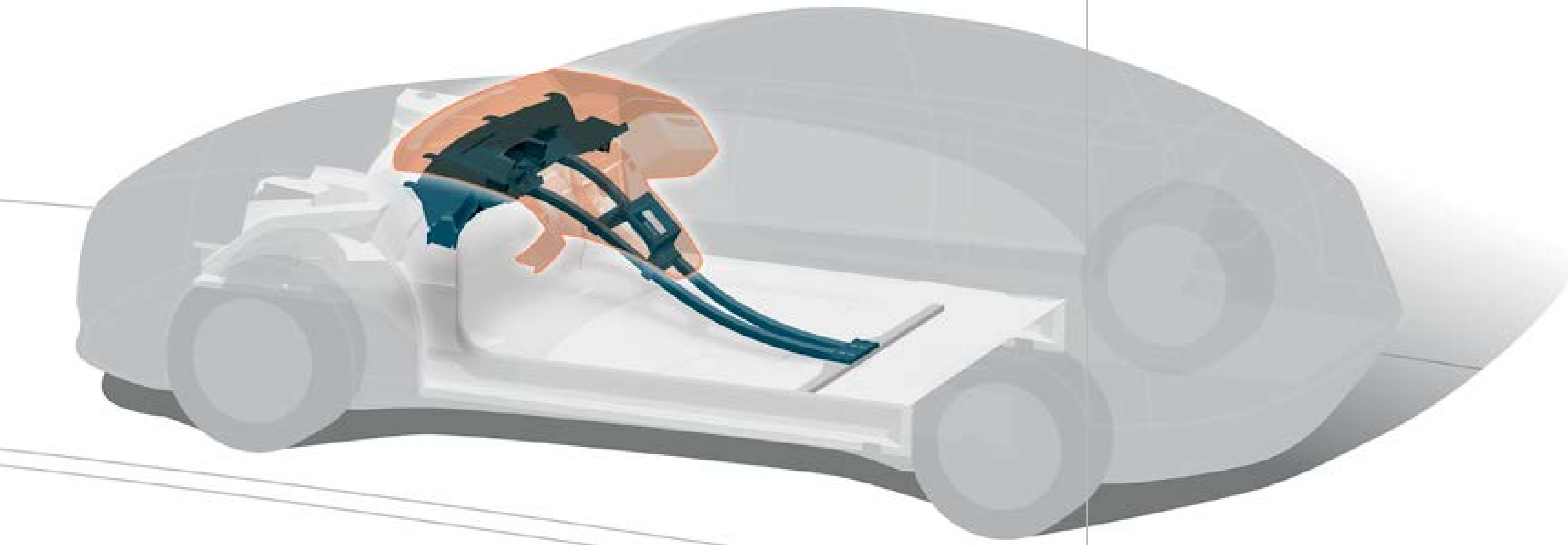
Among other things, the InCar project investigated the areas where a lightweight material with improved stiffness could best be used and this was primarily for large components such as the outer skin, the floor panels and the wheel arches. One problem is that many of these parts have welded studs. The question now is how 4 to 6 millimetre welded studs can be combined with face sheets that are only 0.2 millimetres thick. The trick is to develop a solution that allows us to continue using the standard process in production without any major changes. We are working in this area with manufacturers, research institutions and universities on a number of different ideas and we will be taking the most promising ones forward independently. This has allowed us to jointly develop an approach that replaces welded bolts in the production process without using adhesives or punch riveting and that in our view is strong enough for the majority of applications. You need to understand the production process and the challenges it faces in order to be able to use the best material in each case and to test it together with the manufacturer.

**/ Which requirements are we likely to have to meet in future?**

Lightweight design has not yet reached its limits using current methods, but the situation is getting more difficult. We are discussing new construction methods, new material concepts and new production volumes. Autonomous driving will present us with a considerable challenge. Existing concepts allow drivers to move in their seats. How can we keep them safe? How will safety belts work? Vehicle interiors are becoming bigger and the interesting consideration is how people will move about within this space. Various questions come to mind, such as: where will the roof rack be positioned in future? Will we still need a roof rack? What legal requirements will there be in different countries? We need to prepare ourselves for all of these changes, because I believe that autonomous driving will open up a whole range of opportunities for us and our customers.

Another factor is modularisation. Two steel sheets can be welded together using an existing steel technology, but also using hybrid method such as riveting and bonding. If a joining method of this kind is used in a basic model, it gives greater flexibility and enables aluminium or plastic components to be fitted. The basic car therefore offers all the options for varying the concepts depending on whether the model is a sports car or a fuel-efficient city vehicle, whether it is a GTI or a BlueMotion. This is definitely one method of creating a completely new vehicle structure for autonomous driving. Once the concepts are in place, we can respond flexibly to any requirement using modular designs. Good lightweight design can be easily integrated and also helps to reduce costs. ■

*The interviewer was Gudrun Remmlinger.*



# CARBON CARRIER

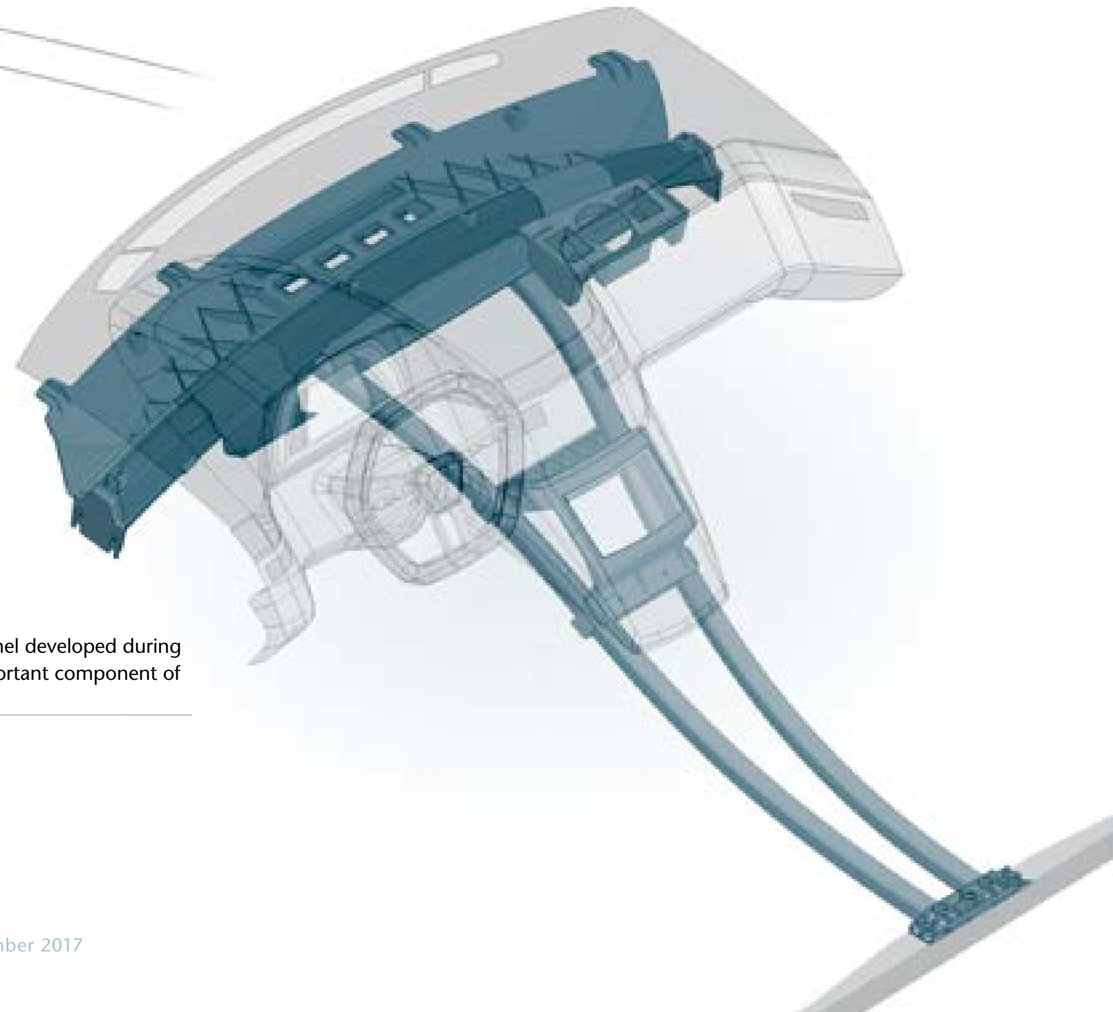
INNOVATIVE VEHICLE STRUCTURES BASED ON LIGHTWEIGHT FIBRE COMPOSITES AND FUNCTIONAL INTEGRATION

As a result of its development activities, Bertrandt has extensive experience of lightweight design. The company's specialists can recommend materials and technologies for specific applications and requirements and these can then be taken into consideration during the development process. Different industries and different manufacturers in the automotive sector have varying approaches to design, materials and processing methods. Other important differences include production volumes, sales prices, the proportion of in-house manufacturing and the use of assemblies, modules and common parts strategies across different models.

