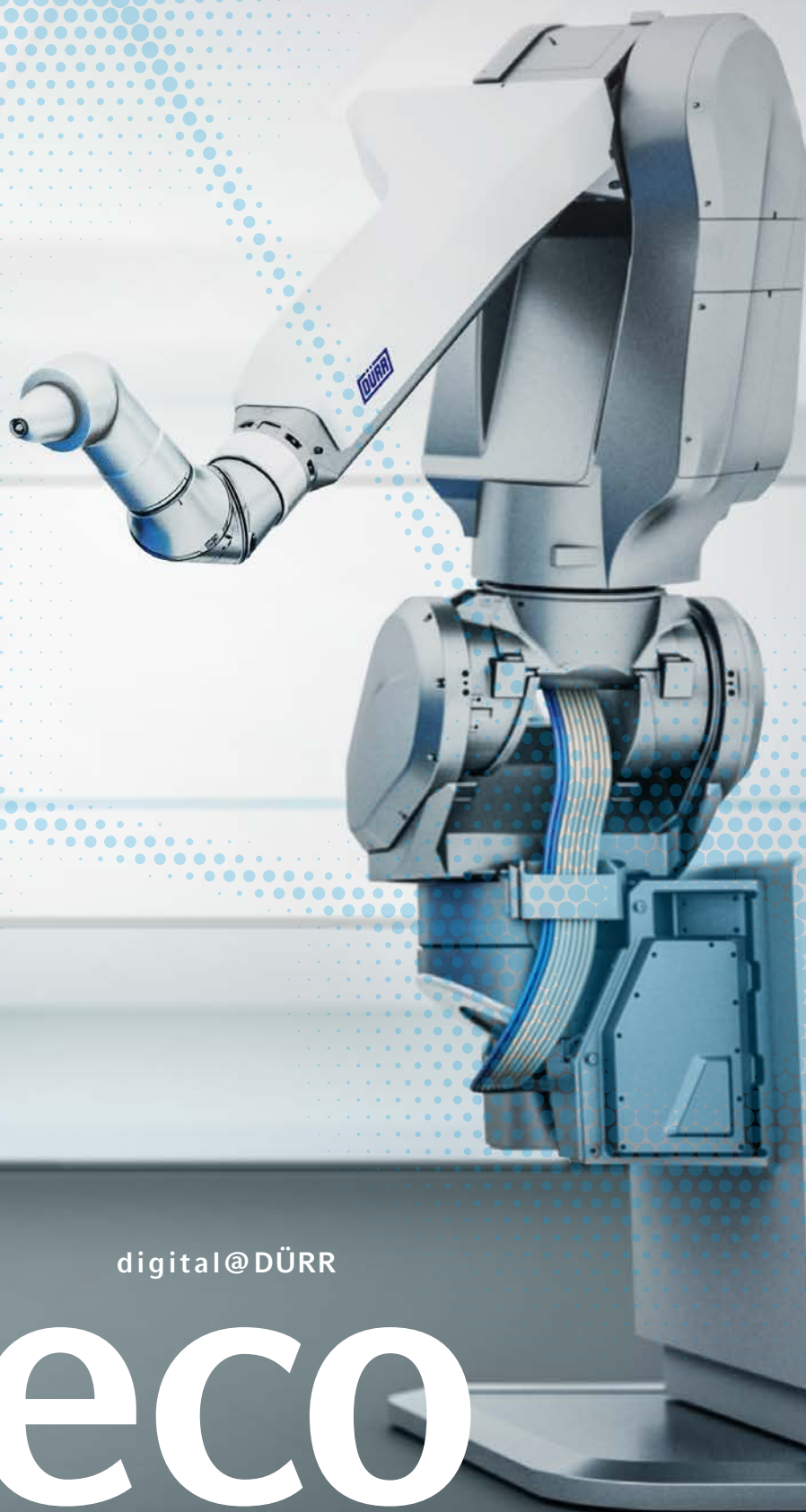




LEADING IN PRODUCTION EFFICIENCY



digital@DÜRR

eco

THE DÜRR MAGAZINE

THE DÜRR GROUP

The Dürr Group is one of the world's leading mechanical and plant engineering firms. Business with automotive manufacturers and their suppliers accounts for 60 % of our sales of € 3.57 billion. Other customer segments include the woodworking industry and the mechanical engineering sector as well as the chemical and pharmaceutical industries.

OUR FIVE DIVISIONS

Paint and Final Assembly Systems

- Paint shops
- Final assembly systems

Sales: € 1,140.0 million
EBIT: € 77.2 million
Employees: 3,384



Application Technology

- Paint application technology
- Glueing technology
- Sealing technology

Sales: € 560.6 million
EBIT: € 76.1 million
Employees: 1,956



Measuring and Process Systems

- Balancing technology
- Filling technology
- Assembly technology
- Testing technology

Sales: € 623.8 million
EBIT: € 79.7 million
Employees: 3,010



Clean Technology Systems

- Exhaust-air purification systems
- Energy-efficiency technology

Sales: € 167.0 million
EBIT: € 6.1 million
Employees: 569



Woodworking Machinery and Systems

- Machinery and systems for woodworking

Sales: € 1,082.0 million
EBIT: € 44.9 million
Employees: 6,126



 SCHENCK

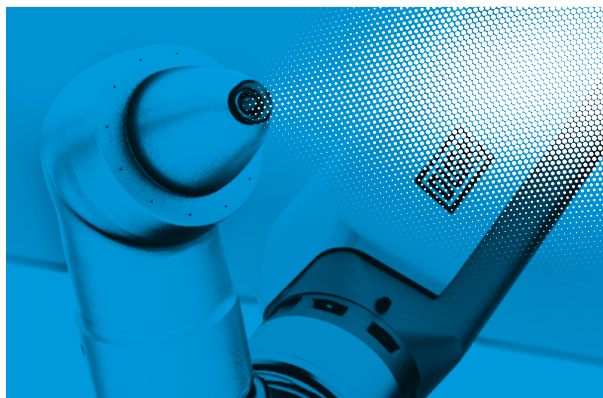
digital @ DÜRR Digitization is a great opportunity both for users of our technology and for ourselves. System connectivity, tracking and big data provide new opportunities for our customers, for example when customizing products, optimizing processes and ensuring system availability. We see digitization as an evolutionary but highly dynamic process. Software, sensors and other smart technologies have been shaping our machines and systems for many years – and will even more so in the future. We are investing in new digital solutions and acquisitions to expand our digitization capability. Dürr has everything required to remain at the leading edge of mechanical and plant engineering in the Industry 4.0 age: financial strength, technological expertise, and highly motivated employees who want to take an active part in shaping digital transformation.



SMART FUTURE

Digital transformation turbocharges the efficiency gains in production systems. Dürr is driving this transformation with the digital@DÜRR strategy.

PAGE 06



SEVEN

Dürr's latest painting robot generation marks a quantum leap: equipped with an additional axis of rotation, the robot is now significantly more mobile and versatile in use. The new smart control provides efficiency, safety and optimum data flow.

PAGE 12



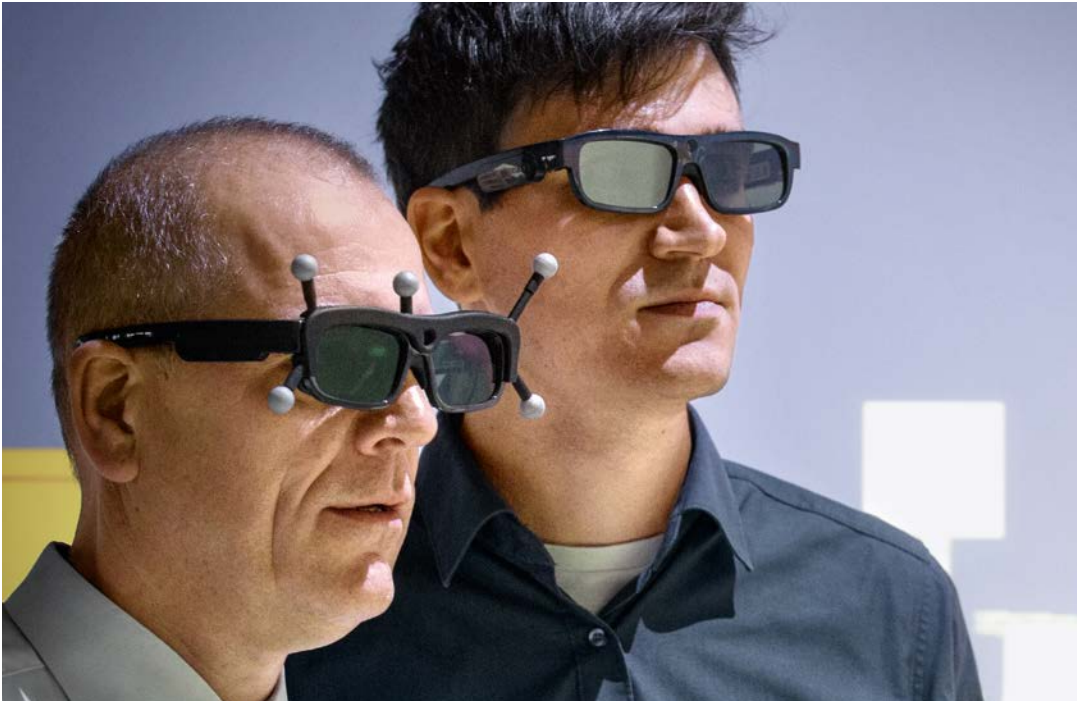
À LA CARTE

It's all about speed – even when it comes to buying a kitchen. A system offered by the HOMAG Group, a Dürr subsidiary, facilitates planning and significantly accelerates production.

