

# FUTURE TRENDS - PIONEERING SOLUTIONS

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Page 18

Driverless safety Page 26

# AD.

## 60 CLEVER MINDS, ONE GOAL

OS

Ready, get set, go! In August 2018, it was all systems go for the second ADAMOS Hackathon. Around 60 developers took part in the programming competition. Divided into agile teams, they developed prototypes for new software products and apps, all based on the ADAMOS IIOT platform. In the top positions were a solution for online orders of spare parts and an app for controlling data traffic in the cloud. You can find out more about software development, our Digital Factories and the Hackathon by reading pages 18 ff.



www.adamos.com

# EDITORIAL



#### Dear Readers,

The world is moving at an ever-increasing pace, not only politically, but also in economic and technological terms. This is why a globally active company such as the Dürr Group must do more than just monitor global trends. It must seize its opportunity when the moment is right.

Over the past decades, we have proved time and again that we take advantage of opportunities and trends, for instance by developing efficient paint shops, using painting robots, entering into equipment provision for the woodworking industry, and developing digitally networked production processes.

We naturally see ourselves as pioneers, always working to create ground-breaking products and services for our customers. The trend toward digitization is currently far ahead of any other. In our Digital Factories, we are developing smart

applications for machines and systems. The growing importance of electromobility is also an incentive for young entrepreneurs to build electrically powered cars. We advise them and provide the right production equipment. We are also taking advantage of the trend toward autonomous driving. Our new generation of test stands can be used to test vehicle functions in traffic scenarios without the need for a driver behind the wheel. Today, many end customers want products that are perfectly tailored to their needs – from the color of their car to their fitted kitchen. Dürr is shaping the trend toward customization and is developing systems suitable for the efficient series production of one-off products.

"Thanks to our pioneering spirit, we develop ground-breaking solutions for our customers." In addition, there is a growing worldwide awareness around environmental issues. With the acquisition of the companies MEGTEC and Universal, we have doubled the volume of our exhaust-air purification business and can provide even more sectors with cutting-edge technologies from a single source.

We do more than just follow future trends. Thanks to our pioneering spirit, we develop groundbreaking solutions for our customers. Find out about them in our magazine: Future Trends – and our Pioneering Solutions.

I hope you enjoy it!

Ralf W. Dieter CEO of Dürr AG

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## AUTONOMOUS DRIVING

Driverless safety Dürr is perfectly equipped for the age of autonomous driving. Page 26



Customized items produced in series Whether fitted kitchen or car – even one-off items can be produced in series. Page 32

Quo vadis, customization? Prof. Dr. Piller talks about the significance of this megatrend. Page 34

## ENVIRONMENTAL TREND

#### An alliance that works

The acquisition of MEGTEC and Universal strengthens our global reach in exhaust-air purification. Page 35

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Lauscha and Rökona rely on Dürr technology for their exhaust-air purification. Page 40

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# More strength for our customers

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# HIGHLIGHTS

#### JANUARY

#### Pace of digitization

At the newly founded Dürr Digital Factory, software experts work together across the departments. This increases the pace of innovation.



At the marketplace of ideas, Dr. Martin Weickgenannt presents a digital innovation.

#### FEBRUARY

#### And the Winner is...

Five employee teams are presented with the Heinz Dürr Innovation Award, for example for smart apps and a concept for digital system documentation.

#### MARCH

#### Smart paint shop in Vietnam

The Vietnamese conglomerate VinGroup enters into automotive production. Dürr receives the order for building the paint shop.



Dürr built the entire painting line for Chinese electric car manufacturer Sokon.

#### MAY

#### Innovation for e-mobility

New technology for the production of e-mobility drives: Schenck RoTec's eTEN0 machine enables the fully automated balancing of electric armatures.

#### JULY

#### Heinz Dürr celebrates his 85th birthday

The anchor shareholder of Dürr AG is the Honorary Chairman of the Supervisory Board and one of the most respected business figures in Germany.

#### AUGUST

#### New Group website

A modern look, nstant results: the new website goes live.



www.durr-group.com





HOMAG-Treff in Schopfloch is an event not to be missed by the woodworking industry.

#### ADAMOS Hackathon at Dürr

New applications, all based on the ADAMOS IIoT platform – this is the objective of the programming competition attended by ADAMOS member companies.

#### SEPTEMBER

#### Innovations at HOMAG Treff

The in-house trade fair in Schopfloch and Holzbronn is a magnet for customers from the furniture industry and woodworking shops.

#### Latest robots for Sokon

We commission a new paint shop for Sokon, a Chinese manufacturer of e-cars. It uses our third generation of robots – a first in China.

#### OCTOBER

#### More than just painting

In the Dürr lobby in Bietigheim, three robots are at the center of the 'White Time' light installation created by the artist Joachim Fleischer.



At the ADAMOS Hackathon, held at the Dürr headquarters, teams took part in a programming competition.



Black-and-white effects in the Dürr lobby.

#### Highlights

#### New opportunities in environmental technology

We expand our market leadership in exhaustair purification technology through the acquisition of the US companies MEGTEC and Universal.



Worldwide emission regulations are becoming stricter.

#### NOVEMBER

#### Top marks

In the 'Best training companies' ranking of business magazine Capital, Dürr Systems and HOMAG reach top positions.

#### DECEMBER

#### Welcome

Our digital onboarding training goes live: all new employees complete it on screen and familiarize themselves with the Group in an interactive way.

#### Continuity

Ralf W. Dieter remains CEO of Dürr until 2023. His reappointment ahead of schedule ensures continuity in the digital transformation environment.

Thorough training is the basis of success.



Delighted customers are our best publicity. The many awards we won in 2018 motivate us for upcoming projects.

# Surcar Award 2018 for new technology

Recognition in the Far East: In Shanghai, we receive the Surcar Award for Innovation for overspray-free paint application.

# Ford World Excellence Award third time in a row [1]

Outstanding performance as a global supplier leads to another award from Ford.

#### FCA Supplier Recognition Award

Carmaker recognizes exceptional performance during modification projects and continued support by Dürr.

#### Mercedes-Benz Award for AGVs

Award-winning "Operational Excellence" for top performance in automated guided vehicles (AGVs).

#### **Geely Capacity Increase Award**

Sustained success through a competent approach: The Chinese carmaker rewards our work.

#### Bluetech Award for new

**multi-pollutant air-control concept** Lower emissions, better air: Our **Ecopure** CCF exhaust-air purification technology is among the winners.

#### SAIC-GM Best Supplier Award

Top-level consistency: For the seventh consecutive time, we are awarded the highest accolade by one of China's leading carmakers.

#### Chery Jaguar Land Rover Award

Long-haul commitment pays off: the "Long-term Service Award 2017" honors outstanding service.

#### ADAMOS receives German Innovation Award [2]

Inspired by innovative strength: The award is presented for the software platform for the Industrial Internet of Things, co-developed by Dürr.

#### Special prize at the XIA Innovation Awards

The panel creates a new award specifically for the first autonomous workshop.

#### tapio among Germany's 100 most innovative start-ups

Top: According to print magazine "The Hundert", the HOMAG Group's digital eco system is one of the 100 most innovative start-ups.