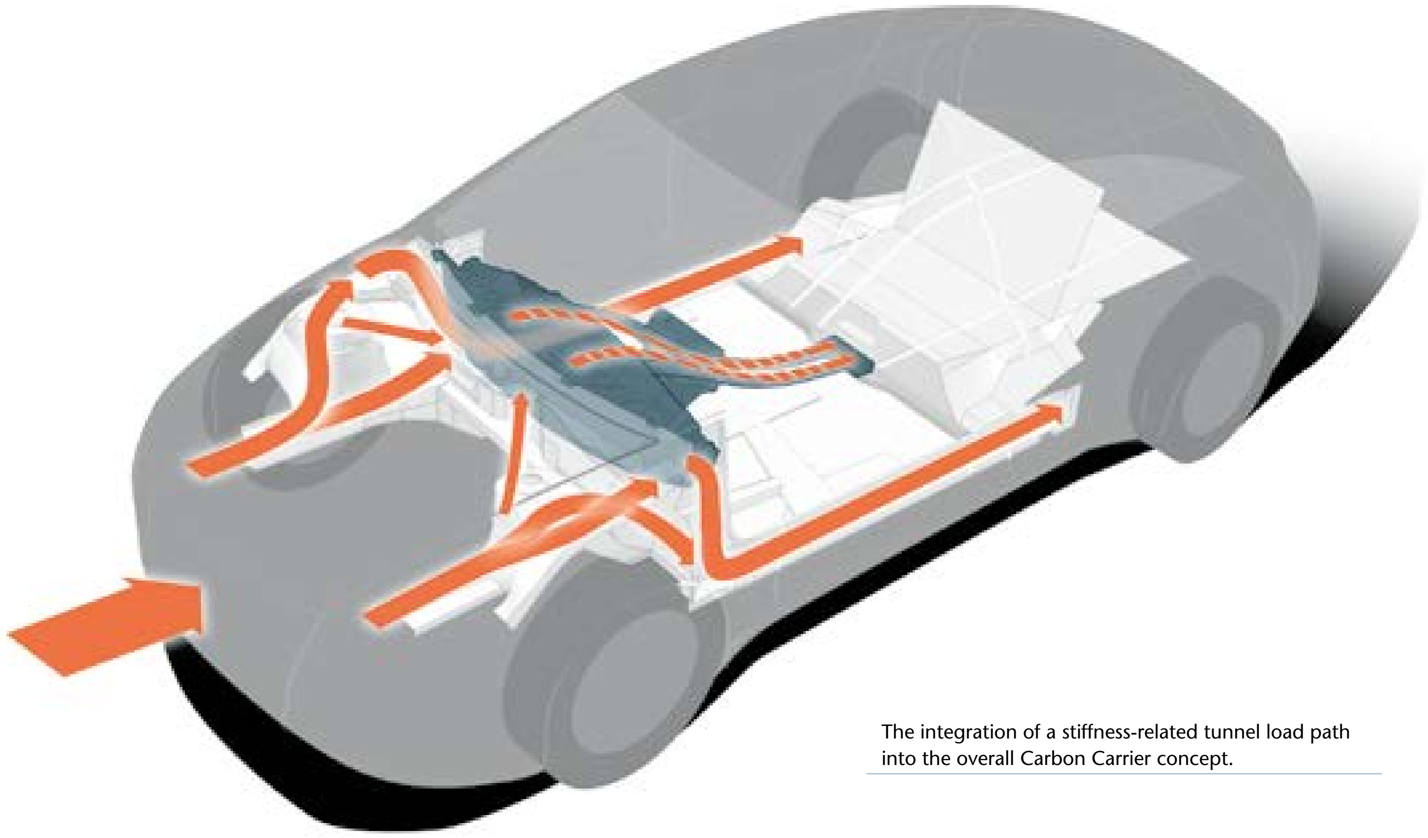


In the field of body development, the preferred materials are high and super-high strength steels and, depending on the manufacturer, increasingly also aluminium and magnesium alloys. Cast parts, sections and body panels are made from these materials. Fibre-reinforced plastics are less commonly used than steel and aluminium. The exceptions include specific well-known manufacturers who make large-scale use of CFRP and the sports car segment. Interior components are often manufactured from short-fibre reinforced materials.

Lightweight structural components in the aviation industry are made either from metals, such as aluminium, magnesium and titanium, or from plastics and, in particular, carbon-fibre reinforced materials (CFRP). The team at Bertrandt's Hamburg site has wide-ranging experience of designing and developing CFRP components. In addition, the Bertrandt Group as a whole has increased its expertise in manufacturing and testing prototypes made from CFRP over recent years. >



Carbon Carrier: the instrument panel developed during the course of the project is an important component of the body structure.



The integration of a stiffness-related tunnel load path into the overall Carbon Carrier concept.

> The instrument panel frame with its intelligent mix of materials makes an ideal subassembly.

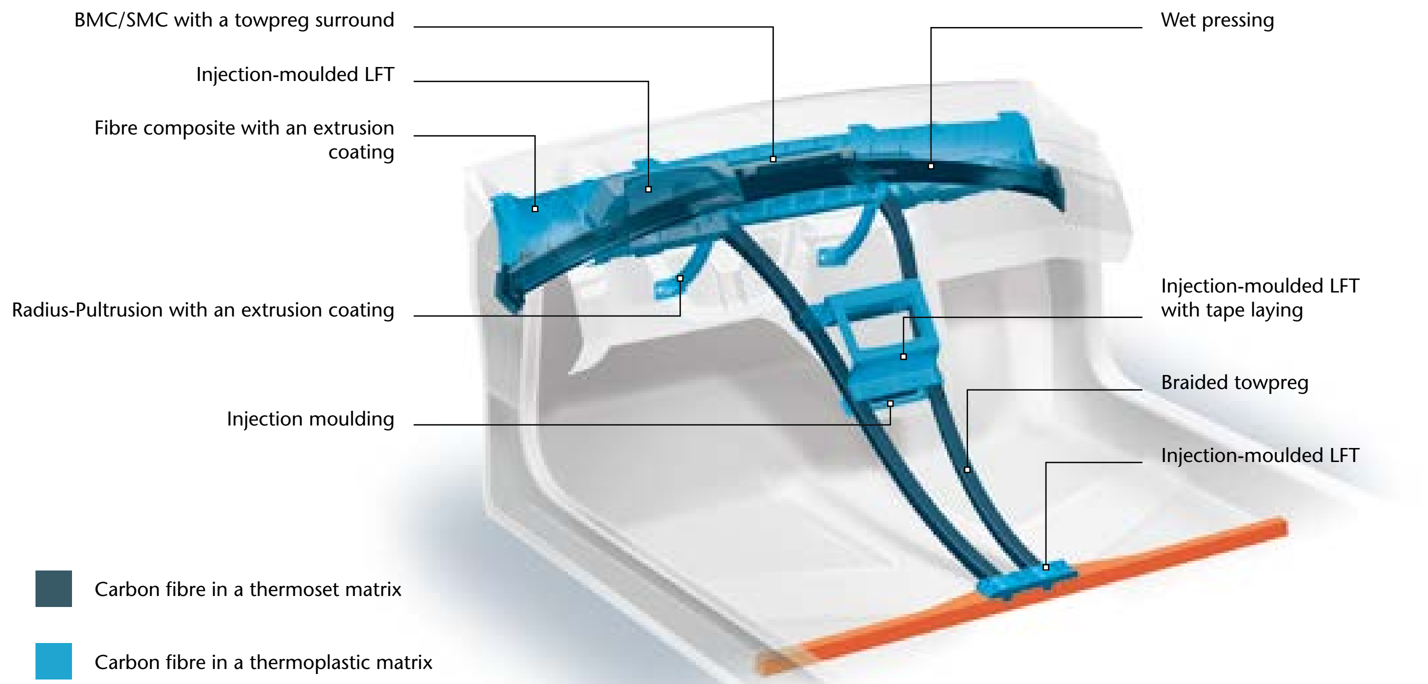
In the case of fibre-reinforced composite materials such as CFRP, the properties and the cost of components depend to a large extent on the process used and the composition of the material, for example whether thermosetting plastics or thermoplastics are used as the matrix and the length, direction and proportion by volume of the fibres, together with the number of layers and the type of semi-finished product. With the aim of expanding its skills in the field of vehicle structures, Bertrandt has set up a bilateral technology product together with the SGL Group, a global company in the field of composite materials and fibre production. The objective is to combine Bertrandt's vehicle development expertise with the materials and technology competence of the SGL Group and to develop a technology demonstrator. Work on the project began in October 2016 after a cooperation agreement was signed.
The project is based on a vehicle developed internally by Bertrandt which is available as a CAD model and will be used to provide a package for the technology demonstrator. Two variants of the vehicle are available with different powertrains – conventional and fully electric – that will allow different stresses and load paths to be investigated.



## The assembly

An important assembly in a vehicle body is the frame of the instrument panel, which is one of three structural components that are bolted to the body. It also represents an ideal introduction to automotive manufacturing in the form of a subassembly with an intelligent mix of materials. This makes it possible to introduce new materials into the vehicle and, at the same time, to continue using large parts of existing production lines without major changes. The resulting findings can later be applied to other areas of the vehicle.
The instrument panel frame, which is made primarily from carbon fibre, represents a new concept for integrating a number of different functions. The new frame is intended to perform the functions of the current instrument panel, instrument panel frame and centre console. A unique feature of the new component is the integration into the overall Carbon Carrier concept of a stiffness-related tunnel load path.

This new Carbon Carrier (CC) will demonstrate the potential of new structural components when used in convertibles and coupés, for example, and in particular those with electric powertrains. This is based on the principle that the convertible and coupé body variants need to compensate for the lower levels of stiffness that result from the introduction of new requirements, such as a level floor for the battery package. In order for the Carbon Carrier to provide support in this area, its structures and its connections to the vehicle body need to be redesigned. A significant improvement in its bending stiffness can be achieved by means of a brace on the bulkhead that can extend as far as the heelboard.
The Carbon Carrier can support all the other instrument panel components and take their requirements into account. It replaces the conventional module cross beam in the body-in-white, the instrument panel frame and the tunnel, including all the relevant functions. >




Carbon fibre in a thermoset matrix
Carbon fibre in a thermoplastic matrix
Cast aluminium

The configuration of the matrix and fibre materials, the fibre length, proportion and orientation and the layer structure and technology for each complex fibre composite component.

> The ongoing detailed development process required close cooperation between the simulation, design and production teams.

## The development process

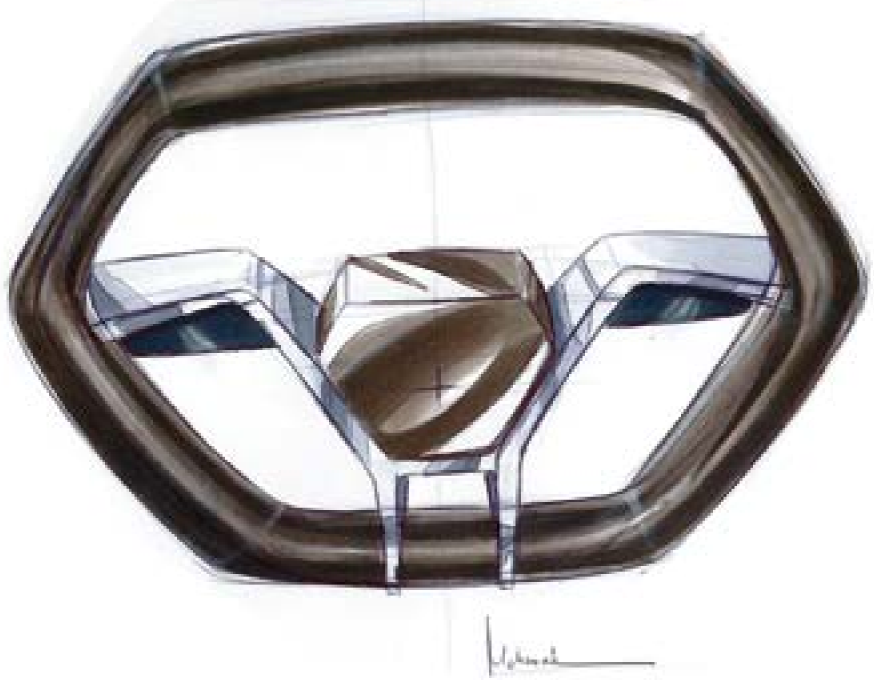
During the initial phase of the project, a functional package model was developed for the interior of the front of a convertible or coupé on the basis of a non-proprietary body design created in-house by Bertrandt. It includes all the important functional and trim-related components of a conventional instrument panel, but with a new and attractive design. For example, the driver will be able to see the central load paths and the CFRP components, despite the fact that no purely decorative, exposed carbon fibre elements have been used. Because of Bertrandt's many years of experience of automotive development, it was possible to develop and integrate the relevant functional components without links to a specific manufacturer.