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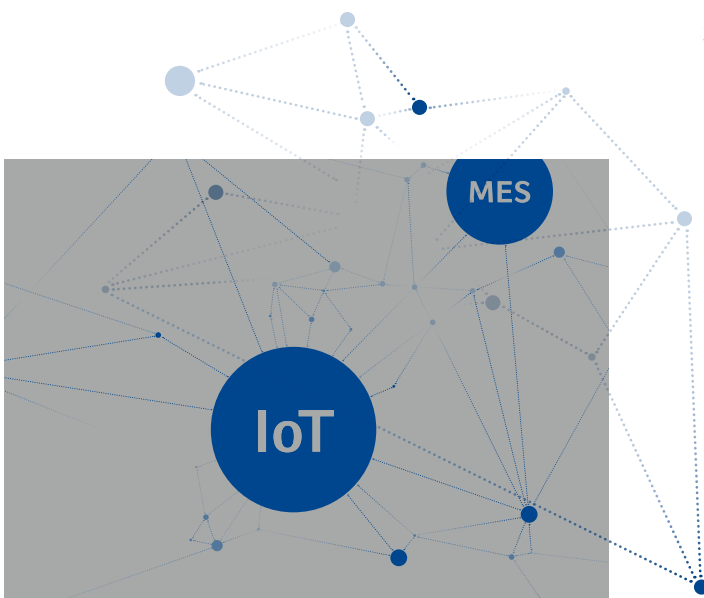
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SOFTWARE AND GUT INSTINCT

Technology changes the work of engineers – and Darmstadt-based Dürr subsidiary Schenck RoTec is no exception. What has already changed? What will stay the same? Where are we heading? An interview with two representatives from different generations of engineers.

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CENTRAL NERVOUS SYSTEM

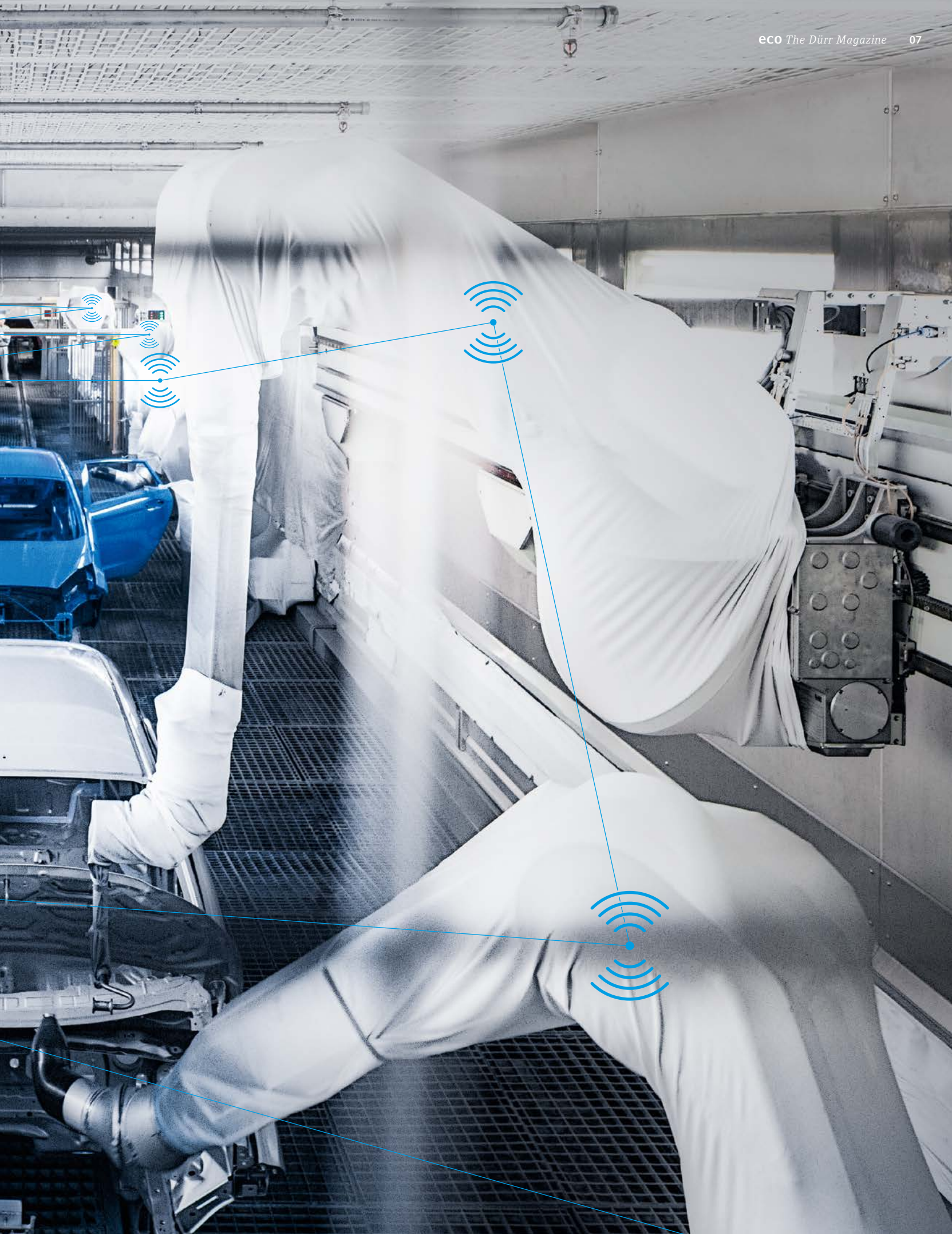
A manufacturing execution system is the central link between individual machines and factory control. Together with software subsidiary iTAC, Dürr supports customers on their path toward the smart factory.