# N E W H O R I Z O N S



To benefit from the electric driving boom in their country, Chinese carmakers are building new production plants within a short timeframe. With its proven expertise, Dürr is helping them.

TEXT: HEIMO FISCHER - PHOTOS: YONG YANG, SHANGHAI SUCHUAN CULTURE COMMUNICATION

A brilliant project: Dürr experts Daniel Zhang (left), Peter Lee (center) and Jack Zhang (right)

In the summer of 2017, Peter Lee in Shanghai receives a phone call. The Dürr sales director is contacted by a manager from Sokon. The Chinese carmaker is building a plant, where its new electric SUV, among other vehicles, will be rolling off the production line. With its long range, the model will not only be leading-edge, but it must also look good and be produced efficiently. For this the carmaker requires an outstanding paint shop. As quickly as possible. Lee travels to the customer, organizes meetings, and pores over the design together with engineers. Then he submits an offer. Sokon agrees - a mere eight weeks after the initial phone call. "The customer had great confidence in us", Lee says. Normally, this phase takes at least half a year.

Dürr is well-known in the Chinese automotive industry. For years, the company has been building painting lines there – also for manufacturers of electrically powered vehicles. "Thanks to our experience, we can not only provide machines and systems, but we can also actively support our customers in planning their painting line", says Lee. New EV companies like Sokon benefit from this engineering expertise, because it speeds up the planning process.

It is not uncommon for Chinese manufacturers of electric cars to put the pressure on. The state promotes alternative drives to improve air quality in large cities, and encourages manufacturers to produce more electric cars. Last year, the country hit the one million mark. The consulting firm PwC estimates that the number of all-electric cars and plug-in hybrids in China will increase to 4.4 million by 2022. Any manufacturer that gets its electric vehicles into the showroom in good time will be able to benefit earlier from the favorable market conditions.



# "The customer had great confidence in us."

PETER LEE, SALES DIRECTOR AT DÜRR IN CHINA





## STRONG PARTNER

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Chinese automaker Sokon is one of the pioneers in building electric cars. From the outset, its management has focused on quality. This quality is reflected in the perfect paint finish of the electrically powered cars. This is why Sokon had faith in Dürr's experience when building its factory in Chongqing. The painting line includes a new generation of robots, which are especially mobile thanks to their seven axes.



#### E-Mobility New horizons



Of the 63 robots, 36 are responsible for paint application. The others seal car bodies or open engine hoods and doors to ensure those areas can also be treated.



# New factory in the industrial region of Chongqing

It was only in 2017 that Sokon was granted a license by the Chinese government for the production of e-cars. Since then it has been powering ahead. The company's new factory, in which the Chinese automotive group Dongfeng also has shares, is located in Chongqing. The southwestern industrial center is home to 30 million people. Numerous manufacturers and their suppliers have moved there in the last few years.

As soon as discussions with Sokon had started, Dürr put together a team that worked out what the paint shop should look like. Amongst them were Jack Zhang and Daniel Zhang. Supported by the colleagues in Germany, they calculated, among other things, how many painting and sealing robots the manufacturer needed to achieve its target of over 30 cars per hour. Thanks to Dürr's support, Sokon was able to keep its own planning work to a minimum. While other carmakers often have ten of their own staff solely dedicated to designing the robot line, Sokon's streamlined setup consisted of just one person. Jun Deng, paintshop specialist at Sokon, maintained constant dialogue with Dürr to ensure smooth planning and execution.

The new factory needs to allow for several models to be painted. The planners must therefore take into account any differences between the cars from the outset. Sokon's electric SUV has a lengthened body, featuring striking lines. There are also a number of subtle differences between electrically powered cars and conventional vehicles. The electric motor requires less space, while the undercarriage is higher as this is where the battery is located. This can have an impact on the painting process as well as on cavity sealing.

# More than **30**

CARS PER HOUR CAN BE PAINTED IN THE FACTORY.

#### E-Mobility New horizons



Dürr also designed the conveyor technology, which will transport the future cars through the paint shop. It includes a high-bay warehouse, where the car bodies can be temporarily stored. Added to that is a state-of-the-art dry scrubber, which binds residual droplets from overspray without the use of chemicals. Modern exhaustair purification technology ensures that solvents are removed from the air.

In the production process, Sokon relies on traditional methods. The company opted for the use of primer, a coating applied to car bodies to cover even the smallest irregularities, following pretreatment in the dip tank. Only then are the base and clear coats applied.

#### The new generation

Sokon also opted for cutting-edge technology for its painting robots. Chongqing will be the first Chinese plant to use Dürr's new seven-axis models. An additional joint makes the arm of the EcoRP E043i especially mobile. The atomizer, located at the end of the arm, can access hard-to-reach areas inside the car body.

# FOUR QUESTIONS FOR

#### JUN DENG, PAINTSHOP SPECIALIST AT SOKON

## Why did you choose Dürr to build your new paint shop in Chongqing?

As soon as Sokon was established, we started planning a high-end automotive plant. When studying the market, we found that almost all high-end cars were produced in car factories that use Dürr paint shops. A lot of these are famous worldwide and have existed for many years. We thus knew that Dürr is a professional, mature and reliable company.

## Which were the main challenges you had to overcome, together with Dürr, during the planning phase of the new paint shop?

Sokon had only recently been established, and even though the planning team had some relevant experience, they had never designed or implemented a high-end paint shop. Furthermore, our schedule from design to mass production was very tight, so holding extensive technical discussions and finalizing the concept within an extremely short timeframe posed a tough challenge.

## As a new electric vehicle producer, how did you benefit from Dürr's experience in paint shop technology?

In the planning phase, Dürr delivered a professional and advanced concept, which served as the basis for Sokon's cutting-edge paint shop with a high level of automation. In the implementation phase, we were amazed by Dürr's professional and highly efficient approach, which ensured that we completed our engineering work on time.

#### How do you rate your collaboration with Dürr?

Dürr staff are not only professional but also dedicated. Most of the time, Dürr executed the project with a high level of efficiency and quality, without having to involve us. The staff's implementation skills were very good, which really impressed us.

# "Thanks to Dürr's well-qualified team, our project was a great success."



In the past, a robot would be mounted on travel rails to enable it to change its location. These required space and came at an additional cost. The seven-axis model can manage without them.

The Dürr planners calculated that Sokon would need a total of 63 robots, 36 of which for paint application. The others will seal car bodies or open engine hoods, trunk lids and doors so paint and seal can also be applied there. The electronically controlled systems for color treatment and cleaning also came from Dürr.

The robots were built at the Group's Bietigheim-Bissingen headquarters. Since the new generation of robots was dispatched to an overseas customer for the first time, the previously used shipping crates had to be modified for maritime transport. "The robots have a different center of gravity compared to their predecessor models. This is why we had to redesign the shipping crates, so they would not tip over during transport", says André Thurner, who provided support from Germany to the Chinese colleagues. Normally, the robots are packed into containers, loaded onto ships and transported across the oceans – this can take up to six weeks. "As time was of the essence in this project, we shipped part of the cargo by rail", reports Thurner. From the loading station in Duisburg, Germany, the robots traveled across Poland and Russia all the way to China. Trucks transported them the last few kilometers to Chongqing. This approach saved two weeks.