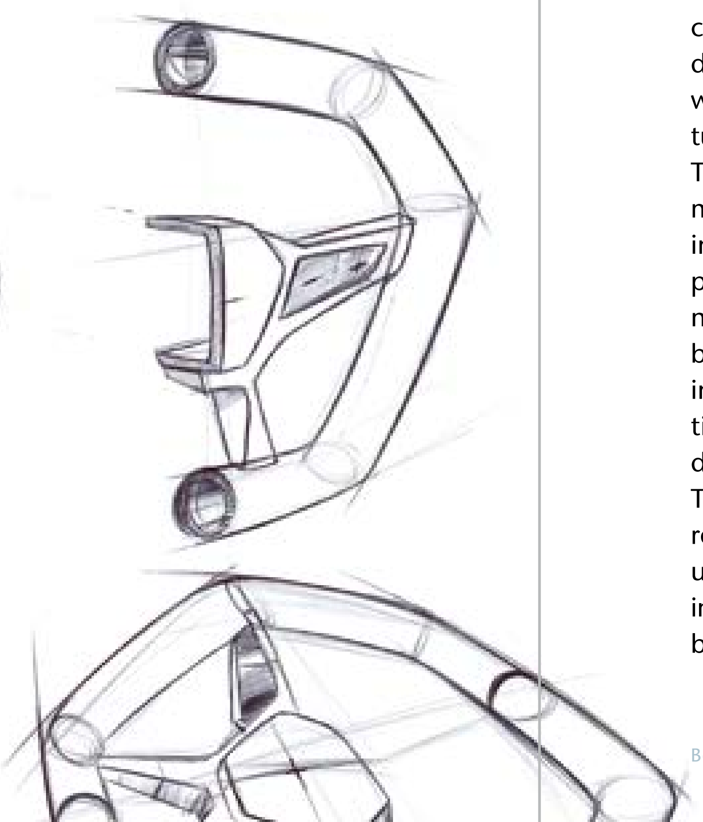
The main supporting structures were defined on the basis of this initial package model. Because the design, simulation and technology specialists at the various Bertrandt sites are used to working closely together, they were able to transform the wide variety of early sketches into a refined 3D concept very quickly.

At the same time, design sketches were created and turned into a new surface design for this area of the interior together with the package model. The design of the structural components gave the interior a more open, light and airy atmosphere, with sharp curves and innovative details to create the feel of a sporty electric car.

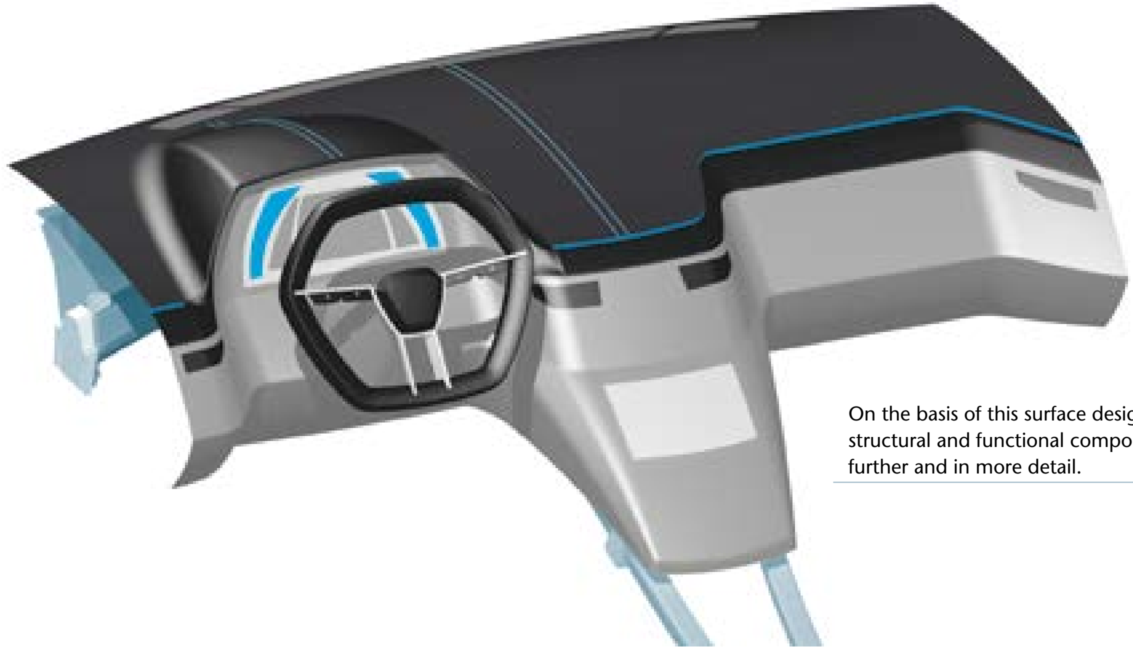
On the basis of this surface design framework, the structural and functional components were developed further and in more detail. The biggest challenge was to identify the configuration of the matrix and fibre materials, the fibre length, proportion and orientation, and the layer structure and technology for each complex fibre composite component that represented the ideal compromise between the various requirements and constraints.

Other considerations included internal and external connecting and joining methods for









On the basis of this surface design framework, the structural and functional components were developed further and in more detail.

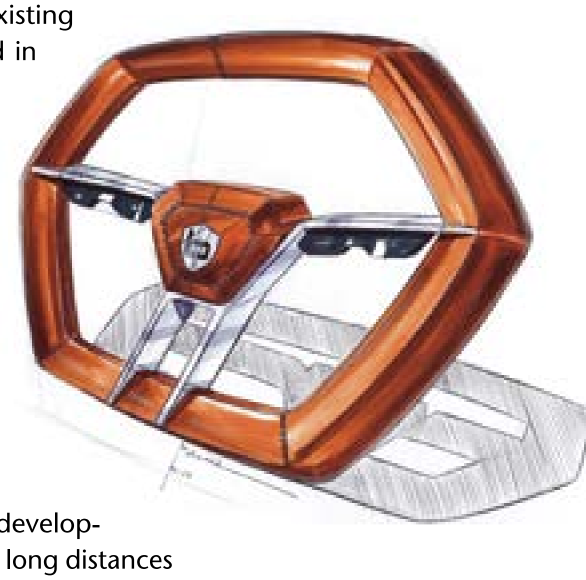
the individual parts, together with the production and assembly conditions. These had to be determined on the basis of visibility, stresses, the selection of materials and the sequence of joining processes.

The laminate structure was defined in a comprehensive set of specifications that incorporated legislative and consumer protection requirements. The factors that determine the size of the load-bearing structural components of the Carbon Carrier include misuse load cases, vibration behaviour and, most importantly, the forces specified in the crash load cases. The laminate structure was designed and the rib patterns were refined with the aim of creating a lightweight structure that could be easily manufactured.

The CATIA V5 Composite Part Design (CPD) module that is used at Bertrandt for designing fibre composite components made it possible to include the laminate in the CAD model. The tool enabled the transitions between the different areas to be designed in detail and allowed for clear and effective communication with the production department.

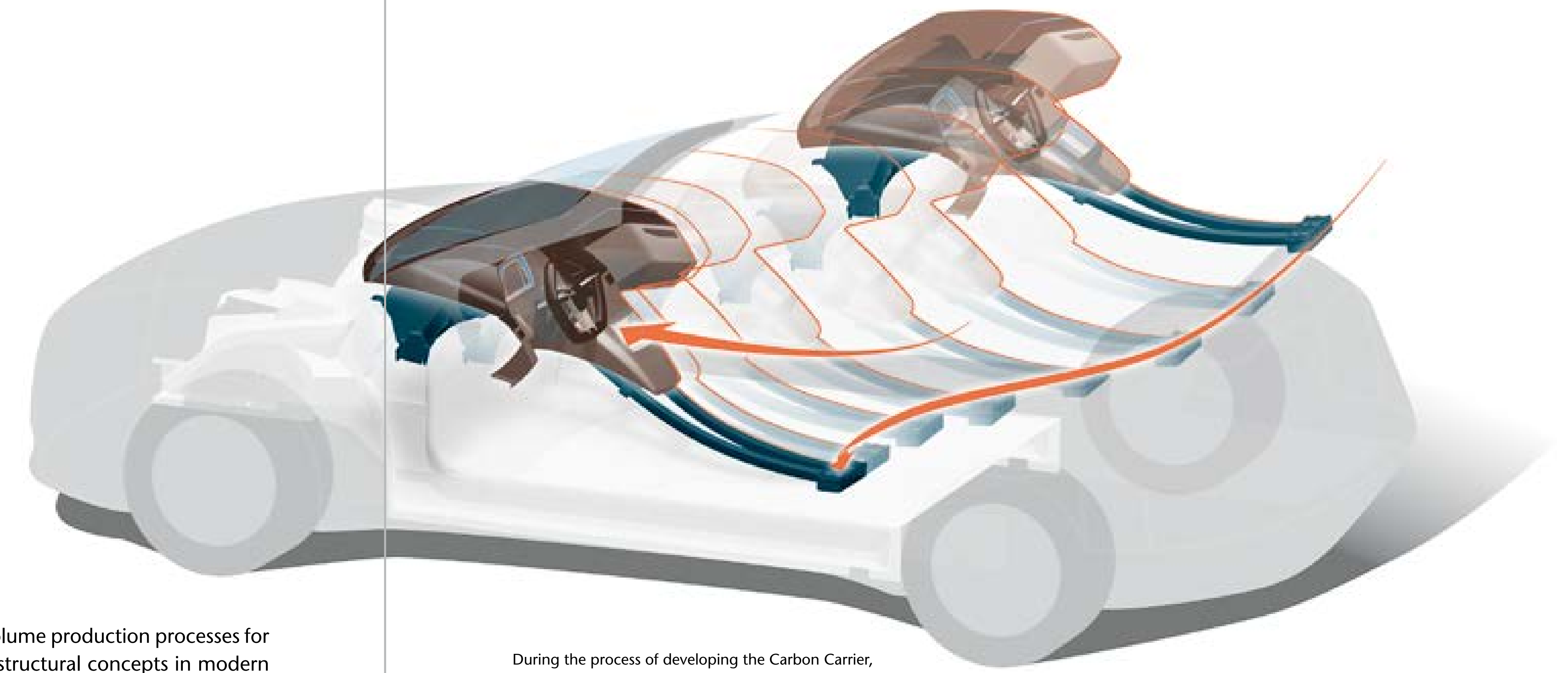
The ongoing detailed development process required close cooperation between the simulation, design and production teams. An interface developed by Bertrandt that enabled the CPD data to be transferred directly into the FE model saved a large amount of valuable time.

In dynamic simulation tools, fibre composites have a much more complex, multi-layered definition than traditional materials. These material definitions depend heavily on the type of process and the materials used and therefore cannot easily be transferred from one manufacturer of materials or semi-finished products to another. For this reason, SGL's existing material cards were used in some cases in the simulation process. However, hardware tests were also carried out using pre-defined samples in order to identify the analysis parameters.



The development departments of Bertrandt and SGL worked closely together throughout the entire development period. Despite the long distances between the teams, the in-depth cooperation was made possible by means of regular meetings at the development sites in Meitingen, Wolfsburg and Rüsselsheim and frequent telephone and video conferences. >

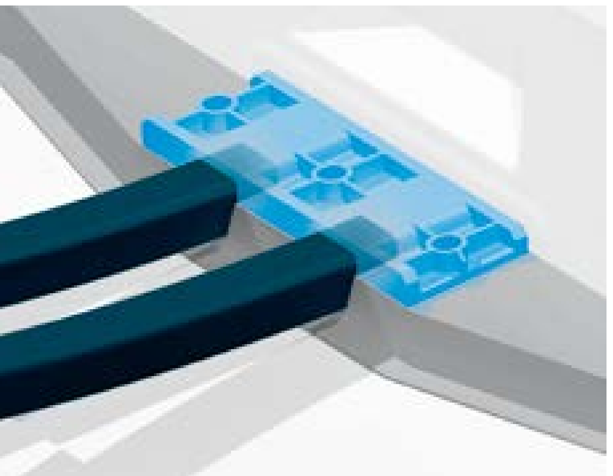
"During the development of the Carbon Carrier, the focus was on the component's suitability for large-scale production."