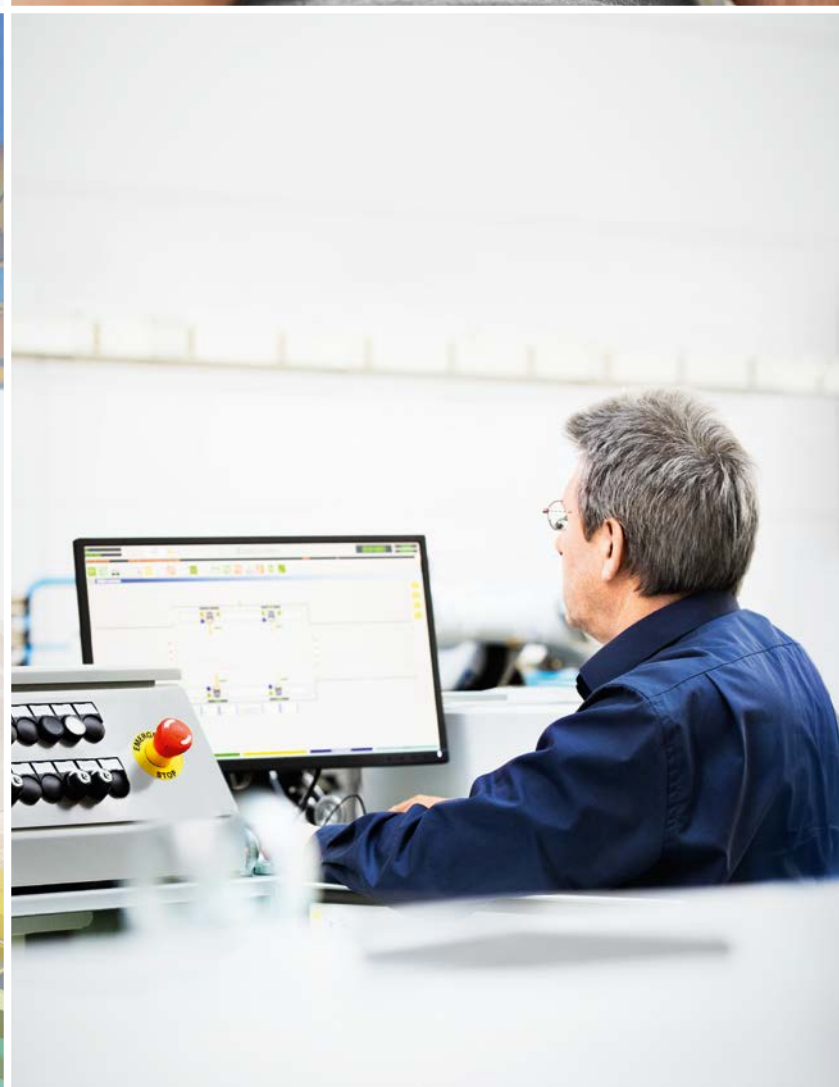
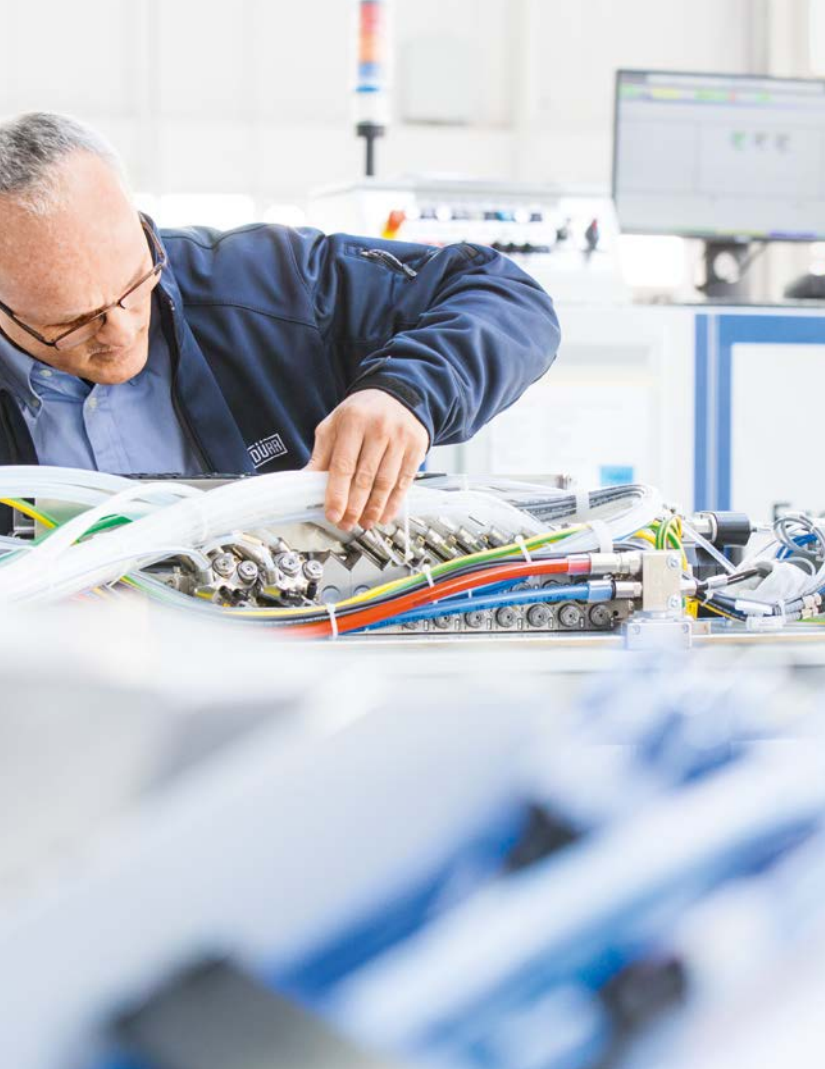
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SMART FUTURE

Digital transformation turbocharges the efficiency gains in production systems. Dürr, too, is promoting this transformation. Through its digital@DÜRR strategy, the company is preparing itself for Industry 4.0. digital@DÜRR consists of four core areas: smart products, smart services, smart processes and smart factories. All of these are based on smart technology, which enables big data to be collected and evaluated to optimize production.







SMART PRODUCTS

Smart products are self-regulating machines and components. They monitor their own status and detect changing production tasks. One example is the **EcoPump9** paint dosing pump for Dürr robots. It uses sensors and software to determine if the correct amount of paint is being used, when maintenance is due, and how long it will be before a component wears out. A traffic light system shows what is required. A green light means: everything is OK. If the light is yellow, the system needs to be repaired. If the red light appears, the pump must be replaced immediately.

SMART SERVICES

Digitization enables new services to be offered. Dürr uses data analysis to support its customers in enhancing system availability – this means less downtime and increased production. Machines are no longer serviced at regular intervals but as and when required. This is known as predictive maintenance. If a malfunction occurs, service experts can access a machine on the other side of the world via the Internet.



SMART PROCESSES

Dürr uses digital tools and processes to deliver bigger projects faster and more efficiently. One example of this is virtual commissioning, where software enables machines and systems to be tested long before they are installed. Simulations are performed to show customers in detail how their future factories will work. To produce complex components, Dürr uses processes such as 3D print and laser sintering.

SMART FACTORIES

A smart factory contains self-organizing production plants and logistics systems, which run more and more autonomously. To control a factory, Dürr offers the **iTAC.IoT.Suite** software platform. Acting as the brain of the smart factory, it sends commands to the machines, determines what material is required, and measures energy consumption. In essence, this software contains a manufacturing execution system (MES) for production control. Added to that are new technical concepts such as big data analytics. This enables large data volumes to be processed and complex production processes to be controlled with maximum accuracy.

» Dürr has a fantastic team, and I am very proud of them. For our digital@DÜRR strategy we need both colleagues with decades of experience and also fresh, innovative minds who can think outside the box.«

..... RALF W. DIETER, CEO

THE STEAM ENGINE OF THE 21ST CENTURY

The pump signals when it requires maintenance, the machine has data evaluated automatically, and the robot becomes a colleague by providing reliable support to workers. Capable of analyzing ever-increasing data packets and determining the necessary steps, intelligent technology is at the heart of Dürr's development work.

The Group has been promoting digitization for a number of years. This will become even more important, because global industry is facing a fundamental transformation.

A NEW ERA

In the business world, this new era is known as Industry 4.0. This term refers to a fourth groundbreaking development that is expected to take hold in factories around the world – steam engine, conveyor belt and microelectronics are now followed by intelligent networking. This is taking place at all levels, from the individual machine to the entire factory. Manufacturers, customers and suppliers are linked via a network through which they constantly exchange information.

There is great demand in industry: in a McKinsey study carried out in 2016, 44 percent of German companies interviewed stated that in the previous year they had made little or no progress in terms of Industry 4.0. However, almost all companies see this trend as an opportunity. They are looking for ways to increase productivity. They want systems that work faster, are available for longer, and require less maintenance. Dürr will support them in this.

Every Dürr innovation must offer customers a measurable added value and, above all, lower per-unit production costs. Machines and equipment must consume less energy and material, and make the production process more efficient and sustainable.

DÜRR IS INVESTING

In 2017 Dürr will once again spend more than € 100 million on innovations. One focus is smart technology, which runs within a network and offers big data capability, i.e. it can collect and evaluate large volumes of data. This type of innovation comes under the digital@DÜRR strategy – a strategic concept which comprises the four areas presented on the overview page.

To offer even more efficient software solutions for the digital factory, Dürr acquired iTAC Software AG based in Montabaur, Germany, at the end of 2015. iTAC specializes in Industry 4.0 platforms for manufacturing execution systems and big data tracking. The software company is one of the leading suppliers in its field. This has been confirmed by the "Industry 4.0/IoT Vendor Benchmark 2017" study conducted by the Experton Group. The IT research company has ranked iTAC as one of the top five leaders with its iTAC.IoT.Suite platform. The software experts of Dürr and iTAC are working together on further developing this platform. They are now receiving support from Dresden-based software company DUALIS. This company became part of the Dürr Group at the end of 2016, because it operates in an up-and-coming field: the digital planning and simulation of production processes.

Dürr will continue to expand its service range in software, because smart Industry 4.0 platforms are the backbone of digital production. They will soon be part of everyday life in industrial companies around the world.

RALF W. DIETER, CEO, ON INDUSTRY 4.0

WHAT ROLE DOES THE INDUSTRY 4.0 CONCEPT PLAY FOR DÜRR TODAY?

Industry 4.0 plays a very important role, and we are well on our way. But it will remain my ongoing task to make sure the whole team understands the importance and the opportunities of digital transformation. This concept is nothing new for us; you might say it is part of our DNA. Nonetheless, it is essential to create awareness – both internally and externally. That's why we set great store by this concept in our communications.