In March 2018, the robots arrived at their destination. In the meantime, Dürr experts had prepared the building, installed the conveyor technology and assembled the other systems. Testing began in July. Initially, ten car bodies made their way through the paint shop every hour. By the end of the year, it was around 15. Since then, the number has continued to increase. Sales director Lee is very happy. He is pleased with the good result – and is waiting for the next opportunity to support young Chinese EV carmakers in turning their visions into reality. dürr robots are standing in the factory

36 OF WHICH FOR PAINT APPLICATION



More information can be found online: www.durr.com/paint-application

# E - MOBILITY PRODUCTIONS FOR



## EcolnCure

There is currently almost no difference between the car bodies of electric cars and those of conventional cars. When looking at the details, however, differences do exist. One example is the rocker panel, an area underneath the door. In e-cars, it must be reinforced to protect the battery in the event of a lateral collision. The freshly painted rocker panel of the e-car dries in the warm air flow of a conventional drying tunnel, but this takes time. This is why Dürr's



EcoInCure car body oven blows hot air onto the components through the windshield opening. To this end, the car bodies are transported through the oven transversely. This makes for gentler drying, prevents thinner car body parts from overheating, and enhances the paint finish. EcoInCure is also economical, lowering energy consumption by 25 percent. **25%** Less energy

**50%** SMOOTHER PAINT FINISH

## e T E N O

Electric motors consist of several components, one of them being the electric armature. To ensure the motor works properly, it is essential for the armature to run free from vibration. This is why manufacturers balance electric armatures. Introduced in 2018, the eTENO balancing machine by Dürr's subsidiary Schenck is ideally suited to the fully automatic

series production of electric armatures, and works with maximum precision. It can be integrated into manufacturing execution systems and other IT networks.



SPECIFIC RESIDUAL UNBALANCE OF 0.1 GMM/KG



UP TO 60 L OF REFRIGERANT IS ADDED FOR THE BATTERIES

### ProLine

The battery is the most valuable part of an electric car. But heavy batteries only function reliably if their temperature is maintained at between 20 and 40 degrees Celsius during operation. This is why they require refrigerant. Up to 60 liters of this needs to be added at the factory. This must happen quickly to ensure that cycle times can be maintained. Filling specialist Dürr Somac offers a suitable system in ProLine. This generates a vacuum in the refrigeration system prior to the filling process. The refrigerant is then added under high pressure. The system is versatile, thanks to its design. Aside from batteries, it can also be used to fill clutches, radiators or power steering systems with fluids.

# THE FUTURE FACTORY

In our Digital Factories, around 100 experts are driving forward networked, smart manufacturing. To develop digital products successfully they must not only be creative but also work fast. This is why they rely on new forms of cooperation.

TEXT: HEIMO FISCHER - PHOTOS: HELMUT PANGERL

Ties? Not worn much around here! Suits? Hardly! Instead, people wear shirts and jeans. In a focused but informal atmosphere, they look at posters and screens, and discuss new digital ideas. The software developers and control engineers are part of the Dürr Digital Factory – Dürr's vanguard into the world of networked industry. Several times a year, they spend a day together in the lobby of the Group's headquarters in Bietigheim-Bissingen, where they discuss their projects at high tables and stands.

One of them is Nico Koch. He manages a team of 11 people between the ages of 23 and 40. Koch enjoys working in the Digital Factory. He likes his colleagues' commitment, passion and energy. "We cooperate really well", says the 40-year-old. Routine? Boredom? They are even rarer in the Digital Factory than they are elsewhere in the Group. One of his current projects is to develop an application for evaluating data from manufacturing, which makes the maintenance of machines even easier and more predictable – thus increasing the quality of production. This



The future as a job: Nico Koch presents a smart application.

"Developers have to identify market trends early on, and be able to assess the opportunities for new applications right away"

DR. JOCHEN WEYRAUCH, CEO OF DÜRR SYSTEMS AG is one of many solutions that offer measurable benefits to customers from the automotive industry.

The Dürr Digital Factory is a cross-divisional organization. This means that employees work together, but belong to different divisions – Paint and Final Assembly Systems, Application Technology or Clean Technology Systems. In the past, there would sometimes be several teams working on similar ideas. Now, their strengths can be used in a targeted way in the Digital Factory.

The same goes for Woodworking Machinery and Systems, the division created following the acquisition of HOMAG Group AG, headquartered in Schopfloch in Germany's Black Forest region. At this division, which produces machines and systems for the woodworking industry, software experts have joined forces in another Digital Factory – specializing in their customers' specific requirements. "We often find that furniture manufacturers no longer buy stand-alone machines or systems", reports Uwe Jonas, Vice President Consulting and Software at HOMAG. Instead, they need end-to-end solutions for their factories and workshops, from cutting to packaging of finished parts. Ideally, production lines must be able to manufacture furniture in batch-size 1 production, where no two pieces of furniture are the same. These production systems are controlled by software that is complex yet easy to operate, developed by HOMAG's Digital Factory. Another Digital Factory can be found at Dürr's subsidiary, Schenck RoTec.

#### Radical transformation

Industry is undergoing a profound, technological transformation worldwide. Today, production between individual plants is already closely interconnected. In the long term, it is likely that factories will no longer work in isolation, but will self-coordinate via digital platforms. Thanks to the Industrial Internet of Things (IIoT), this will one day be possible across continents, fully automatically. Companies can compare and coordinate the plants of their production network. Dr. Jochen Weyrauch, CEO of Dürr Systems AG, has no doubt: "This is a trend in mechanical engineering that plays a crucial role in shaping the future of this industry."

As a result, Dürr's competitors not only include familiar companies from the mechanical and plant engineering sector. "Software companies also want to gain a foothold in the market", says Dr. Annabel Jondral, Senior Manager at the Dürr Digital Factory. They offer their own IIoT platforms and also provide applications.

This is why Dürr has developed the ADAMOS IIoT platform, together with partners from the mechanical engineering and software sectors. Linked to this are the LOXEO and tapio online marketplaces. Customers can use these to obtain services and applications that will make their machines more productive. LOXEO is aimed at customers of the Dürr and Schenck brands, while tapio is a digital ecosystem for the entire woodworking industry, where even competitors are allowed to offer their own apps.

#### Quick decisions, flexible work

Digitization is increasing the pace of development in all industries. A good machine is ready for the market within three years, good software within just a few months. "This is why developers have to identify market trends early on, and be able to assess the opportunities for new



Well organized and at high speed: Marcel Geister from the Dürr Digital Factory at work.

applications right away", says Dr. Weyrauch. Customers' wishes can also change very quickly. This means suppliers like Dürr are decreasingly able to plan the development of new software in any detail. Flexibility is key.

This is another reason why the Digital Factory relies on the principle of agile working – a method whereby teams organize themselves in an independent and flexible manner, where appropriate, and work incrementally. This means the software development occurs in small steps, and improvements are implemented continuously. In the Dürr Digital Factory most teams generally self-organize, take responsibility for their decisions and divide tasks among themselves. This ensures that work carries on, even when managers are not available to make important decisions.