During the process of developing the Carbon Carrier, the engineers focused on ensuring that the materials, technologies and assembly concepts would be suitable for volume production either now or in the near future.

### Production

During the process of developing the Carbon Carrier, the engineers focused on ensuring that the materials, technologies and assembly concepts would be suitable for volume production either now or in the near future. In addition, the latest results of research and pre-development activities at SGL, Bertrandt and other research institutions were included in the process. One example is the elements used for joining panels made from fibre composite and metal that are currently being investigated at the universities of Braunschweig and Magdeburg.



Innovative solutions for joining components: connecting the side rail to the heelboard.

### Conclusion

A highly innovative test structure with the potential for volume production has been developed by the SGL Group and Bertrandt working in close cooperation. It demonstrates how new structures can be incorporated into modern vehicle concepts. Both organisations have enhanced their knowledge of the volume production processes for new types of structural concepts in modern vehicle bodies, starting with the initial idea and the pre-development activities and also including the design and the close interaction between CAD, CAE and production. This knowledge has been put into practice in a demonstrator that can be used by both companies to illustrate the different challenges and approaches involved in the increased use of fibre composites in the structure of vehicles. The newly developed component has excellent structural properties and a pleasing aesthetic appearance. It also forms the basis for the use of other combinations of materials and technologies.
The Carbon Carrier is an innovative, integrated concept for use in interior structures that can be presented to large-scale vehicle manufacturers and producers of niche models and incorporated into their vehicle concepts. SGL and Bertrandt regard the new structural component as an opportunity for working with users and end customers to increase their understanding of the use and behaviour of fibre reinforced plastics and, in particular, CFRP. It will also allow more sophisticated components and systems to be designed specifically for these materials. In addition, both companies gained valuable new experience for use in current and future projects. ■

*Michael Hage, BPG*

**SGL GROUP**
THE CARBON COMPANY

**The SGL Group** is one of the world's leading manufacturers of carbon-based products. The company has comprehensive knowledge of raw materials, sophisticated manufacturing processes, many years' experience of applications and engineering and a wide-ranging portfolio of carbon, graphite and carbon fibre products.
Together with its customers, the company develops customised solutions for the automotive industry in its Lightweight and Application Centre in Meitingen, making use of its extensive range of materials and its process expertise throughout the entire fibre composite value chain.

http://www.sglgroup.com

**Thermoset material toolbox**

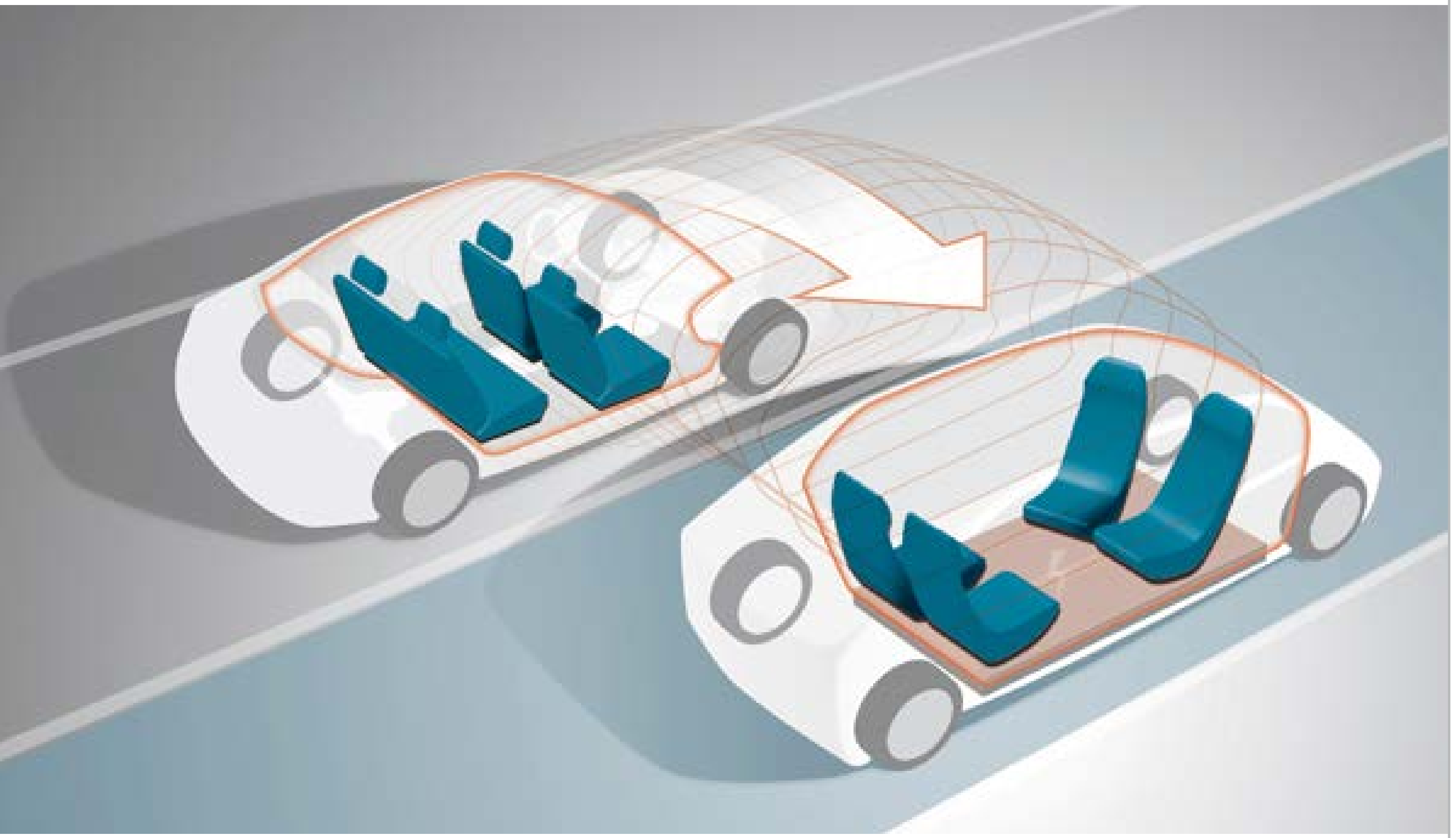
- Curing time: 30 s/mm at T > 150 °C
- Storage at room temperature: 4 weeks, $T_g$: 140 °C
- Epoxy snape-cure resin system
- With internal release agent if required

Prepreg materials
TowPregs
Pre-impregnated carbon fiber non-wovens
Stacks

**Thermoplastic material toolbox**

- Customized sizing solutions
- Various semi-finished materials as a toolbox approach
- Carbon and glass fiber-based

Organo sheets
UD tapes
LFT materials
Laminates



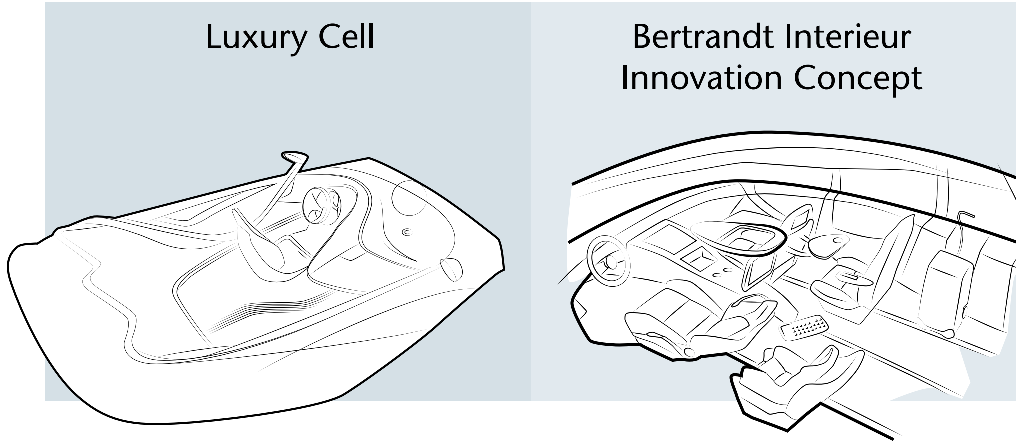
# THE INTERIOR OF THE FUTURE

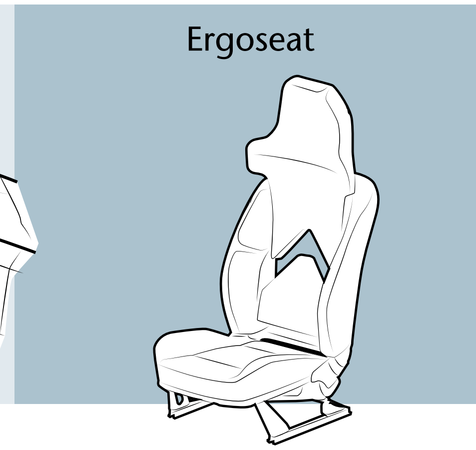
NEW FUNCTIONALITY FOR AUTONOMOUS DRIVING

Against the background of the emergence of autonomous driving, the automotive industry is increasingly focusing on the vehicle interior of the future. The shift from driver assistance systems to highly or fully automated cars will mean that changes are needed in the interior of vehicles and that new options are available. The interior will become our "third living space" alongside our homes and workplaces. This addition to our living space leads to the requirement for new functionality in the interior of our cars in areas such as information, entertainment and comfort. Vehicle safety functions will also influence the design of the interior as we move towards autonomous driving.



> The interior will become the third living space.




## Based on in-house concepts

Bertrandt has been developing its own interior concepts for several years and they represent interesting starting points for autonomous driving. The "Luxury Cell" concept demonstrated the interior design process from the initial sketch to the final result. The emphasis was on enabling vehicle occupants to work, as well as on creating a third living space. The interior has been designed on the basis of lounge concepts.
The "Bertrandt Interior Innovation Concept" concentrated on integrating devices not normally found in vehicles. Using a vehicle with minimalist equipment, different types of uses, including business, sport and family, were evaluated as part of the development of the concept. These approaches could be applied to the car sharing schemes of the future.
The objective of developing several variants of the Ergoseat was to create a seat which could be adjusted to suit a wide range of occupants from the 5th percentile to the 95th percentile, while also taking into consideration ergonomic, comfort and safety criteria. An integrated safety belt solution was also developed with a larger number of functions and, at the same time, a lower level of complexity. >

New solutions are needed for the air conditioning system, in particular with regard to the positioning of the vents.

The vehicle interior of the future will allow displays to be placed in new locations. The windows will become a key feature of the interior when they are used to display information.

The safety levels of autonomous driving will be very similar to current levels. The focus is likely to be on a safety belt system that is integrated into the seat, together with airbags and appropriate sensors.

## New approaches to air conditioning

The air conditioned roofliner concept provides air conditioning for the vehicle interior by diffusing cooled air over the roofliner. Hoses in the interior that are filled with a brine solution provide additional cooling by making use of the physical properties of the vehicle. This allows the air flow from the traditional air vents to be reduced.

## Adapting the development process

In order to accommodate the dynamics of autonomous driving and the hardware-related changes, Bertrandt is focusing on the requirements that face the development process and the tools it uses. In this area, virtual tools are becoming increasingly important. Using a demonstrator, our strategy is to design the HMI (human-machine interface) in interaction with the remainder of the vehicle interior. The objective is to enhance existing development methods and tools. The demonstrator will enable people to experience autonomous driving in a flexible environment and can be used as a platform for sharing information with manufacturers and system suppliers. The aim of bringing together virtual and augmented reality and real-life hardware environments is to reduce the complexity of the systems over time during the development process.