WHAT IS CHANGING FOR EMPLOYEES IN THE DÜRR GROUP?

Dürr has a fantastic team, and I am very proud of them. For our digital@DÜRR strategy we need both colleagues with decades of experience and also fresh, innovative minds who can think outside the box. Training and development is therefore particularly close to my heart. When trying to recruit new experts, our reputation as an attractive employer is especially important. And, last but not least: even the best expert is only as good as his tools, which is why we always have the latest technology available within the company, and we invest in digitization. One important factor here is that our people do not worry, and they have no reason to. They are curious and creative, and that's a perfect combination.

WHAT ROLE WILL DIGITIZATION, CONNECTIVITY AND AUTOMATION – IN SHORT: INDUSTRY 4.0 – PLAY FOR DÜRR IN TEN YEARS' TIME?

I think we will have to pinch ourselves. The triumph of the Internet, smartphones etc. has given us a taste of things to come. The connectivity and intelligence of machines and factories will go on increasing. Companies that cannot keep up will regress, lose business, and they may not even survive at all in the market. Being a company group with a wealth of digitized production technologies, we are in an excellent position. We can share our expertise among us and thus drive markets. With the help of Dürr technology, our customers will have highly automated batch size 1 manufacturing systems, and enjoy the benefits of having their data link to us.

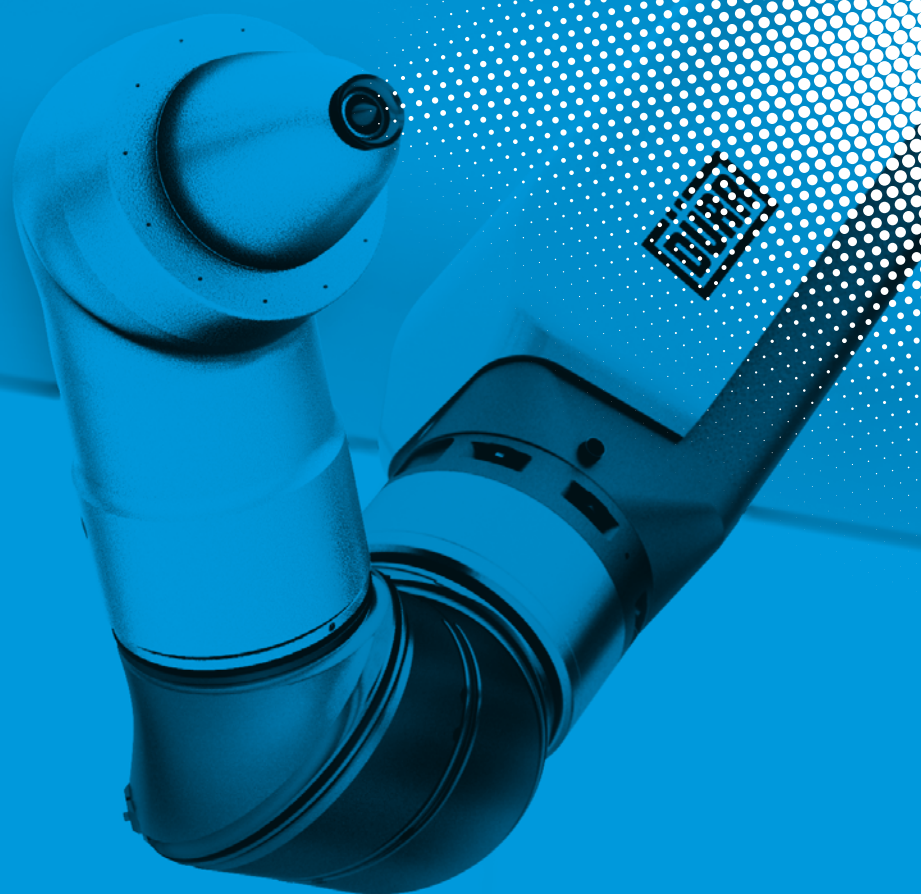
IS INDUSTRY 4.0 NOW TURNING DÜRR INTO AN IT COMPANY?

What use is the best software if the paint atomizer is poorly made? In our business, things never work without the perfect hardware. But it's true that software is becoming more and more important. I see great potential for Dürr, especially when it comes to Industry 4.0 platforms, which is why we have acquired iTAC and DUALIS.

WILL WE SEE FURTHER IT ACQUISITIONS?

I would not rule out the possibility of further acquisitions to make us even stronger. But there is no doubt that our Industry 4.0 expertise is also an asset when looking for acquisitions in the mechanical and plant engineering sector. Smaller companies, in particular, often find it hard to build this level of expertise. The Dürr umbrella offers them perfect conditions for accelerating their digital business.





SEVEN

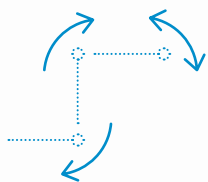
The smart automotive factory of tomorrow demands flexibility. Painting robots, too, are having to take on ever more varied tasks. Dürr's new generation of robots has seven axes of rotation, which makes them especially maneuverable. They can also feed a large amount of information into the digital data network.

Text: Heimo Fischer

Photos: Sascha Feuster

Dürr's new painting robot hums quietly in the test center in Bietigheim-Bissingen. It tilts forward, rotates, then extends its arm right out. The new EcoRP E043i robot's strength is its maneuverability. Thanks to its additional joint, it can carry out maneuvers which were not possible previously. "It's significantly more versatile in use than all preceding models," says Detlev Hannig, Head of Robot Systems and Mechanical Engineering at Dürr.





7th axis

It's only one more axis for the robot – one giant leap for maneuverability and efficiency in automotive paint shops. The seventh axis of rotation extends the robot work zone, enabling it to paint vehicle models with completely different outlines on a single line. It replaces an expensive and space-grabbing rail, along which the robot had to move to and fro in the past.

Thanks to smart technology, automotive manufacturers can now paint completely different vehicle models in changing colors on one and the same line. The robot has to adjust to changing vehicle shapes within seconds. It moves the atomizer, which sprays the paint, precisely over the surface, while adhering to strict specifications in terms of distance and speed. This is essential in ensuring that the paint is applied to best effect. Maneuverable robots are therefore especially important in meeting customers' ever more stringent requirements.

NO ROOM FOR RAILS

A conventional painting robot has six joints – the technical term for which is axes. Although these make it fairly mobile, it's still not enough to reach really difficult-to-access corners inside a vehicle body. That's why painting robots often have to move forward and backward on rails to extend their work zone. "This procedure is effective, but expensive," says Hannig. Because rails need space and have to be maintained. Dürr's developers looked for a more elegant solution and opted to use a seventh axis of rotation



» The new EcoRP E043i is significantly more versatile in use than all preceding models. «

..... DETLEV HANNIG, HEAD OF ROBOT SYSTEMS AND MECHANICAL ENGINEERING

to render the rails superfluous and extend the robot's work zone. Rotary axes, unlike linear ones, are especially mobile and inexpensive.

Hannig set about his task at the beginning of 2014 together with a team of mechanics, engineers and drafting technicians. The first question they had to settle was where to locate the seventh axis. "We spent more than a year exhaustively discussing this issue," says Hannig. They then turned to a special computer program and drafted the robot digitally, including its electronics, pneumatics and hose routing. Then, using comprehensive simulations, they improved one detail after another. Is there good access to the component for a service technician, if required? An exact 3D model helped to take account of such aspects in the design, too. In December 2015 the first metal prototype finally moved.

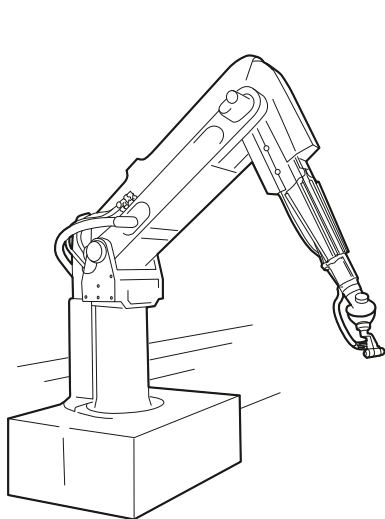
In human terms, the seventh joint is approximately at hip level. The first robot arm can be tilted to the side by rotating this additional axis. It can also more easily overcome

obstacles. If a body passes with its doors open, the arm articulates upwards out of the way at the appropriate location, without interrupting its work. Another important aspect for the developers was designing a reliable and robust robot that is easy to maintain.