#### Digital data is the new raw material

Having your own ideas and thinking outside the box are welcome characteristics at the Dürr Digital Factory. It's the kind of environment that really suits Paul Thomä. The 30-year-old mathematician has been working at Dürr for a year and is happy here: "I like the relaxed approach and the flat hierarchies." Thomä is working on the development of self-learning systems, which use large data sets. His work forms the basis for manufacturing lines which, in the age of artificial intelligence, are designed to optimize their processes autonomously.



Modern management: Dr. Annabel Jondral and Nico Koch discuss the progress of a project.



The employees of the Digital Factories have regular meetings to exchange ideas

Manufacturing data is the raw material for the Digital Factory - from pump pressure and temperature through to operating hours. In factories this data has long been determined by means of sensors, among other things. These are installed at different locations and have, until now, mostly served to monitor processes. The Digital Factory experts are taking it further: their applications perform real-time comparisons between current values and setpoints, something that experts refer to as 'streaming analytics'. Historical data is also analyzed. This helps to identify deviations or patterns. The results are used to optimize troubleshooting and maintenance. They also allow indications of process quality and therefore quality of manufactured products. The aim is to manufacture as many parts as possible, defect-free from the outset. The higher this 'first run rate', the lower the cost of any rework.

There are currently around 20 development projects at the Dürr Digital Factory. Automotive factories are already using the first software products. For employees, this provides a high level of motivation. Success is important to ensure that work in the Digital Factory is fun.

And it should remain so in the future. So far, this has not been an issue. According to team leader Koch, his employees "are really passionate about these topics".



# SMART APPLICATIONS FROM THE DIGITAL FACTORIES

**ADAMOS** In 2017, ADAMOS was created as the IIoT platform for the entire mechanical and plant engineering sector. Our customers can use the digital marketplaces, LOXEO and

tapio, to find services from a single source, specially developed for optimum equipment use. These new, innovative applications are conceived in our Digital Factories and are designed to make production more efficient. Here are three examples from Dürr and the HOMAG Group.



#### **EcoScreen Equipment Analytics**

This analysis software seamlessly records all data from the painting process. Based on this, a 'digital fingerprint' is created for every painted car body. It contains information, for example, on the painting robots' movements, on paint consumption, and on the exact position of the car body during painting. If a quality problem occurs, the cause can be determined immediately using the recorded

data. For instance: for each painted car body the plant operator can project every path

taken by the painting robot onto the CAD model of the car body on the screen. In addition, algorithms process data from the painting process in real time and show anomalies. Thanks to this Streaming Analytics function, any errors can immediately be rectified. A Batch Analytics function will soon also be available. Here, the software analyzes historical data, detects trends, and uses artificial intelligence to develop predictions and recommended actions



#### **EcoScreen Maintenance Assistant**

This application supports customers in the maintenance of large automotive paint shops, where thousands of components, such as pumps, valves, filters or sensors, must be serviced. The EcoScreen Maintenance Assistant keeps a record of all components. It shows maintenance dates, provides access to instructions, prompts completed work acknowledgment, and prepares





a maintenance history. One unique selling point is that the software not only signals the dates of fixed maintenance intervals, but it also works on a cyclical basis. This means it counts how often a component has been used and calculates the remaining operating time. For this purpose, it accesses the controls in the paint shop to retrieve usage data.



#### intelliSanding

Whether sanding, painting, laminating or planning - using the right app makes everyday jobs simpler and more efficient. This is why the HOMAG Group has developed a special app family for this purpose. The apps of the Surface Processing business unit include digital production assistants for machine operators in industry and trade. One example is the sanding app, intelliSanding.

It suggests to the user the settings that are most suitable for the project. Moreover, it calculates and visualizes the remaining life of the sanding belts, and estimates the volume of chips to be extracted per day, shift or minute. HOMAG applications also work with the machines of other manufacturers and thus offer huge market potential.

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vis.yml

python-tool

# HACK-ATH (

#### \_A programmers' competition

Focused on the job and having fun together – this best describes the atmosphere at the second ADAMOS Hackathon. For three days, 60 programmers developed apps and other software products for the Industrial Internet of Things (IIoT). The photo series below shows impressions of the competition hosted by Dürr, which is now planned to be held on a regular basis.

TEXT: HEIMO FISCHER - PHOTOS: SASCHA FEUSTER



Overview: The seven Hackathon teams have to organize their work themselves. The participants come from Dürr and other partners of the ADAMOS IIoT platform.

#### \_What is a Hackathon?

A Hackathon is a software programming competition. The participants mostly come from different fields and work in mixed teams. They are thus able to share their experiences and make new contacts. Unlike a normal work meeting, the Hackathon focuses even more on having fun with the activities and showing a passion for the product. The term 'Hackathon' is an invented word: the first syllable refers to the verb to hack, which used to refer to the activity of gaining unauthorized access to third-party IT systems. In IT circles, the word is now also synonymous with legitimate programming. The second part of the term comes from marathon – after all, a Hackathon requires stamina. It often lasts several days.



Informal and relaxed: Dürr CEO Ralf W. Dieter (center) puts the good Hackathon results down to the fact that no restrictive rules were given.



ECO The Dürr Group Magazine

Working as a team: There are no lone warriors at the Hackathon. All problems are

61

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Sharing the outcome: The teams have to prepare a detailed presentation of their results.





Keep calm: It's not just stress but also fun that leads to success.



Discussing ideas, sharing knowledge, presenting solutions: Communication is an important part of the Hackathon. AD 



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Open-air meetings: The teams can choose their own workplace.

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ECO The Dürr Group Magazine







# "Informal yet focused and motivated to the max: The Hackathon team really impressed me."

RALF W. DIETER, CEO OF DÜRR AG



A typical Hackathon day: The team is surrounded by notebooks, post-it notes and tables.

ECO The Dürr Group Magazine

# D R I V E R L E S S S A F E T Y

The first driverless cars are scheduled to go into production in 2025. Manufacturers will need to ensure early planning for the necessary production systems. Dürr has therefore developed test stands for fully automated testing of self-driving cars after assembly – and these are already simplifying the acceptance of conventional vehicles.

TEXT: HEIMO FISCHER - PHOTOS: OLIVIER HESS



All the wheels are in motion: Development Director Dr. Thomas Tentrup in front of the x-road curve test stand.

# "We are prepared for the age of autonomous driving."

DR. THOMAS TENTRUP, DEVELOPMENT DIRECTOR

The new car rolls off the assembly line. Its engine starts automatically. The vehicle drives itself to the final stations in the plant – the endof-line test stands. It maneuvers into the correct position. Lasers light up, the car is automatically measured, and a large screen then swings into place in front of the hood. The simulated test drive begins shortly after that. Fully automatically. Gas, brakes, sensor systems – state-of-theart software has completed all the checks within just a few minutes, without any human intervention. The driverless car drives slowly away from the test stand and is ready for shipping to the customer a short time later.