## An interior for autonomous cars

In the context of highly automated driving, the interior must generate confidence in the autonomous functions of the car and give the occupants a feeling of well-being and security. It must also guarantee their safety, the availability of information about the status of the vehicle and maximum comfort in any seating position. In addition, it must safely transfer responsibility for driving to the driver if required. As a result, the occupants will be able to make the best possible use of their time for work, relaxation or entertainment. This means that the focus is increasingly on the interior, which becomes an important purchase criterion.

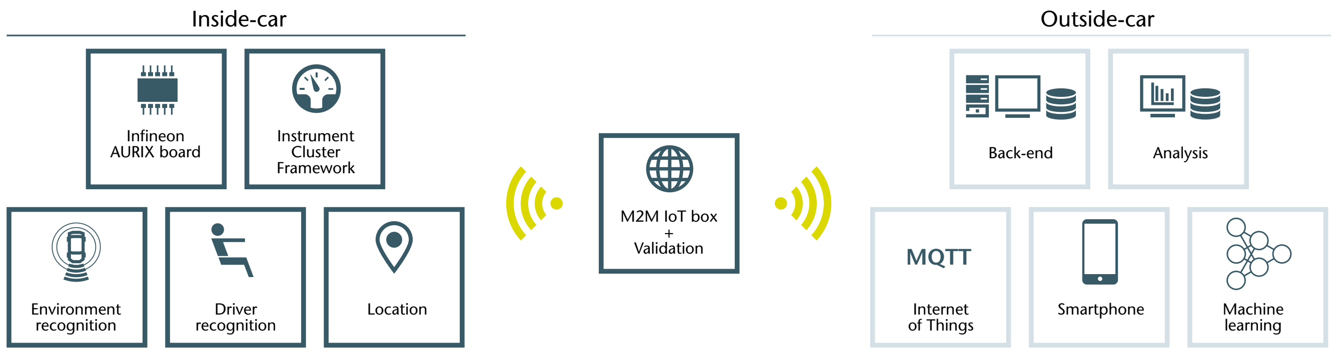
Bertrandt's objective is to continue developing its interior concepts and to provide its partners and customers with new starting points for their future developments. ■

*Dirk Zimmer, Ingolstadt/Neckarsulm*

# PAVING THE WAY FOR AUTONOMOUS DRIVING

TECHNOLOGICAL DEVELOPMENTS IN VEHICLES AND IN THE CLOUD

The b.competent 2.0 innovation project is Bertrandt's response to the latest challenges presented by connected vehicles and autonomous driving. It treats the vehicle as a sensor in the IoT (Internet of Things).




This internal, non-customer-related project has its origins in the concept of increasing the acceptance of driver assistance systems. The key consideration is driver adaptation, which means that the assistance system adapts itself to the driving style of the person behind the wheel. First of all, the vehicle analyses their driving style and then the assistance system adapts to it. This allows the system to behave in a similar way to the driver. This form of adaptation is called short-term learning and covers one driving cycle from the engine being started to the ignition being switched off. This means that external structures are needed to collect and analyse the data. Long-lasting results and, therefore, a genuine adaptation to the driver, which is referred to as long-term learning, can only be achieved by permanent data storage in back-end and database structures.

## Two areas: inside-car and outside-car

For this reason, b.competent covers a range of different factors. They include the ongoing development of driver assistance systems, sensor fusion and multicore processing in the vehicle (inside-car), together with information sharing with external entities via the mobile data network and the analysis of the data that has been collected (outside-car). It is not only the flow of data from the car that is crucial, but also bidirectional communication. Only analyses carried out on the back-end server will be able to produce recommendations for action that can be sent back to the car. Machine learning with a neural network is used for these processes. Where large volumes of data are generated (by cameras or lidar for example), the mobile data network reaches its performance limits. This is why these processes are also used in the vehicle itself to reduce the bandwidth required and to make the car's behaviour less dependent on the availability of a data connection.

## Implementation in the vehicle and charging management

M2M gateways (machine-to-machine communication) and software components have been installed on high-performance multicore hardware (tricore processors) in a specially equipped vehicle for demonstration purposes. The MQTT (message queue telemetry transport) protocol is used to transfer the vehicle data via the M2M gateways to the back-end. Web-based services (front-ends) and an app for back-end data allow selected data to be visualised. Using a dynamic signal manager, the signals themselves can be configured. Bertrandt's in-house Instrument Cluster Framework (ICF), a flexible prototyping HMI, is installed in the vehicle as a programmable instrument panel.
This agile development environment makes it possible to access current applications quickly. For example, an in-house prototype of a connected, intelligent charging station has been incorporated into the Bertrandt cloud. This accepts the customer's requests to charge the vehicle and allows the required departure time to be specified. The charging station then receives the charging plan based on the customer's requirements. This plan can be further refined on the basis of weather forecasts and data from the energy exchange to allow the car to be charged at times when the electricity price is lower.

## Connecting different areas for successful autonomous driving

The inside-car and outside-car areas are very closely connected. It is not only technologies and models inside the vehicle that will pave the way for highly automated driving, but also other smart and connected vehicles. These technologies can also be transferred to other industries for use in their business models.

*Felizitas Hausner, Stefan Maier, Regensburg*

# DESIGNING VEHICLES USING PLASTICS

THE 4A IMPETUS SYSTEM IDENTIFIES THE REQUIREMENTS FOR LIGHTWEIGHT MATERIALS IN CRASH SIMULATIONS

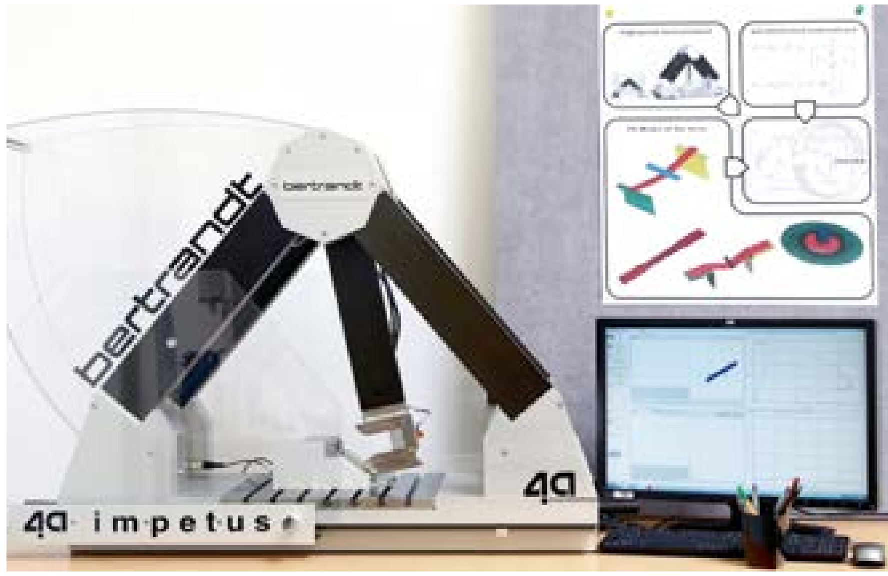
Legislation relating to the safety of vehicle occupants and pedestrians in the event of road accidents is becoming increasingly stringent, together with consumer protection regulations and vehicle manufacturers' specifications. At the same time, the requirements for reducing vehicles' $CO_2$ emissions and the use of resources during their production are also being tightened up. As a result, the forecasts produced by numerical simulations, which are run during the early phases of a vehicle development project, have to be increasingly accurate.



The quality of the simulation results depends heavily on the mathematical modelling of the physical properties of the materials and the corresponding material data. The data needed for modelling purposes is stored in material cards. In crash simulations, these include non-linear stress-strain curves that are dependent on the deformation speed. In the field of occupant and pedestrian protection, it is particularly important that the mechanical behaviour of plastic components is reproduced as precisely as possible.

The mechanical properties of polymers are also determined by the manufacturing process of the component. This can result in the same material having different characteristics in prototypes and in production parts. In many cases this can have a serious impact on the behaviour of the component, which means that the material cards need to be modified.

If there are discrepancies in the material behaviour of a component between simulation and testing, the simulation should first be validated on the basis of the test results, before the design process for the component is continued. This approach, which is known as reverse engineering, involves varying individual parameters of the material card iteratively to achieve a better correspondence with the results of the test. This process is very time-consuming and does not always achieve the required results, because a number of different factors can influence the measurements made in crash tests.




4a impetus: a complete system for generating valid material data for simulation purposes.

## 4a impetus guarantees that the material data is valid

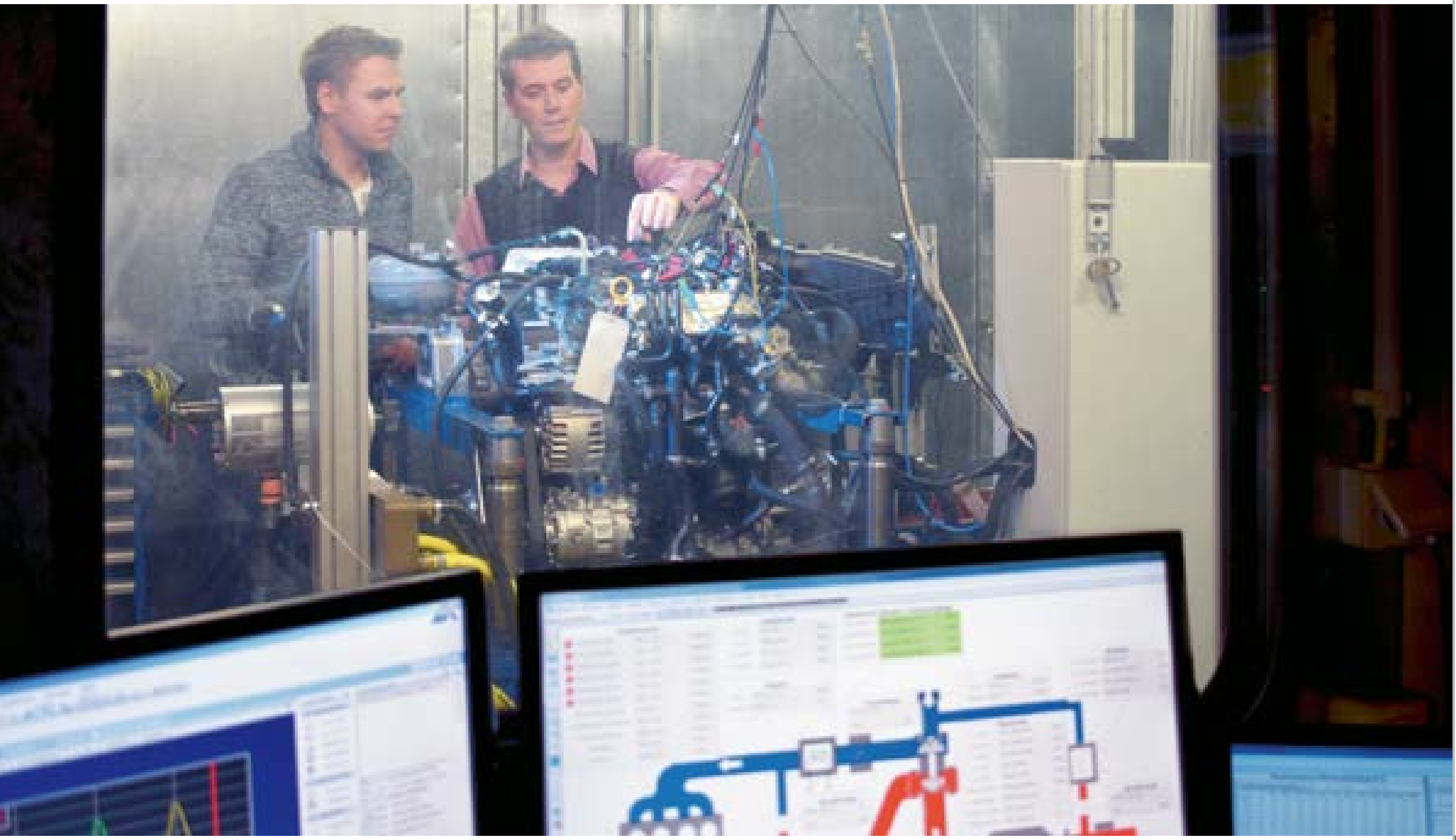
For this reason, since April Bertrandt has been using the 4a impetus system to generate strain-rate-related material data. This allows us to accelerate and improve the validation process and increase the quality of the forecasts from crash simulations.