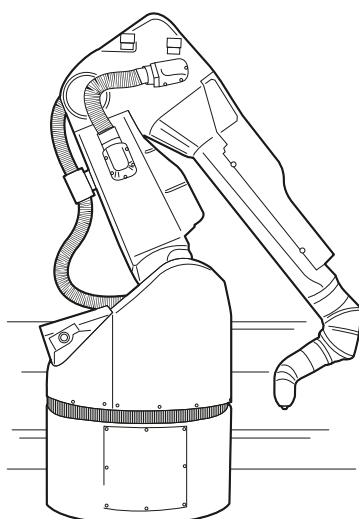
SMART HAZARD CONTROL

The EcoRP E043i is better than its predecessors in many respects. Its axes have more powerful motors and gears. This enables the arm to jump to a new position after an extremely short pause in order to continue painting the body at a different location. Although these dead times last just a few seconds per vehicle, they can add up to more than an hour a day in a paint shop.

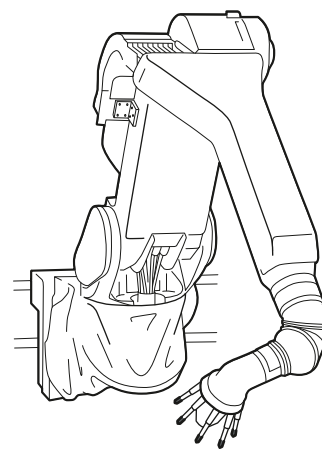
However, the robot's new mobility also entails risks. It would be conceivable, in light of the additional axis, for the arm to swivel out of its work zone, smash through the booth wall and put people in danger. With that in mind, Dürr has developed a smart safety controller for the EcoRP E043i. Sensors constantly capture the positions

**1984****Behr 3/6**

First steps in robot technology: painting robot with a hydraulic drive, though maintenance-intensive and lacking in dynamic movement.

**1998****EcoRP 6/7**

Servomotors and a fiberglass arm mean that the robot responds substantially more dynamically.

**2005****EcoRP E/L XX3**

Lower weight, even better performance, a working height of 1.90 m – the new generation is faster, more maneuverable and, thanks to its modular construction, available as a family of robots.

of the joints and, using this data, the controller continuously recalculates the position of the robot arm. "In the event of danger, the system shuts down," says Jens Häcker, Senior Manager Product Development Control Products.

THE FRUIT OF DECADES OF WORK

The **EcoRP E043i** is right at the leading edge of the products that Dürr can offer in painting technology. It has benefited from decades of experience. As recently as the 1990s, painting gantries were still the norm. They sprayed the large body panels with paint. Human spray painters, working with a spray gun and respirator in a hot and humid booth, then dealt with those areas which were difficult to access. That was time-intensive, and a great deal of paint also missed the vehicle body.

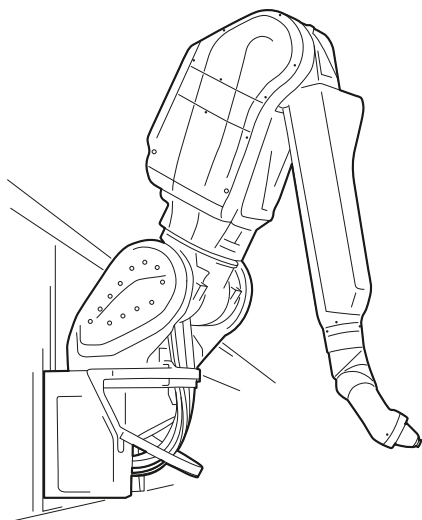
Dürr has had painting robots for more than 20 years. The first ones still worked with a hydraulic drive. In the late 1990s developers fitted the robots with servomotors, which delivered more dynamic movement. 2005 saw the launch by Dürr of the **EcoRP E/L** family. The seven-axis painting robot is now the latest generation. The first two such robots were installed on a painting line at the VW plant

in Wolfsburg, Germany, in December. There they are undergoing beta testing – i.e. field testing on the production line.

The **EcoRP E043i** offers everything the smart factory of the future needs. It's a straightforward matter to connect it to a company's central data network. Sensors capture its components' temperature, operating hours and degree of wear. The controller transmits this information to higher-level maintenance and control systems or to the Dürr Service Cloud. This technology enables data from a number of paint booths or even entire paint shops to be merged. Maintenance visits can be scheduled centrally, and the robots' health can be monitored remotely.

THE GOOD-LOOKING ONE WITH THE SMART CONTROL CABINET

The robot's controller delivers the data. It is located in a control cabinet next to the painting line. The almost airtight housing protects the electronics against soiling. However, the electronics generate heat, which raises the temperature in the control cabinet. In the past, therefore, a power-guzzling cooling system was required. "Up to an ambient temperature of 40 °C, the control cabinets for



2016

EcoRP E/L XX3i

New arrival: the latest generation adds a 7-axis robot. The additional axis makes it a really efficient mover, while its smart controller ensures the transfer of data.

the new robot no longer need that," says Häcker. The heat generated by various parts is routed to the back of the control cabinet and discharged via an air duct, which saves energy.

A modern robot not only has to work smartly, it also has to be easy to operate – for example, if it needs to be reprogrammed when the car factory changes models. "That's why we attached great importance to the easy operation of the additional axis," says Häcker. The customer merely determines the key points on the body for painting and specifies the elbow's angle of tilt for each operational step. The controller then automatically calculates all the other positions from these variables.

This results in movements such as those being described by the arm of the **EcoRP E043i** in the Bietigheim-Bissingen test center – powerful, yet elegant. Developer Hannig is proud. "The outlines were developed in collaboration with an industrial designer and bear the unmistakable Dürr signature." Smart technology doesn't just have to work perfectly – it should also look good.



JENS HÄCKER (48), LEFT

Jens Häcker has been working at Dürr since 1995. He was team leader for many years, developing software for the operation of technical systems. Today Jens Häcker is Senior Manager Product Development Control Systems.

DETLEV HANNIG (56), RIGHT

Having studied mechanical engineering, Hannig began his career as an engineer with a machine tool maker. He then joined a manufacturer of special machines, where he was in charge of engineering. Since 2008 he has been Head of Robot Systems and Mechanical Engineering at Dürr.



Precise and mobile: this video shows the new 7-axis robot at work:

www.durr.com/press/movies/smart-mover

À LA CARTE

The customized fitted kitchen is becoming the centerpiece of the modern apartment. But designing it can be a complicated and lengthy process. Dürr's subsidiary HOMAG has therefore developed a smart system, allowing retailers, carpenters or end customers to design kitchens on the screen. The information is simply sent to the furniture manufacturer via the Internet. Using this software means the customer can take delivery of cupboards, drawers and other components within just a couple of days after placing the order – all customized. Log of a digitized kitchen purchase.

Text: Heimo Fischer

Photos: Jakub Wqs, Piotr Zaczny/HOMAG Group





SIT BACK AND SELECT

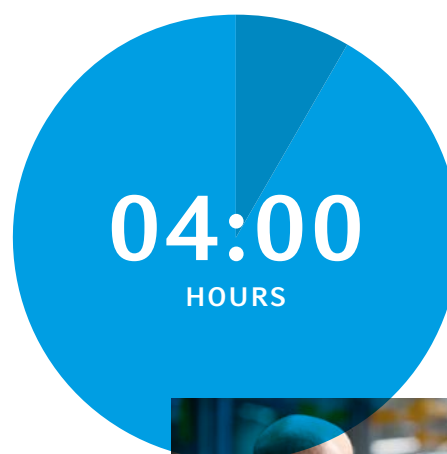
The carpenter arrives for his early-morning appointment at the customer's home. He looks at the room and starts designing together with the customer. Cupboards here, drawers there, fridge at the end, cooker in the middle. The carpenter carefully measures walls and floor, notes down lengths, widths, heights, angles and distances. Then from his laptop he logs onto his supplier's website. The kitchen manufacturer manages the sales process with the help of HOMAG's woodNET program. Once the carpenter has entered all the dimensions, a picture of the new kitchen appears on the screen. Each cupboard can now be viewed from different angles and changed individually. The carpenter and his customer can experiment with colors and shapes, or change knobs and handles. The woodNET software provides all data required for this from the manufacturer's electronic catalog. Then, finally, it is decided: this is how the new kitchen should look. One final check, and the carpenter presses the send button.



00:00
HOURS

OFF TO THE FACTORY!

At the furniture factory, HOMAG's woodCAD/CAM software starts processing the order. The program converts the data sent by the carpenter into specific commands for the machines, which is a fully automated process. When this takes place depends on the manufacturer's production philosophy. Some start manufacturing as soon as the order comes in, while others first collect several orders and then carry out sub-operations simultaneously. It is more efficient, for example, to cut furniture of the same color for different kitchens from the same boards, as they are collected from the same stack. This reduces material wastage. Good planning saves trips and reduces costs. Before production begins, HOMAG's woodFactory software decides which saw is best for which board, where edges are processed and holes drilled. Each workpiece is given a bar code, showing which order it belongs to. Guided by this electronically scannable ticket, each item travels through the factory, taking an optimized route. Manufacturing is either fully automated or relies on a worker manually placing the items into the machines. Most older furniture factories can also be retrofitted and networked using HOMAG's digital systems.