For the moment, this scene only exists in a computer animation, but it could already reflect reality in many automobile plants. Development Director Dr. Thomas Tentrup and his 20-strong project team at Dürr Assembly Products in Püttlingen, in the German state of Saarland, have designed test stands that enable fully automated end-of-line testing of conventional cars – while also offering so much more: "They also permit automated testing of autonomous and semiautonomous vehicles," says Tentrup. Manufacturers are already selling cars that can cover short distances driverlessly. Their plan is to launch fully automated cars from 2025 onward. In-plant testing will then become even more crucial because occupants will have to have implicit faith in the faultless operation of self-driving vehicles. Tentrup confirms that the necessary testing technology is already available. "We are prepared for the age of autonomous driving."

#### Final testing before operation

Test stands are some of the most important stations of the automotive production process. This is where the decision is made as to whether a car can be shipped or has to be sent for reworking. All functions that have a bearing on safety are meticulously inspected once more. The results are so important that they are stored in databases. In the event of an accident even years later, manufacturers can then demonstrate that testing was carried out correctly. This documented proof will become even more important with driverless cars.

**170** KM/H



Focusing on the essential: Design Engineer Stefan Rothfuchs explains how the rollers on the x-road curve test stand work.

Car manufacturers around the world rely on test stands from Dürr Assembly Products, which are also manufactured in China, Brazil and the Czech Republic in addition to Germany. Püttlingen is home to the parent plant, where workers manufacture the test stands to customer specification in large production buildings. They assemble metal framework structures, on which they then mount motors and sensor systems. However, a large part of the work takes place in the background rather than on the shop floor itself. Dürr experts develop and design the test stands on the computer and provide them with the appropriate software.

Test stands are not off-the-shelf products. "They consist of modules that are individually combined," states Tentrup. Exactly what they look like depends primarily on the vehicle manufacturers and the models they have to test. The experts from Püttlingen continuously improve their products. The company has a groundbreaking, patent-pending innovation in the form of the x-road curve test stand, on which autonomous and semiautonomous vehicles can be tested. But it also makes testing of conventional cars substantially simpler.

#### Tiltable rollers prevent vehicle drift

Up till now, there has always had to be a person at the wheel to drive a new car onto the test stand. The driver parks the wheels of the drive axle on rollers mounted in the floor of the platform. Pressing the gas pedal causes the wheels and the rollers to rotate. The vehicle therefore remains on the same spot. However, if the steering wheel is not set to drive straight ahead, the vehicle moves to one side or the other. Someone therefore has to correct the steering to prevent the car from breaking away laterally. With the new x-road curve test stand, that is no longer necessary. Design engineer Stefan Rothfuchs points to two tiltable roller mounts. They automatically correct steering movements by the wheels. Two lines of red light shimmer on the sidewalls of the tires. "Laser sensors measure the wheel angle relative to the roller

mounts," explains Rothfuchs. Smart software analyzes the data and transmits control signals to electric motors that adjust the direction of the rollers. In this way, they correct the wheels' steering movements and prevent the vehicle from drifting to the side. Tests can therefore be run automatically without having to have a driver at the wheel to intervene. In addition, cornering can also be simulated in a practical test for the first time.

A new take on the drive-in cinema: Testing the car's response

important when it comes to autonomous driving.

to the traffic scenarios displayed on screen. This is particularly

Although the principle sounds simple, the development of the tiltable rollers was difficult. According to Tentrup, who has a doctorate in theoretical physics, understanding the force that acts when the wheels make a steering movement was one of the major challenges. "It took us a long time to understand the effect." Since there was nothing in the literature either, the principles had to be developed in-house with support from universities, and verified in a computer model. Only once the developers had grasped the principle did they move on to designing the new test stand. Today, Dürr also supplies the tiltable roller units as a retrofit kit that vehicle manufacturers can use to upgrade existing test stands.

#### Virtual streets and scenery

The x-road curve can be linked to virtual scenery that passes by on a screen to test autonomous vehicles. That means the car drives along the road as in a computer game and tackles various traffic situations. This enables the system to test how well the electronic systems work in conjunction with autonomous or semiautonomous driving. Do they detect obstacles quickly enough? Do they register traffic lights, traffic signs and avenues of trees? Are pedestrians identified in good time in the dark? Driver assistance systems, as fitted in practically all new cars, already handle some of these tasks. They are more or less the precursors of autonomous driving, operating by means of a camera, laser or radar. A handful of these sensors are tested in passing on conventional test stands. But their number rises every time a model is changed. "We assume that around 40 sensors will have to be calibrated in autonomous vehicles," says Tentrup.

This high number would exceed the capabilities of conventional test stands. Particularly as the sensors in a driverless car have to work with extreme precision. They will play a crucial role in safe driving with autonomous vehicles.

#### Lights out

Calibration of the safety-relevant sensors is therefore a crucial step – for which Dürr has developed the new x-around test stand. It looks

# Around 4

SENSORS HAVE TO BE CALIBRATED IN AUTONOMOUS VEHICLES AT THE FACTORY.



The right perspective: Martin Wagner, Product Manager Autonomous Driving (left), discusses the optical sensor test with Design Engineer Vincent Thiel (right). like a garage and can be completely blacked out. That is important as no interference from a light source can be permitted while the sensors of an autonomous car are finding their optimal position.

The chassis geometry of each vehicle must be precisely measured before the sensors are calibrated on the test stand. Every vehicle deviates from the specifications as a result of production tolerances. These variations have to be taken into account during setup so that the sensors can precisely determine distances from objects and their speeds.

Martin Wagner, Product Manager Autonomous Driving, shows how the sensors are set up. A screen swings into place in front of the vehicle, and it goes dark in the test stand. Patterns of circles and rectangles are displayed on the monitor, similar to an eye test. "The optical sensors are automatically calibrated with the aid of the outlines," explains Wagner. Test stands often still use printed panels to calibrate the sensors, but the Püttlingen developers regard that as unsatisfactory. "We have found that the most precise results are achieved when the calibration patterns are displayed on monitors," says Development Director Tentrup.

Setup takes just a few minutes. The vehicle can then exit the test stand. Tentrup is happy. Dürr unveiled the new test stands to car manufacturers from around the world in the fall of 2018. The first sales talks are underway – which indicates

that fully automated testing in automotive plants will become standard before the first autonomous vehicles roll off the production line.





## THE X-AROUND STAND – POSITIONING, MEASURING, SETUP

Setup

The optical sensors are automatically calibrated with the aid of the patterns displayed on the monitor.



The movable base plate adjusts the vehicle prior to measuring.

**Measuring** The chassis geometry of the vehicle is measured by lasers fixed to tiltable mounts, before calibration begins.





# "Our test stands consist of modules that are individually combined."

DR. THOMAS TENTRUP, DEVELOPMENT DIRECTOR

## BERLIN BUSES OPERATE DRIVERLESSLY

Autonomous driving can already be seen in action in Berlin, where automated buses transport patients and visitors to their destination on the Charité hospital site. The small, yellow vehicles of the BVG, Berlin's municipal public transport company, travel almost silently along a defined route. They operate across the extensive site with its institutes, restaurant and administrative buildings at a speed of up to twelve kilometers per hour. The pilot project, under the name "Stimulate", is scheduled to run until 2020 with the aim of providing answers to practical questions on autonomous driving.



Up till now, a qualified driver from the Berlin transport company has been on board as a precaution.

"Our aim is to make Berlin one of the leading smart cities."