4a impetus produces automatic characterisations of dynamically loaded material samples and components. It is the first test system in the world that includes a process for creating validated material cards. It has been specifically developed to characterise plastic materials and is based on a pendulum in which all the moving parts have the optimum stiffness and vibration behaviour.

Many common material models for different simulation solvers are included in 4a impetus. This enables application-related material cards of different levels of complexity to be produced, which range from the elastic and plastic material behaviour with von Mises plasticity through to complex, strain-rate-dependent, asymmetrical material models that take failure criteria into consideration.

The investment in 4a impetus adds the finishing touch to Bertrandt's range of crash simulation services at its Ingolstadt site. The system sets a new standard for generating validated material cards for dynamic simulations in all areas.

*Peter Malisi, Norman Lämmler, Ingolstadt*



# NEW TEST BENCH FOR INTERNAL COMBUSTION ENGINES

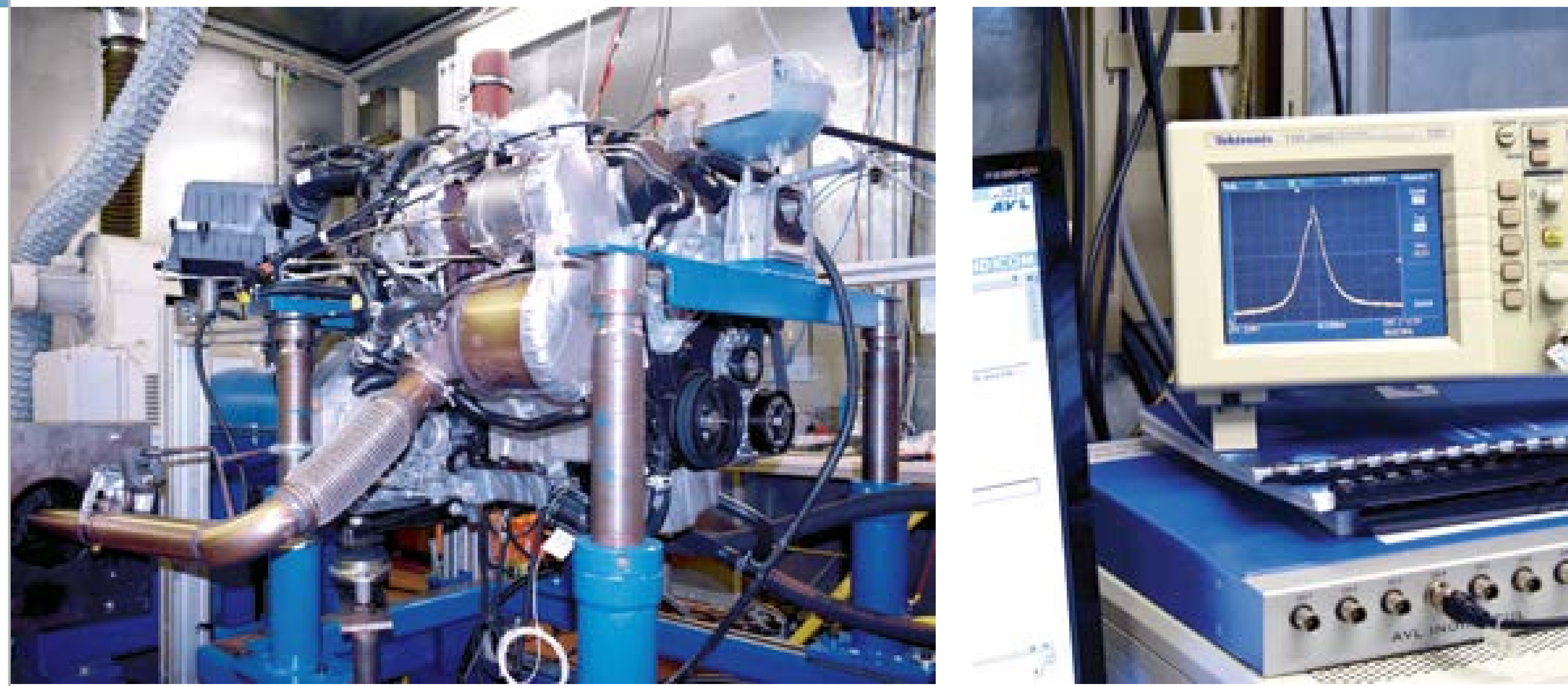
## COOPERATING ON RESEARCH WITH THE LEIBNIZ UNIVERSITY OF HANOVER

Internal combustion engines remain the most common type of powertrain. They are widely used in cars and commercial vehicles, for offshore and off-highway applications and as stationary engines. The standards that combustion engines are required to meet are undergoing a period of change and will become more stringent in future. In addition, the growing electrification of powertrains is likely to lead in the medium-term to an increase in hybridisation, in other words, combining a combustion engine with an electric drive motor. Furthermore, developers are introducing a wide range of measures to reduce both emissions and fuel consumption.



The development of combustion engines is a highly time-consuming and complex process as a result of the number of parameters involved and the increasingly stringent requirements of the Real Driving Emissions test (RDE) and the Worldwide Harmonised Light Vehicles Test Procedure (WLTP), for example. If you add the need for the combustion engine and the electric motor to interact without problems, the amount of work involved is even greater.
On the one hand, combustion engines will continue to play a dominant role in the global economy over decades to come as the demand for mobility grows. On the other, the work involved in the testing, application and certification of these engines is likely to go on increasing.
For this reason, Bertrandt has entered into a cooperative research agreement with the Institute of Technical Combustion at the Leibniz University of Hanover, which has involved constructing a test bench for combustion engines. As well as allowing pollutant emission levels to be evaluated and other common measurements to be made, the test rig also offers a state-of-the-art environment for control units and applications and an automation system.
The objectives of the cooperation include the preliminary development and testing of application processes, which can then be transferred to customers' use cases. The test bench is also available for Bertrandt's own research projects. One of the first areas to be evaluated is b.eco, a new approach involving the efficient calibration of combustion engines that was recently presented at the SAE International Powertrains, Fuels and Lubricants Meeting.

*Dr Hubertus Ulmer, Wolfsburg*



Recording engine and measurement data at Bertrandt: detailed perspectives.

# FROM INDIVIDUAL SYSTEMS TO ONE ALL-EMBRACING PROJECT

## RUNNING A LARGER NUMBER OF TESTS ON MORE COMPLEX SYSTEMS IN A SHORTER TIME

Networked functions and interconnected systems in vehicles are becoming increasingly complicated, but Bertrandt can link together the individual areas to create one complete and comprehensive project. This may sound simple, but it requires a great deal of innovative ability. The same applies to electronic systems in cars.
Tests are carried out on a number of levels to validate the functions. Software-in-the-loop (SiL), model-in-the-loop (MiL) and hardware-in-the-loop (HiL) methods are used to evaluate functionality ranging from individual software packages up to complete systems.

Our engineers offer the full spectrum of services, including drawing up the test specifications, automating the testing process and running and analysing the tests. Investigations are carried out to ensure that all the control units are performing the required function correctly. For example, in the event of an accident the crash sensors must react and the appropriate airbag must be triggered. If these functions are tested by crashing a real vehicle, it will inevitably be badly damaged and, as a result, will have to be replaced. In an HiL test, the components are simulated, which means that the test can be run as many times as necessary and different scenarios can be evaluated.
In today's vehicles, the crash sensors not only trigger the airbags, but also call the emergency services, close the windows and switch on the hazard lights. The result of this is that a number of small local systems are linked together across several components to form a network. An HiL test system covering a networked system of this kind across several control units would be very large and highly complex. A huge amount of work would be involved in developing it and the necessary tests could not be completed in the time available.
This is precisely where Bertrandt's innovative approach comes in. We use several small test systems that allow us to evaluate in-depth and in parallel all the subsystems that are less closely networked. However, if an entire vehicle system has to be validated, for example in relation to a crash, the individual HiL test systems can be linked together to form a complete whole. This allows networked vehicle systems to be fully tested with all the relevant control units. It is no longer necessary to simulate certain sections or to interrupt the chain of effects.
However, this is not as simple as it sounds. The key is to find the balance between creating small, local HiL systems in order to obtain results quickly and covering as many areas of testing as possible at the same time. Our specialists have extensive experience and can develop test systems quickly with specific customers' needs in mind. During the subsequent customisation process, our engineers focus on keeping to a minimum the overall cost and the time required. A few years ago, a period of almost twelve weeks was available between the delivery of the software to be tested and the handover of the results. This has now been reduced to only six weeks. In order to increase the maturity level of the

software in time for the next development cycle and to reduce the development time needed, 75percent of the test cases are run and analysed within the first ten days. The challenge here lies in the large number of test cases, which in the case of the vehicle functions in modern model ranges can amount to as many as 30,000. It is now possible to test the full chain of effects of a complex system in a short time and without interruptions. Bertrandt's innovative solution has led to more in-depth, wide-ranging tests over a shorter period, which increases the quality of the test results.
The constant increases in the standards required by car manufacturers have led Bertrandt to consistently expand and enhance its testing methods. This innovative concept ensures that it is well equipped to meet new challenges in the field of HiL testing.