SAFELY DISPATCHED!

woodFactory organizes the internal logistics, and checks the completeness and quality of the processed order. Just before leaving the factory, all items belonging to one kitchen arrive at the same place. They are sized, carefully stacked and eventually wrapped in cardboard packaging. Each packet receives a label, so the carpenter on site can see straightaway what it contains. Kitchens can be delivered in several different ways: some businesses collect the material from the factory, others have it delivered directly to the end customer. This is handled either by the manufacturer or by a delivery company.



24:00
HOURS





UP IT GOES!

The carpenter unpacks the items at the customer's home. Before assembling the components of the fitted kitchen, he checks the delivery. Nasty surprises hardly ever happen. Carpenters no longer have to worry about holes being in the wrong place. The system automatically decides the right positions for the holes. Now, nothing stands in the way of a fast assembly. Just two days after the order has been placed, the kitchen can be installed at the customer's home. It can even happen faster. Some manufacturers who use the HOMAG system guarantee a 24-hour delivery.



>1,000,000

*data points are processed by
Dürr's EcoEMOS software in a
large automotive factory*

220

*factories are already using
iTAC'S MES*

CENTRAL NERVOUS SYSTEM

Producing non-stop, always delivering 100 percent quality – and at exactly the right time. The demands placed on the smart factory are great. To meet them, Dürr is in the process of networking all machinery and facilities in the factory along the entire value added chain. The absolute linchpin in this context is the manufacturing execution system.

What matters is to win a new heart every minute, 300,000 times a year: the heart of the motorist who gets into his new car for the first time, caressing its paintwork gently before he does so. Its uncompromising quality is ensured in a Dürr paint shop by up to 130 robots that apply about 10 kilograms of paint per car body. Another 40 robots are deployed for sealing and conveying technology and must also work with meticulous precision to ensure unrivaled results. The technology is managed by invisible hands: EcoEMOS is the name of the software likewise created by Dürr. It ensures that in spite of the large variety of models, in a modern carmaking plant each and every car body leaves the paint shop not only with the right paint but also with a perfect finish.

"Since the turn of the millennium, we have gradually expanded our plant control systems into a complete manufacturing execution system," explains Holger Thienst, Director for Control Systems and MES at Dürr. A manufacturing execution system (MES) represents the linchpin between the programmable logic controllers (PLCs) of individual units of machinery and the IT systems for administration of the entire factory. For one thing, this can be used to pass on information on pending orders to the individual facilities – in view of the many configurations possible in automotive engineering, this represents a par-

*Smart factories is one of
the four fields of the
digital@DÜRR strategy*

Top 5

"The iTAC.IoT.Suite software is one of Germany's leading Industry 4.0 platforms." (Experton Group)

MES

The manufacturing execution system controls the entire factory

IoT

Machines communicate directly with each other via the Internet of Things

Predictive maintenance extends the service life of machines by predicting potential damage

25

terabytes a day are sent into the cloud by the factory of the future

Cloud: big data analysis forms the basis of a cloud-enabled MES

ticularly important task. For another, the MES is the central nerve tract for all information generated in individual factory sections and used by the plant management in consolidated form in order to run the factory. This provides the shop manager with a target-actual comparison of unit numbers for each individual step of the manufacturing and assembly process. The range of **EcoEMOS** functions has been extended step by step, for instance to include software modules that monitor the condition of machinery and equipment and automatically trigger an alarm when disruptions strike. "In the process, we have always made use of our core expertise: being plant engineers, we know exactly what goes on inside each individual piece of machinery," says Thienst.

Change of scene. A modern, somber-looking office building near the Intercity Express railroad station in Montabaur; many young people and even more screens. The general atmosphere gives the impression of a start-up rather than a mechanical engineering firm. And yet the software enterprise iTAC located here has been a wholly owned subsidiary of the Dürr Group since end-2015. iTAC founder Dieter Meuser had a simple idea back in 1998: he wanted to transfer the new Internet technologies at the time to factories. He was not always taken seriously, he says with a smile. "Only since the term Industry 4.0 was coined have such ideas had a chance of succeeding." First of all, iTAC developed a classic MES that has meanwhile become a standard in electronic manufacturing of numerous automotive suppliers: iTAC's MES is in use in over 220 factories today. The next milestone has now been reached in the form of the Industry 4.0 software iTAC.IoT.Suite, combining the strengths of Dürr's **EcoEMOS** and iTAC's MES – and thanks to additional modules such as big data analysis, it can accomplish a whole lot more. "A first pilot application is scheduled to be launched this year," says Ullrich Möllmann, Product Manager for **EcoEMOS**. "We are combining the system landscapes step by step and thus accompanying our customers on their route to Industry 4.0."

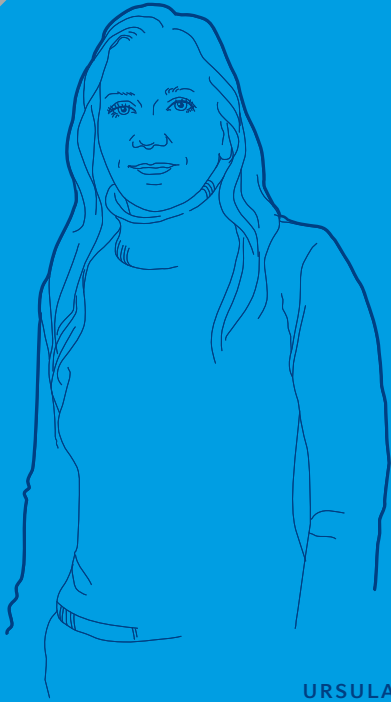
Configured in this way, the IoT Suite not only ensures smooth data exchange, it also thinks ahead: when will which pieces of machinery need to be serviced and therefore not be available? How can existing orders continue to be processed? Where could errors occur in the process, and how can these be avoided? These are tasks conventionally handled by humans – on the basis of incomplete information. If, in contrast, historical and current data is browsed in search of the answer using big data and artificial intelligence, forecasts are considerably more reliable. Such tools serve to enrich the classic functionality of the MES – and are offered as additional

modules within the iTAC.IoT.Suite. For instance, iTAC collaborates with data experts of the Fraunhofer-Gesellschaft and other research institutions on self-learning algorithms that enable process-specific analyses to be performed in electronic manufacturing.

An important question for the factory IT of the future is: what is still being computed locally, and what on the server? And who is the owner of the data on the server? It is clear that large data volumes can only be stored on large servers – in most cases, therefore, in the cloud. "As a rule, we're going to see hybrid cloud systems," explains Meuser. Particularly sensitive data is stored separately on servers located on the company's own premises. Alternatively, however, the MES will also be offered as a fully cloud-based suite for the Internet of Things. This may be interesting for SMEs whose IT budget does not allow them to purchase servers and databases with a required availability class of 3, equivalent to 99.999 percent.

As a solution provider for the smart factory, Dürr is constantly expanding its portfolio. For instance, in December 2016, iTAC took over the software house DUALIS, which specializes in advanced planning and scheduling systems. Systems of this kind are deployed in fine-tuning production facilities – to determine, for example, in which sequence pre-assembly work must be carried out to ensure the smooth running of the main assembly line. Moving forward, the DUALIS solution will be integrated into the iTAC software.

According to experts, it will take years before the vision of a self-regulating, fully networked factory becomes a reality. Senior Manager Thienst already sees Dürr in pole position today: "With innovative software and maximum industry experience, we will be able to lead our customers into the new production era," he confirms. "Thanks to the stage being set right now, we will also be one of the leading providers for IoT platforms."



URSULA ZIWEY,

VICE PRESIDENT GLOBAL IT

The process engineer has been working at Dürr's IT department since 1999. In 2009 she became responsible for the Group's global IT operations.

THREE QUESTIONS FOR URSULA ZIWEY

WHAT WILL BE THE MAKINGS OF A SMART FACTORY?

Production facilities are already well networked horizontally. The added benefit of digitization is the vertical networking of commercial and administrative systems, the manufacturing execution system and even individual plant controls. This results in an end-to-end data flow from customers' orders all the way through to machinery control. A second key feature is how to deal with the data generated in production, which will be collected and evaluated within a cloud.

HOW DO CUSTOMERS STAND TO BENEFIT?

Thanks to intelligent data analysis, the causes of production errors can be identified better and faster. This enhances quality, reducing rework time and therefore costs. For us as a plant engineering firm, there is a further aspect to consider: we can monitor the performance of a factory type worldwide. This helps us address the actual conditions of use even more effectively when further developing hardware and software.