> MICHAEL MÜLLER, GOVERNING MAYOR OF BERLIN

Source: Berliner Verkehrsbetriebe, Andreas Süß

# CUSTOMIZED ITEMS PRODUCED IN SERIES

It should really be something special – more and more people are guided by this principle when making a purchasing decision. Whether fitted kitchen or car – customized items can be produced in series thanks to manufacturing technology by the Dürr Group.

TEXT: HEIMO FISCHER



**1,200 KG** LOAD OF THE AUTONOMOUS GUIDED VEHICLE

#### 400-500 PIECES MACHINABLE PER SHIFT



# AUTONOMOUS CARPENTRY WORKSHOP

A wider drawer, a higher table, a narrower cupboard - customers are requesting more tailor-made furniture. The woodworking industry has long been prepared for this and uses HOMAG Group technology to produce customized items fully automatically and with an efficiency similar to that of series production. What has so far been the reserve of large companies is now also a viable option for small carpentry workshops. The Dürr subsidiary from the Black Forest in Germany has developed the 'autonomous cell', a workshop that operates fully automatically. Tailor-made wood panels are initially given a machine-readable bar code, containing all machining information. In a subsequent step, a machine applies glue to the cut edges of the wood. Now comes the centerpiece: a CNC machine, which drills holes and fits dowels with maximum precision. The workpieces are transported by a small autonomous guided vehicle. The movable robot travels between the stations, collects panels and deposits them at the next machine or in a temporary storage facility. This is controlled by software which interconnects all components in the workshop.



# CLEAR CONTOURS FOR MULTIPLE COLORS

To stand out from the crowd, buyers of new cars often order a contrasting color for the car roof. Or they ask for a decorative stripe to give the car a nice, sleek look. Making owners happy means a lot of effort for manufacturers. After the first coating, factory workers must cover the car body with masking film and, as if applying a template, expose just those areas which will be sprayed in a different color. After the second coating, the masking film is removed. This requires time and material. Dürr's **Eco**PaintJet process offers a solution, whereby the nozzles in the robot arm no longer leave overspray on the car body. Since overspray lands in unintended places, sharp edges cannot be created without a template. The EcoPaintJet nozzles hover very closely over the car body surface and work so accurately that even the tiniest paint droplets land in precisely the right place. This enables color stripes to be applied exactly side by side and with sharp edges and the result is faster, cleaner and more economical than ever before.

## CLEANING PIGS

They are reminiscent of rainbows, sapphires or Sahara sand - such are the names given to special colors popular among vehicle buyers. The number of striking and unusual paints applied to passenger cars and commercial vehicles has multiplied in recent years. The models with special colors are often painted in very small series, which increases costs. Manufacturers therefore want to equip their painting lines in a way that enables special colors to be changed quickly, economically and with minimum residues in series production. For this purpose, Dürr has developed the **Eco**Supply P special paint supply system, which is particularly suitable for low quantities. The system uses the so-called 'pigging technology'. Pigs are small, movable plugs which move paint through hoses. Once paint has been applied, these pigs push any residual paint back into the containers without leaving any residue, then clean the hoses. This happens faster and with substantially less paint loss than in the previous, commonly used small-ring hose systems. The entire system, from pig through to painting robot, is controlled using Dürr's smart system technology.

UP TO 95% LESS PAINT LOSS

UP TO 2,000 Additional colors





#### Customization Quo vadis, customization?

# QUO VADIS, customization?

Globalization, digitization and increased prosperity have multiplied the options for self-fulfillment – while also fanning the desire for it. Customization is a trend that is not only impacting society, but also offering opportunities for business. Prof. Dr. Frank T. Piller is one of the leading experts on strategies for customer-centric value creation, such as mass customization and personalization. We discussed this trend with him.

#### Professor Piller, why is customization gaining ever greater traction nowadays?

There are two significant societal developments in this regard. First, the growing diversity in terms of ages, cultures and lifestyles. This is also reflected in greater product variety. Second, generations Y and Z are now becoming consumers. In their personal media consumption, customization is all they know. TV and LPs are an alien world to them. They are used to video-on-demand, streaming and self-curated newsfeeds. Ultimately, that also carries over into their personal consumption. Overall, however, the retail sector remains the main driver for customization of consumer goods. Because products or packaging customized for a retail chain ensure an exclusive range. And exclusive ranges are not subject to the usual price competition.

# So, does every company need to ensure that its products are customizable?

No, and what is also important is that customization does not mean that a product is manufactured on demand as a one-off. Customers want what they want – how the manufacturer satisfies that is not their concern. And if a mass-produced product satisfies this need, that's fine. Hence the very successful match-to-order applications in the sports shoe sector, for instance, in which an existing product is offered to a customer to match their requirement. There are enough sports shoes on the market. I just don't know which of them best meet my needs. Mass customization occurs here in the sales process.

## How can mechanical and plant engineering companies benefit from customization?

By creating benefit for their customers! Customization is not an end in itself. It has to come into play where the machine purchaser is willing to pay for the customization - such as for a machine capable itself of manufacturing customized products. But I know enough machinery manufacturers who proudly demonstrate the many options for the customized production of goods using their plant, only to be surprised later on that the potential machine purchasers have no idea what they are supposed to do with all the customization options. That's because there is no appropriate business model in place yet. I also see great potential in the customization of accompanying services. Service business, if well managed, is always mass customization.

#### What direction do you think we are heading in? By 2050, will we only be ordering clothes and cars that are fully tailored to our specifications?

An exciting question – without a one-size-fits-all answer. In the future, we will be more likely to share cars than to own them. Customization will then be all the more important during the usage phase. Not via hardware components, but via smart products. By that we mean that users will customize commoditized products to their own tastes and wishes via software adaptations or personalized services. Networked cars offer plentiful options in that regard. For instance, they automatically adjust the interior lighting to my preferences. At the same time, however, in those markets where people still own the car, the desire for customization of the "hardware" will continue to grow. In the case of clothing, we can already see that production is relocating from low-wage countries to the sales markets themselves, thanks to automated production technology. In this case again, though, I don't see the end customer as the main user of customization but rather the retailers or business-to-business-to-consumer business models: Every retailer can now order a customized collection for the coming week, but also, for instance, an influencer on Instagram can create her own extremely short-run fashion collection and sell it to her followers. This type of customization offers huge potential!



**Brief resume** 

Prof. Dr. Frank T. Piller heads the Institute for Technology and Innovation Management at RWTH Aachen University in Germany. He is also the director of studies on the joint Executive MBA of RWTH Aachen University and Fraunhofer Gesellschaft. He is the co-founder of the Smart Customization Group at Massachusetts Institute of Technology (MIT) in the United States, where he worked at the MIT Sloan School of Management from the end of 2004 until early 2007. Environmental Trend An alliance that works

# AN ALLIANCE THAT WORKS

The acquisition of the US companies MEGTEC and Universal has enabled Dürr to expand its market leadership in exhaust-air purification technology. Customers benefit from tailor-made solutions and quick service from a single source.

### STRONG PRESENCE WORLDWIDE



"Through the acquisition of MEGTEC and Universal we are strengthening our position as a high-performing world market leader in industrial exhaust-air purification technology, who can deliver first-class products and services to customers around the world."