*Christoph Schelhammer, Alexander Merkel, Ehningen*

# BERTRANDT WORLD

Bertrandt Group

## ELECTRIC TRANSPORT SOLUTIONS FOR THE FUTURE

Bertrandt has been part of the "Elektromobilität Süd-West" (electric mobility south-west) cluster since December 2016. This network of businesses, academic and research institutions and public bodies, which is organised by the innovation agency of the German state of Baden-Württemberg (e-mobil BW), intends to drive the technology transformation that will lead to the introduction of electric mobility. Energy companies, well-known car manufacturers, suppliers, research bodies and local authorities are all working together to develop electric transport solutions for the future. Each of the participants is contributing specialist knowledge to the network. This will allow them to learn to manage the complete system for electric mobility from a technological perspective and to help establish it. As a development specialist and long-term partner of the automotive industry, Bertrandt is involved in many projects relating to environmentally friendly transport and connected driving, including alternative drive systems, lightweight components and new interior concepts. At the network's events, Bertrandt is able to provide in-depth technical expertise.
The goal of e-mobil BW is to launch new research projects in areas such as the development of electric vehicles suitable for mass production, manufacturing facilities for batteries and electric motors, charging technologies and systems for networking traffic. The wide-ranging knowledge of the organisations involved will allow new ideas to be developed and implemented. In addition, the innovation agency is coordinating a number of support programmes with a focus on cars, energy, information and communication technology, and production. ■

Bertrandt Group

## PROMOTING STEM SUBJECTS

Bertrandt is supporting the NAT (science and technology) initiative in Hamburg, which is working to encourage more young people to study STEM subjects. For example, it offers an early, practical introduction to the field to help young people to choose a profession or a degree course. They have the chance to find out about the industries and jobs where scientific knowledge plays an important role. By making contact with people working in the fields of business and science, they discover the opportunities that the STEM subjects (science, technology, engineering and maths) can offer them. ■



Wolfsburg

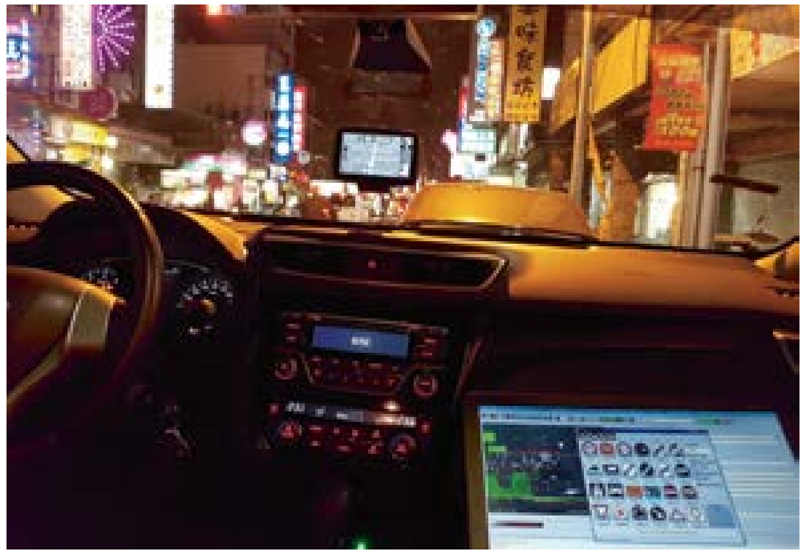
## EXTENSION TO THE MATERIAL TESTING LAB

Cars have to meet high standards of quality, but not only in terms of their performance and external appearance. The design of the interior is also important and has to comply with increasingly stringent safety requirements. This is why the specialists in Bertrandt's testing department evaluate the stability and structure of components, together with their functionality and ease of assembly. The laboratory at the company's Tappenbeck site near Wolfsburg has been extended to enable it to continue conducting in-depth tests of materials in future.
Bertrandt has constructed its own antistatic test bench for the first time, so that it can help customers to choose the best possible material for each application. A number of surface test benches and colour and gloss measurement systems have now been added to the test facilities. Chemical analyses and mechanical tests are currently carried out in other areas of the site. Here the tensile and pressure properties, the flammability and the thermal characteristics of the materials are measured. In addition, a new test chamber for components and complete vehicles is planned, which will allow the emission behaviour of individual parts and entire vehicles to be analysed. ■

Testing

## EN ROUTE TO AUTONOMOUS DRIVING

The teams from the endurance testing department in Munich overcame with style all the challenges that faced them, including the worst winter weather for decades in Sweden, journeys through the deserts of the United Arab Emirates and trips into the wilds of Australia and New Zealand. Three teams of two people were on the road during a period of almost five months collecting, labelling and validating training data for traffic sign recognition throughout the world. Country-specific data is imported into the functions of driver assistance systems using a fast tracking process to allow them to recognise traffic signs in every country. The driving profile includes motorways, main roads and city streets. Around 60 percent of the journeys took place in daylight and 40 percent at dusk or at night.
Driver assistance systems represent the key to autonomous driving. ■



Cologne

# A VERSATILE TESTING FACILITY


## COMPLETE DEVELOPMENTS FOR A MOBILE WORLD

Bertrandt's Cologne site was established in 1993. Alongside the development of door modules, lock systems, complete interior fittings and headlamp and bumper systems, the site's portfolio of services includes developing body-in-white, engine, gearbox, chassis and electronic systems, plus simulation. Bertrandt Cologne expanded its testing services in order to allow projects to be validated as part of its comprehensive development strategy. The new services include endurance testing, environmental simulations and vehicle conversions. The site has accredited test laboratories and several test buildings for this purpose. The in-house test rig construction facility guarantees that customer-specific testing solutions can be provided.

### Testing: Understanding complexity, offering comprehensive services

The testing specialists at Bertrandt Cologne focus on supplying tailor-made solutions. The department, which was established in 2006 in one building, now offers services to customers from all over Europe across seven different buildings. The team is highly flexible, which allows it to fulfil customers' individual requirements quickly. A range of different equipment for simulation and testing is available over an area of 3,500 square metres. The department also offers a range of upstream and downstream services, including workshop facilities, logistics, transport and documentation.

The testing department has expanded its services in the field of vibration testing, seat validation, environmental simulations and functional testing/electrical systems in particular. It now has six shakers for automotive, aviation, rail and industrial testing. One special feature is a new shaker system with a maximum force vector of 130 kN that will be available from the autumn of 2017 onwards.

At the end of 2015, the department added tests of seat components, seat structures and complete seats to its portfolio of services. These began simply with tensile and pressure tests, but now the seat testing facilities occupy a separate building with a floor area of 450 square metres. Here endurance tests are carried out on pneumatic and electric test benches, together with validation processes using a robot arm. Realistic tests include H-point determinations where the human body is replaced by a dummy. The metal and reinforced plastic structure consists of separate bowl-shaped components representing the human spine and pelvis, which can rotate around the hips or the H-point. This allows them to imitate the rotation axis of the human body and the thighs and enables different impacts on the human body to be reproduced. In addition, Bertrandt carries out standards-based impact tests using a drop tower that was developed in-house. This makes it possible using replaceable, cost-effective individual parts to carry out crash tests that would otherwise be highly expensive and time-consuming. Other safety-related tests include airbag inflation evaluations at a component and complete vehicle level. This test system has four high-speed colour cameras, which take up to 12,000 images

per second, and LED lighting. Sled tests are also carried out on behalf of other sites and departments.

The environmental simulation facility has climate testing chambers with capacities ranging from 0.7 cubic metres to 48 cubic metres. Tests can be run here at temperatures from -70 °C to +180 °C and humidity levels from 0 percent to 98 percent, including endurance testing of components and complete vehicles. Sun simulation and corrosion chambers, which can be used for condensation tests, for example, complete the range of services.

Electric drives and mechatronic systems are tested in the functional testing/electrical system area. The key services provided here include testing the motors of radiator fans, thermal systems and coolant circuits. All of this demonstrates the versatility of the Cologne testing department.

*Adrian Zinke, Cologne*

Bertrandt Group

## SPECIALISING IN PRODUCTION PLANNING

For Bertrandt as a service provider to the automotive industry, its production planning services play an important role in its business. The way in which contracts are awarded is changing and now involves larger numbers of coherent packages covering the entire product development process. This means that expertise from the development department needs to be passed on to the production facilities.

### Bodywork planning

Bodywork is one of the key features of Bertrandt's production planning services. In the past, bodies were welded by hand, but now the process is almost entirely automated. Bertrandt's portfolio starts with the creation of concepts for manufacturing machinery, from new production lines to the integration of systems into existing lines. On the basis of these concepts, the sequence of assembly processes is determined and the quantities are defined. During the creation of the layout, the production requirements must be coordinated with the facilities available in the factory building. At the same time, the automation system is developed, including offline robot programming, which involves writing the programs independently of the robot cells. In the final stage, Bertrandt brings the production line into operation. The offline programs are transferred to the production systems and then tested and fine-tuned online. Bertrandt's specialists work on the customer's premises to provide a competent construction site management service.

### Assembly planning

The assembly processes are initially planned in virtual form with a focus on an efficient flow of materials. In the same way as in the bodywork planning process, first of all the production facilities and the layout are designed. The next phase involves Bertrandt's specialists simulating, testing and improving the results. The digital development process allows changes to be introduced quickly and cost-effectively. In order to ensure that the assembly processes are as efficient as possible, Bertrandt provides professional time management services, for example, Methods-Time Measurement (MTM). This allows accurate production plans to be drawn up. In the case of existing manufacturing processes, workshops are used to identify potential areas for improvement. In addition, the Ergonomic Assessment Worksheet (EAWS) can be used to evaluate the ergonomic aspects of the assembly process.

### Design and construction

Bertrandt's design and construction service for production facilities allows it to offer the full range of planning activities. This includes not only developing production machines, test equipment and jigs, but also manufacturing them to meet customers' specific requirements. Our specialists put the emphasis on functionality, ease of use and safety. CAD tools such as CATIA V5, Siemens NX and Autodesk Inventor allow for high levels of software compatibility.

### Logistics planning

In this area, the focus is on inbound, in-house and layout planning. A line-back planning strategy is used, which means starting from the production line and working backwards to the goods inwards department or the supplier.
In-house planning involves designing the internal routes. As well as conventional techniques, new approaches are used, such as the FTS method for driverless transport systems. Bertrandt's range of services also includes the design, construction and approval of parts containers and picking and sequencing racks. In order to ensure that the goods transport system within the factory functions as efficiently as possible, potential bottlenecks where there is an increased volume of traffic within the building are identified at an early stage.
Inbound planning covers the transport of goods outside the production facility. One aspect of this is the simulation of truck bodies and the measurement of their capacity. Our planning team also coordinates the entrances to and exits from the goods inwards department. An external warehouse can also be organised, depending on individual requirements. The objective of all these measures is to bring about significant cost reductions for customers.

### Tool landscape

Nowadays, production planning would not be possible without digital factory tools. High-performance software packages, such as Process Designer/Simulate for planning and CATIA V5 for design, complement one another perfectly. Our experienced team members regularly develop intelligent solutions for customers.