IS DÜRR INCREASINGLY DEVELOPING INTO A SOFTWARE PROVIDER?

Yes, definitely. We can see ourselves developing from a classic mechanical and plant engineering firm into an enterprise in which software solutions are becoming a key element of our portfolio. Of course, our focus is clearly on the Internet of Things (IoT). We have therefore developed an IoT framework on a centralized basis for Dürr. This defines the digital capabilities we will require for future business models. On this basis, the divisions can then offer individually tailored, industry-specific platforms.

» Thanks to intelligent data analysis, the causes of production errors can be identified better and faster. This enhances quality, reducing rework time and therefore costs. «

..... URSULA ZIWEY, VICE PRESIDENT GLOBAL IT



SOFTWARE AND GUT INSTINCT

Industry 4.0 is making our machines and systems more complex. It is also changing the work our colleagues do. Martin Rogalla and Julian Scheuring from the Dürr subsidiary Schenck RoTec in Darmstadt represent two generations of engineers. We have asked them how things were different in the past and where we are heading now.

Text: Andreas Kempf

Photos: Marcus Pietrek





HOW ARE YOU EXPERIENCING THE CHANGES IN MECHANICAL ENGINEERING IN THE INDUSTRY 4.0 ERA?

ROGALLA: *We have always faced changes and the challenges they create. They do also provide opportunities.*

And, luckily, our engineering tools keep on developing.

SCHEURING: *Here is an example to illustrate this. For the last six months we have had a "Cave" – a room that can display machines and systems three-dimensionally and that enables us to improve ergonomic details. This opens up a completely new world in engineering and has also made a huge impression on customers.*

ONE OF THE MAIN FEATURES OF INDUSTRY 4.0 IS THE INCREASED USE OF SOFTWARE. IS THERE NO LONGER ANY NEED FOR GUT INSTINCT AND EXPERIENCE?

SCHEURING: *While software can provide support, our work remains a creative process. But software allows us to check more quickly if an idea is feasible, and then to implement it.*

ROGALLA: *It is not so much the gut we need but rather the mind, which we will never be able to replace. Our greatest asset is – and will remain – our engineers' great experience. But software is a real boon, because you can avoid many errors that used to occur during the engineering process.*

For example, certain components would not always fit. Thanks to 3D CAD software, Mr. Scheuring does not have to deal with this kind of problem anymore. (laughs)

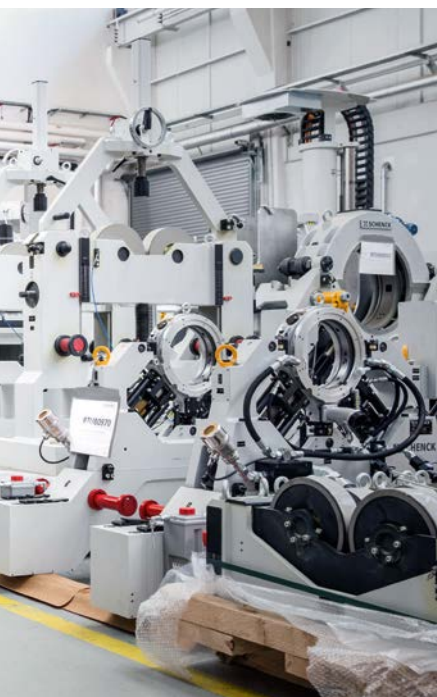
WHAT HAS CHANGED IN THE COOPERATION WITH CUSTOMERS?

ROGALLA: *The term "simultaneous engineering" is nothing new. You develop an initial solution without knowing exactly what customers need, because they are not even sure themselves. Today, customers want solutions that are more complex than ever, yet they expect drastically shorter delivery times. Years ago, we would deliver within 12 to 18 months, but today this has gone down to a mere 12 to 18 weeks.*

SCHEURING: *Customer contact has intensified. In addition to working with the production planning team via our consulting department, we also communicate with our customers' product developers.*

HAVE THE MARKETS ALSO CHANGED?

ROGALLA: *Today, our customers are global players. Only a few years ago we would be delivering most of the equipment to Germany or Western Europe. Now we are selling a lot to customers in Asia, Eastern Europe and America. For*



» While software can provide support, our work remains a creative process. «

..... JULIAN SCHEURING, HEAD OF MECHANICAL ENGINEERING TURBOCHARGER AND DIAGNOSTICS

employees, English has become the business language at almost every stage of the value chain. For a long time, we had to translate all order documents into German first, which was very time-consuming.

HOW HAVE WORKING METHODS CHANGED IN THE COMPANY?

SCHEURING: *In the past, the engineer would do the engineering work, while the draftsman was responsible for the design. Nowadays, you can do a lot more drawings yourself with 3D CAD, which has increased the scope of responsibilities. In addition to that, collaboration among colleagues has changed considerably. Today, the Group's subsidiaries cooperate around the world.*

ROGALLA: *Today, when we develop products, we work together across the borders and define responsibilities. Then we decide who takes on which task as the work goes on. This type of collaboration continues all the way through to manufacturing. You can tell we have an international team, for example because some colleagues are only available first thing in the morning and others in the evening, depending on the time difference.*

HOW DO YOU KEEP YOUR KNOWLEDGE UP TO DATE?

ROGALLA: *The basic knowledge does not change drastically, even though there are, of course, new technologies with which we need to familiarize ourselves. What is especially important to us is knowing about the processes and applications for our own products. In our RoTec Academy, experienced employees pass their knowledge on to others.*

SCHEURING: *We have also set up an in-house RoTec Wiki, which is a database containing development information based on our existing wealth of experience. We don't call it "know-how" but "know-why", in other words why the engineer has done something in a certain way.*

TECHNICAL TRANSFORMATION IS ULTIMATELY REFLECTED IN THE PRODUCTS. WHAT DO YOU THINK HAS CHANGED?

ROGALLA: *The biggest driver has always been the requirement to improve our customers' production efficiency. Here we have certainly made remarkable progress.*

SCHEURING: *These days, energy consumption, resources and environmental impact are important issues. In the last 15 years, for example, we have lowered the energy required to balance a crankshaft from 0.2 to 0.04 kilowatt hours, which is an 80 percent reduction. Also, machines are so*



versatile in use that upgrades must be possible with minimal effort and expense. Some upgrades can even be carried out automatically.

HOW DOES DIGITIZATION MANIFEST ITSELF IN YOUR AREA?

SCHEURING: Our teleservice is one example. It enables us to support the customer faster via remote maintenance. Although we can be on site anywhere within 24 hours, this is still quicker.

ROGALLA: Another example is our fingerprint technology. We can record a vibration pattern for a machine before its first use at the customer's site. We save this individual fingerprint as a reference. A regular comparison with the current vibration pattern enables targeted, predictive maintenance and facilitates troubleshooting, if things don't run as smoothly as they should. If we compare this data with information about systems with identical designs, we can systematically determine the cause of the malfunction.

HOW WILL INDUSTRY 4.0 CHANGE YOUR WORK?

ROGALLA: Above all else, it will change our perspective. We will have to put on our 'data glasses' to look at our products and ask ourselves how we can make optimum use of the information collected. This leads to questions such as: What data is relevant? Who does it belong to? And what data are we still missing? Lots of exciting topics, which are new to us as well.

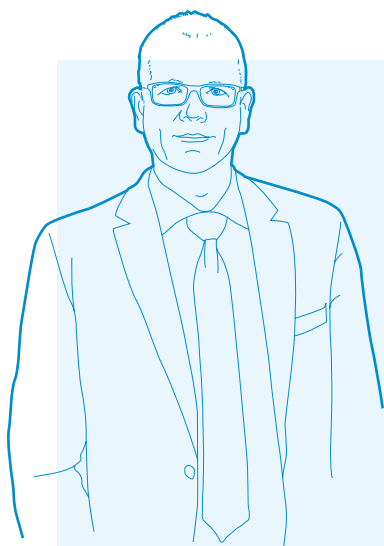
SCHEURING: (laughs) Unfortunately, despite all the software we don't have a crystal ball! But we have to assume that change will only accelerate, given the new opportunities offered by digitization.

ROGALLA: Our approach is important here. We have always benefited from change and, being an innovation leader in the market, you could even say that change is what we are all about. It is therefore a responsibility and an opportunity at the same time.

SCHEURING: I am very excited to see how we will develop machines in 15 years' time. But I have no doubt that we will still be developing the best solutions for our customers, thanks to our wealth of experience and the use of state-of-the-art technology.