> RALF W. DIETER, CEO OF DÜRR AG



### K N O W - H O W

The reorganized Clean Technology Systems division now benefits from a comprehensive product portfolio. MEGTEC and Universal offer air pollution control, noise abatement and battery coating systems, which round out Dürr's range. Benefits also result from the comprehensive industry knowledge: Dürr is particularly familiar with the automotive, pharmaceutical and chemical industries, while MEGTEC knows the packaging industry, and Universal has good contacts in companies in the oil and gas industry.



## NEW MARKETS, NEW OPPORTUNITIES

Emission limits are getting stricter almost everywhere in the world – and this also includes the emerging regions. There is a growing demand for high-performance exhaust-air purification systems. Dürr is now present in all important regions, with 1,500 highly qualified experts working to serve customers in the exhaust-air purification sector. Clean Technology Systems is planning to increase its sales to as much as € 500 million by 2021.



Today, Dürr is the only player in the market who can offer its customers all exhaust-air purification technologies and acoustic solutions from a single source. Those requiring a filter system for particulate matter and a thermal exhaust-air purification system, for example, no longer need to approach different suppliers. Dürr can provide a tailor-made technology mix from a single source.

# MORE STRENGTH FOR OUR CUSTOMERS

Interview on the completed acquisition of MEGTEC and Universal



All around the world, countries are adopting stricter environmental regulations to protect both nature and humans. Industry must therefore further reduce its emission levels – with the help of new technologies. To meet the growing demand, Dürr has acquired US companies MEGTEC and Universal, thus expanding its leading position as a supplier of exhaust-air purification technology. Dr. Daniel Schmitt, head of Dürr's Clean Technology Systems division, and Kenneth Zak, former Senior Vice President of the acquired companies, now head of the division in America, explain the background of the takeover and how this benefits the customer.

INTERVIEW: HEIMO FISCHER - PHOTOS: SASCHA FEUSTER, DAVE SIMPSON

Symbolic handshake between Dr. Daniel Schmitt (left) and Kenneth Zak (right): MEGTEC and Universal have been part of the Dürr Group's Clean Technology Systems division since October 2018.

#### Dürr already had a wide environmental technology range. Why did you decide to make this acquisition?

S DR. SCHMITT: Because we see the expansion of the division as a strategic opportunity, not just for our customers but also for us. Sales in exhaust-air purification technology have already seen encouraging growth over the last few years. With the acquisition of MEGTEC and Universal, we are moving to the next stage of growth. We now have 1,500 highly qualified experts working on first-class products in our exhaust-air purification section. For 2019, we are targeting annual sales of between 430 and 460 million euros. In 2018, it was 227 million euros. We expect this figure to increase to up to 500 million euros by 2021.

#### What makes you so confident?

- S Emission limits are becoming more stringent, especially in emerging markets but also in industrial countries. There, our industrial customers need ever-more efficient exhaust-air purification systems. We are thus already seeing a marked increase in the demand for our products.
- ZAK: An added fact is that, together, we are the only player in the market who can offer customers all exhaust-air purification systems from a single source. The same goes for acoustic solutions. Noise control is another area where regulations are getting stricter and where our customers need efficient and economical solutions. This is an excellent basis for future growth.

#### What goals are you pursuing through your combined work?

We want to impress customers with our products and lead the Clean Technology Systems division into the future as the global market leader in industrial exhaust-air purification. We can achieve this by consolidating our knowledge as a united and strong team to develop new products worldwide that the market is waiting for. S Furthermore, we are now close to our customers in all important regions. Our combined, global ranges complement each other perfectly. Emerging industrial customers in Asian and possibly South American economies represent a huge market potential for our products and services. Already in 2018, 44 percent of incoming orders in environmental technology came from companies in emerging countries, with China alone making up 28 percent.

#### What does your new portfolio look like?

S Aside from our existing range, we are increasingly developing optimum solutions for very different customer groups.

#### Can you be more specific?

A company requiring both a filter system for particulate matter and an exhaust-air purification system, for example, no longer needs to deal with several suppliers, but can purchase the ideal technology mix, suited to its needs, from us.

# Complex systems require excellent service – how will you provide this together?

- S We have moved closer to our customers over the last few months. We can respond to their wishes better and faster, because our site network has become much denser. This enables us to offer ever better service. But it is not just our engineers that reach our customers faster. Spare parts are also available more quickly.
- Z We cannot stress these aspects highly enough. Service is extremely important to our customers and for future sales. Customers will only be loyal if their experience shows that their systems work properly. Every minute of outage costs them money.

#### How do your product ranges complement each other?

- The technologies of Dürr, MEGTEC and Universal complement each other very well. There are only a few overlaps, for example in thermal exhaust-air purification systems. For particulate matter, sound control and acid gas systems, on the other hand, MEGTEC and Universal offer products that complement the combined range perfectly for customers.
- S Furthermore, our strengths benefit a number of very different sectors. Dürr supplies the automobile, pharmaceutical and chemical industries. MEGTEC is particularly familiar with customers in the packaging industry, while Universal has extensive expertise that benefits the oil and gas industry.
- Z MEGTEC also offers complementary technologies. One example is the wet electrostatic precipitator, which is used not only in the mining industry for smelting operations but also in the wood products industry.

# "We will respond even faster and better to customer wishes."

KENNETH ZAK



### WELCOME TO DÜRR

In 2018, Dürr bought the industrial environmental technology business of US plant engineering firm Babcock & Wilcox. The three subsidiaries with the core brands of MEGTEC and Universal cost 104 million euros. They round out Dürr's industrial exhaust-air purification range. In 2018, MEGTEC and Universal together achieved annual sales of roughly 200 million euros. With the acquisition being completed in the fall, Dürr was still able to book around one quarter of this in 2018. Around 860 employees work in the acquired companies. Through the expanded Clean Technology Systems division, Dürr now has three key sites in the United States. Added to that are further sites, including in China, Australia, India, Korea, Thailand and Mexico. The division is thus represented through 25 sites in 13 countries.



Exhaust-air purification system at night

#### What are the economic benefits of the acquisition?

S It is aimed at providing synergies to offer industry better and more efficient products. Our combined product portfolio alone is increasing our market opportunities. In addition, our cooperation will lead to substantial cost savings in procurement – not least as a result of product standardization. This will also benefit customers because components, for example, will be available more quickly.

#### How do your customers recognize you in the market today?

S We offer our products by using three brands that are all clearly part of the Dürr family: Dürr, Dürr MEGTEC and Dürr Universal. We operate as a unit when dealing with customers.

#### What does this mean?

S We are creating teams of experts for individual industries. Our sales people offer the entire range of our exhaust-air purification technology to customers in automotive construction, for example. Others act as designated contact points for the pharmaceutical or wood products industry.

# Will customers still be able to reach their usual contact points?

Absolutely. Nothing has changed with regard to phone numbers or email addresses within the companies. We are here as one team for our customers, and we are making sure that changes will not cause them any inconvenience.

# How did you proceed in your search for the right acquisition partner?

S To begin with, we prepared a list of potential acquisition candidates. The most important requirement was that they should be a good match for us. We also wanted them to help us expand our range and further penetrate markets. MEGTEC and Universal were among the candidates we thought most likely to fulfill this. And as it happened – shortly after that, the two companies were indeed up for sale. We did not hesitate for one minute.