*Stephan Boost, Michael Krause, Mönsheim*

PORTFOLIO OF PRODUCTION PLANNING SERVICES

**Bodywork planning**
- Tools/body components
- Machines/assembly
- Automation systems
- Validating products and processes
- Industrial engineering (MTM)
- Managing suppliers and bought-in parts

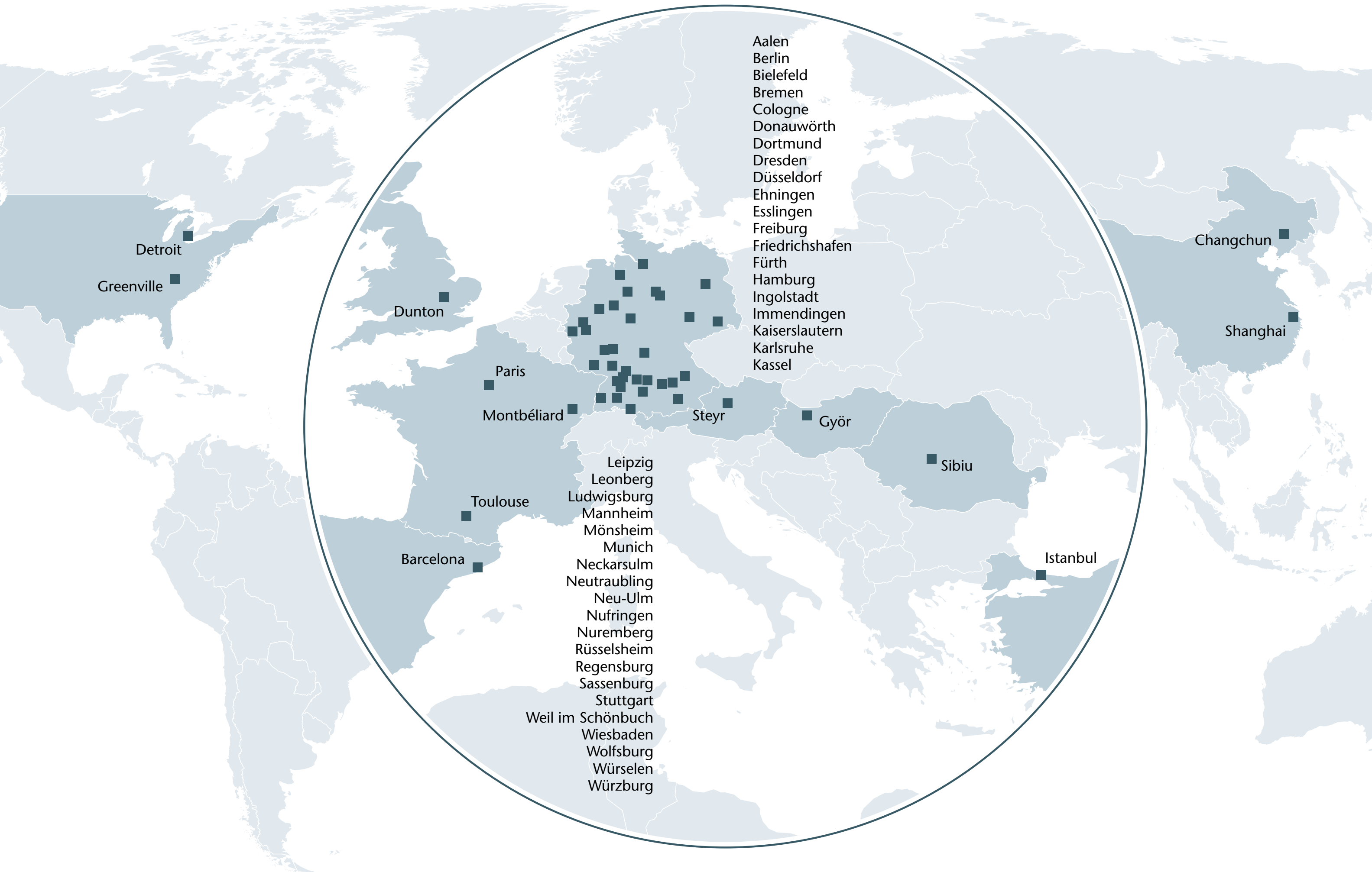
**Assembly planning**
- Production machinery
- Automation systems
- Industrial engineering (MTM)
- Layout planning
- Process FMEA

**Design and construction**
- Test equipment and jigs
- Production machinery
- Drawings
- Pneumatic systems

**Logistics planning**
- In-house logistics
- Layout planning
- Industrial engineering (MTM)
- Inbound logistics
- Container planning
- Material flow simulation

**Tool landscape**
- Process Designer
- Process Simulate
- Plant Simulation
- Microstation (HLS)
- CATIA V5
- Connect (Team Center)
- P-DMU
- Work plan

# BERTRANDT IS NEAR YOU – WORLDWIDE



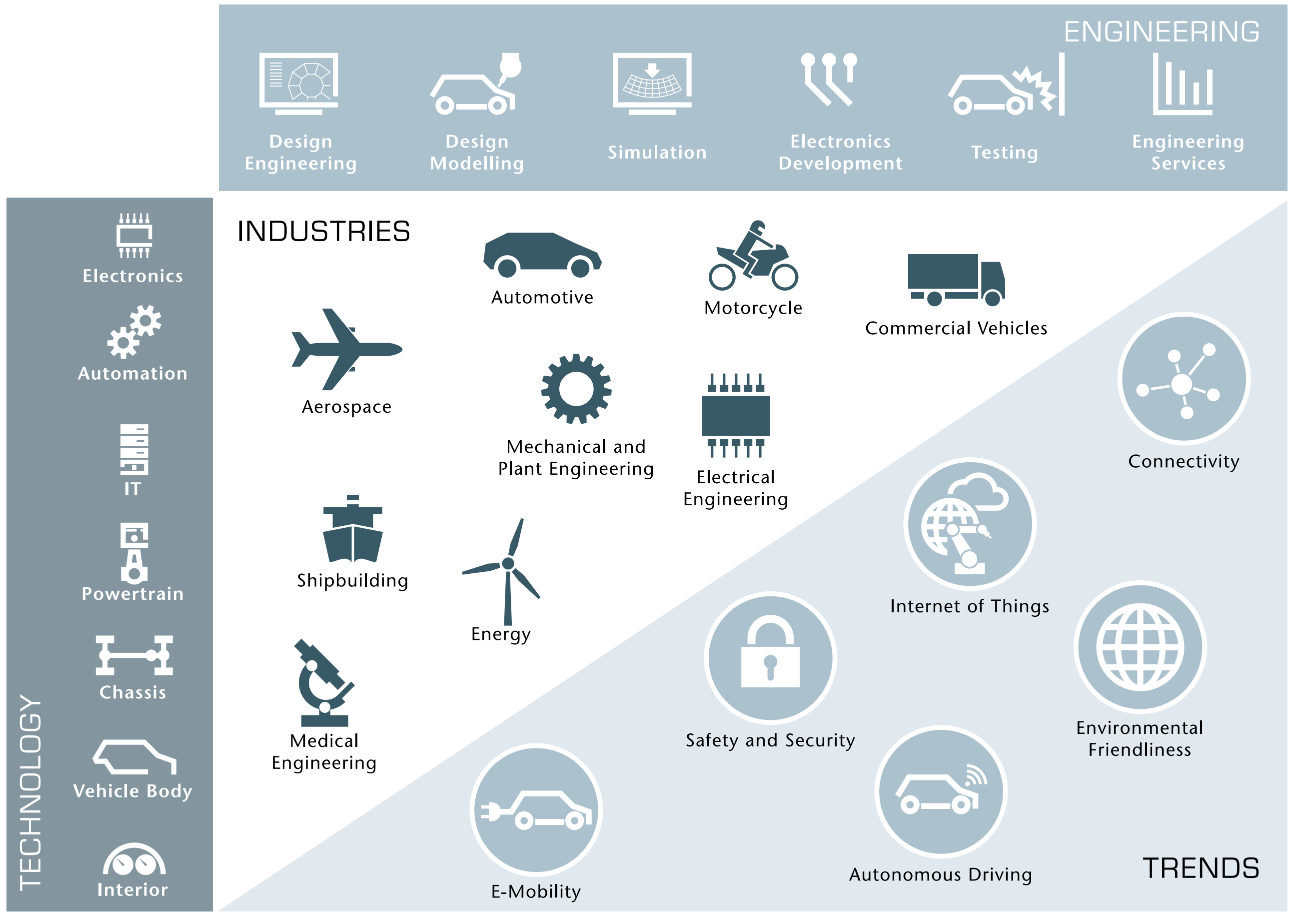

**Headquarter**
Bertrandt AG
Birkensee 1, 71139 Ehningen, Germany
Phone: +49 7034 656-0
info@bertrandt.com

You can find more information about our locations at:

http://www.bertrandt.com/en/company/locations.html



# BERTRANDT'S RANGE OF SERVICES

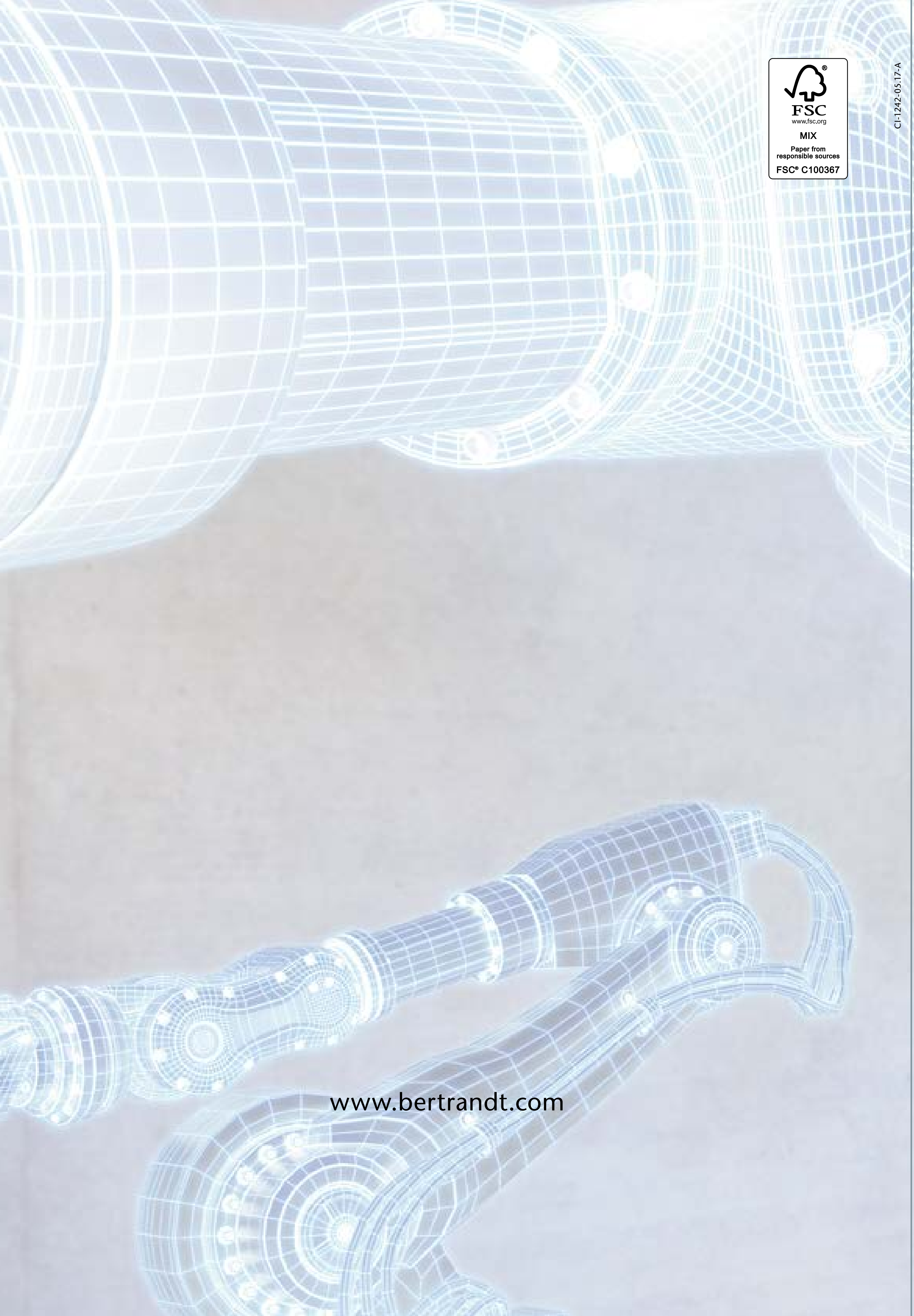



You can find details of Bertrandt's entire range of services on our website at:

http://www.bertrandt.com/en/range-of-services.html

Discover more about the events that Bertrandt will be attending on our website at:

http://www.bertrandt.com/en/company/events.html



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