» We have always benefited from change and, being an innovation leader in the market, you could even say that change is what we are all about. It is therefore a responsibility and an opportunity at the same time. «

..... MARTIN ROGALLA, DIRECTOR MECHATRONICS ENGINEERING BUSINESS UNIT SPECIAL



MARTIN ROGALLA

Martin Rogalla (53) studied mechanical engineering at RWTH Aachen. Given his clear career path at Carl Schenck AG and the possibility of going abroad he abandoned his pursuit of a PhD. In 1991 he began working at the Schenck headquarters in Darmstadt. Soon after, he moved to a US subsidiary to head up the engineering department. He subsequently held several positions in Darmstadt. Since 2000 Martin Rogalla has been in charge of mechatronics engineering in the 'Special' business unit. "I still enjoy the variety of my job!", he explains. Over the years, he has received several internal awards and been involved in 32 patent applications.

JULIAN SCHEURING

Julian Scheuring (36) studied mechanical engineering in Karlsruhe. He initially wanted to specialize in microsystem technology. "I then came across Schenck RoTec", he remembers. In 2010 the company had a vacancy for an engineer. He was interested in the scope of the job and the opportunities for promotion. These materialized in 2016, when his boss at the time changed jobs and Julian Scheuring became head of mechanical engineering in the field of 'turbocharger and diagnostics'. Asked what he finds particularly exciting in his job, he replies: "You come into contact with many different industries, and are always faced with new challenges."



HIGHLIGHTS 2016

JANUARY

FULL SPEED AHEAD INTO THE NEW YEAR

Busiest time for upgrade business: At the beginning of January we complete no fewer than 54 upgrades in paint shops right across the world. The Christmas break is the ideal time to carry out such projects on our customers' premises.

FEBRUARY

TOP SUPPLIER

We have completed a large number of projects for Volvo Group Trucks since 1983. The truck manufacturer recognizes our reliability by presenting us with its Purchasing Supplier Award.

MARCH

GROUNDBREAKING CEREMONY IN CHINA

Work on the new Dürr campus in Shanghai Qingpu starts with a grand ceremony.

APRIL

SERVICE OFFENSIVE IN KOREA

We officially open our new service center for Korean customers in Ulsan. The training department is equipped with the latest robot technology.

MAY

SUSTAINABLE

Ford honors us with its World Excellence Award. We receive the prize in the "Green Brand Pillar" category for our sustainable production technology.

JUNE

US CAMPUS OFFICIALLY OPENED

We officially commission our new US site in Southfield, Michigan, in which we have invested € 40 million so we can support our customers even more effectively.

JULY

2,000th SEALING ROBOT

The Application Technology division installs its 2,000th sealing robot. This is in operation at Škoda in Kvasiny (Czech Republic), ensuring perfectly sealed welds.

AUGUST

STRATEGIC SALE

On August 8, we announce the sale of Dürr Ecoclean to the Chinese machinery manufacturer SBS Group. The new owner is able to offer better growth opportunities for the industrial cleaning technology business.

SEPTEMBER

DAZZLING ARRAY OF INNOVATIONS AT THE HOMAG GROUP

More than 4,000 visitors attend the HOMAG & HOLZMA Treff 2016 in Schopfloch and Holzbronn. At this in-house show, they experience a wealth of innovations for every area of the woodworking sector, with the focus on digitally connected production systems.

OCTOBER

SMART MOVER

Première for the EcoRP E043i! The new painting robot operates with seven rotary motion axes, opening up new options for automotive paint shops. Our third-generation robots are controlled by the new EcoRCMP 2 smart controller.

NEW CUSTOMER THANKS TO E-MOBILITY

In China, we win the order to build a paint shop for electric vehicles. The customer is a new automotive manufacturer who wishes to be part of the electromobility megatrend.

NOVEMBER

INNOVATION FOR THE COMMERCIAL VEHICLE SECTOR

Schenck RoTec presents the flexible Cardano system for balancing medium and heavy-duty commercial vehicle cardan shafts.

LOOKING AHEAD:

FOURTH "DÜRR CHALLENGE"

Inspired by the motto "World of Tomorrow", Dürr sent three teams of students along with their camera equipment to Buenos Aires, Dubai and Kuala Lumpur. We run this competition for the best short film to attract attention to Dürr as an international employer.



DECEMBER

NEW BOARD MEMBER

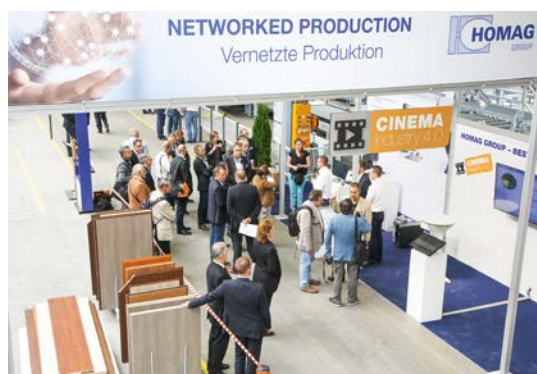
The Supervisory Board appoints a new member to the Board of Management in Dr. Jochen Weyrauch with effect from January 1, 2017. The Board is thus expanded to three members in response to the Group's strong growth.

SMALL-SCALE ACQUISITIONS

iTAC Software AG acquires software company DUALIS, enabling it to expand the application spectrum of the Industry 4.0 platform iTAC.IoT.Suite. In the exhaust-air purification technology field, we take over the KBA-Clean Air division of Koenig & Bauer.



November: Dürr Challenge 2016



September: HOMAG & HOLZMA Treff 2016



May: Ford World Excellence Award



March: Ground-breaking ceremony at Shanghai Qingpu

DÜRR AT A GLANCE

KEY FIGURES (IFRS)

		2016	2015	2014	2016/2015 Change in %
Incoming orders	€ million	3,701.7	3,467.5	2,793.0	6.8
Orders on hand (Dec. 31)	€ million	2,568.4	2,465.7	2,725.3	4.2
Sales revenues	€ million	3,573.5	3,767.1	2,574.9	-5.1
of which abroad	%	84.8	86.0	84.8	-1.2 % ppts.
EBIT	€ million	271.4	267.8	220.9	1.3
EBIT before extraordinary effects ¹	€ million	286.4	294.3	237.4	-2.7
EBT	€ million	258.1	244.5	204.7	5.6
Net profit	€ million	187.8	166.6	150.3	12.8
Cash flow from operating activities	€ million	227.4	173.0	291.3	31.4
Cash flow from investing activities	€ million	-116.9	-94.4	-224.3	
Cash flow from financing activities	€ million	192.5	-162.4	-20.0	
Free cash flow	€ million	129.9	62.8	221.1	106.8
Equity (with non-controlling interests) (Dec. 31)	€ million	831.0	714.4	725.8	16.3
Net financial status (Dec. 31)	€ million	176.5	129.4	167.8	36.4
Net working capital (Dec. 31)	€ million	194.4	236.8	87.6	-17.9
Employees (Dec. 31)		15,235	14,850	14,151	2.6
of which abroad	%	46.1	46.0	45.3	0.1 % ppts.
Equity ratio (Dec. 31)	%	24.8	23.9	24.4	0.9 % ppts.
EBIT margin	%	7.6	7.1	8.6	0.5 % ppts.
EBIT margin before extraordinary effects ¹	%	8.0	7.8	9.2	0.2 % ppts.
ROCE ²	%	41.1	45.3	38.7	-4.2 % ppts.
Dürr stock (ISIN: DE0005565204)					
High ³	€	79.95	109.80	74.50	
Low ³	€	49.52	58.22	49.09	
Close ³	€	76.35	73.60	73.26	
Number of shares		34,601,040	34,601,040	34,601,040	
Earnings per share	€	5.26	4.67	4.33	12.6
Dividend per share	€	2.10 ⁴	1.85	1.65	13.5

¹ Extraordinary effects: € -15,0 million (2016), € -26,6 million (2015), € -16,5 million (2014). Further information can be found in table 2.32 in the management report.

² The according balance sheet figures of the Dürr Ecoclean Group (held for sale) were taken into account in the interests of full comparability.

³ XETRA

⁴ Dividend proposal for the annual general meeting

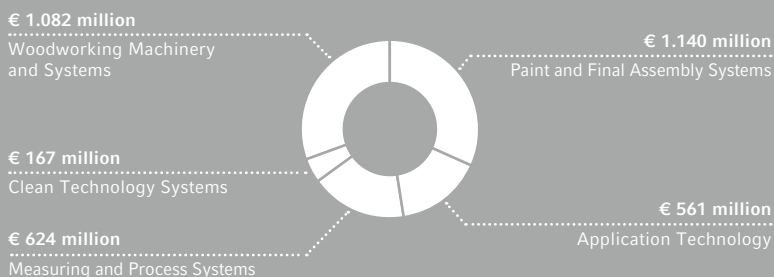
€ 3,702 million

Incoming orders reached an all-time high in 2016

15,235

Employees worldwide

2016 SALES BY DIVISION



2016 SALES BY REGION



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