#### Many thanks for the interview.



More information can be found online: www.durr.com/environmental-technology

# CLEAN!

Whether in the chemical factory, in food manufacturing or in a plastics plant – many production processes generate contaminants which accumulate in exhaust air. This is why Dürr has been building exhaust-air purification systems for five decades. The following two examples feature customers who have clean production thanks to Dürr.

TEXT: HEIMO FISCHER - ILLUSTRATION: JAN SCHMITT

#### Three methods in one plant

Lauscha Fiber, a company based in Thuringia (Germany), produces glass fibers. These are an important component, for example, of batteries used in cars with an automatic start-stop system. Producing the glass material in the furnace generates dust and nitrogen oxide. To reduce emissions, Lauscha Fiber wanted to modernize its exhaust-air purification system. Following a thorough search, the company became one of the first German customers opting for Dürr's Ecopure CCF. The system can simultaneously reduce dust, sulfur and nitrogen oxide contained in exhaust air. This is a major advantage compared to conventional systems with a multi-stage purification process, where exhaust gases have to be heated and cooled several times. Now, the dust and nitrogen oxide emissions are substantially below thresholds expected in the future. Ecopure CCF is also lowmaintenance: For the purpose of servicing, it is possible to switch off individual modules rather than the entire system, without interrupting regular operation. And in the event of a fault, service technicians are available to help immediately via remote access.



#### A breath of fresh air

The plant of Rökona Textilwerk GmbH & Co. KG is located near a residential area. As a good neighbor – as well as to meet legal requirements – the company places great importance on ensuring that nobody is affected by any contaminants or unpleasant odors in the exhaust air.

The Tübingen-based plant manufactures its products largely for the automotive industry. The textiles are processed to ensure specific technical properties. To this end, long panels are soaked in liquid and dried at high temperatures. This generates exhaust air which must not escape through the chimney without first being cleaned. In view of forthcoming legal changes, the company opted for a new exhaust-air purification system made by Dürr. It is based on the principle of regenerative thermal oxidation (RTO). The system heats the exhaust air to temperatures of over 800 degrees Celsius. Harmful hydrocarbons are converted to non-harmful, almost odorless substances.

"We avoid polluting our neighborhood and stay within current emission limits. Thanks to Dürr technology, we can even face a tightening of these emission limits with confidence." says Rökona Managing Director Arved Westerkamp. He also appreciates the simple, automatic operation and the low maintenance requirements.



Emission regulations are becoming increasingly stringent, not only in Europe and America, but also in the Asian emerging markets, where pollution through poor air quality is on the rise. Industrial companies around the world are thus investing in technology which can be used to clean exhaust air generated by factories.



"Thanks to Dürr technology, we can even face a tightening of these emission limits with confidence."

> ARVED WESTERKAMP, RÖKONA MANAGING DIRECTOR

BOO DEGREES CELSIUS IS THE TEMPERATURE

AT WHICH HARMFUL HYDROCARBONS TRANSFORM INTO NON-HARMFUL SUBSTANCES.

EXHAUST-AIR PURIFICATION SYSTEMS HAVE ALREADY BEEN INSTALLED BY DÜRR.

# DÜRR AT A GLANCE

#### **KEY FIGURES**<sup>1</sup>

|   |           | 2018              | 2017       | 2016       | 2018/2017<br>Change in % |
|---|-----------|-------------------|------------|------------|--------------------------|
| Incoming orders                                       | € million | 3,930.9           | 3,803.0    | 3,701.7    | 3.4                      |
| Orders on hand (Dec. 31)                              | € million | 2,577.2           | 2,449.4    | 2,568.4    | 5.2                      |
| Sales revenues  | € million | 3,869.8           | 3,713.2    | 3,573.5    | 4.2                      |
| of which abroad                                       | %         | 84.3              | 86.9       | 84.8       | -2.6 pp                  |
|   |           |                   |            |            |                          |
| EBIT  | € million | 233.5             | 287.0      | 271.4      | -18.6                    |
| EBIT before extraordinary effects <sup>2</sup>        | € million | 274.9             | 283.7      | 286.4      | -3.1                     |
| EBT   | € million | 219.7             | 267.3      | 258.1      | -17.8                    |
| Net profit  | € million | 163.5             | 199.6      | 187.8      | -18.1                    |
| Cash flow from operating activities                   | € million | 162.3             | 119.8      | 227.4      | 35.5                     |
| Cash flow from investing activities                   | € million | -30.1             | -17.2      | -116.9     |                          |
| Cash flow from financing activities                   | € million | -134.0            | -152.2     | 192.5      |                          |
| Free cash flow  | € million | 78.4              | 14.3       | 129.9      | 448.4                    |
| Equity (with non-controlling interests) (Dec. 31)     | € million | 992.2             | 900.5      | 831.0      | 10.2                     |
| Net financial status (Dec. 31)                        | € million | 32.3              | 176.3      | 176.5      | -81.7                    |
| Net working capital (Dec. 31)                         | € million | 441.4             | 373.7      | 194.4      | 18.1                     |
|   |           |                   |            |            |                          |
| Employees (Dec. 31)                                   |           | 16,312            | 14,974     | 15,235     | 8.9                      |
| of which abroad                                       | %         | 50.0              | 47.7       | 46.1       | 2.3 рр                   |
| Gearing (Dec. 31)                                     |           | -3.4              | -24.3      | -27 0      | 20.9 nn                  |
| Equity ratio (Dec. 31)                                |           | 27.4              | 25.6       | 24.8       | <u>18 pp</u>             |
| EBIT margin   |           | 6.0               | 7.7        | 7.6        | -1.7 pp                  |
| EBIT margin before extraordinary effects <sup>2</sup> | %         | 7.1               | 7.6        | 8.0        | -0.5 pp                  |
| ROCE  | %         | 24.0              | 38.6       | 41.1       | -14.6 pp                 |
| EVA   | € million | 76.0              | 142.7      | 142.5      | -46.8                    |
|   |           |                   |            |            |                          |
| Dürr stock (ISIN: DE0005565204)                       |           |                   |            |            |                          |
| High  | €         | 57.18             | 60.28      | 39.98      |                          |
| Low   | €         | 27.30             | 37.00      | 24.76      |                          |
| Close   | €         | 30.53             | 53.28      | 38.18      |                          |
| Number of shares                                      |           | 69,202,080        | 69,202,080 | 69,202,080 |                          |
| Earnings per share                                    | €         | 2.27              | 2.78       | 2.63       | -18.3                    |
| Dividend per share                                    | €         | 1.00 <sup>3</sup> | 1.10       | 1.05       | -9.1                     |

<sup>1</sup> The figures for fiscal 2017 have been adjusted slightly due to the first-time application of the International Financial Reporting Standard 15 and other effects.

Detailed information on the figures and their comparability with previous years can be found in the 2018 annual report from page 55.

<sup>2</sup> Extraordinary effects: € -41.4 million (2018), € +3.3 million (2017), € -15.0 million (2016)

<sup>3</sup> Dividend proposal for the annual general meeting

services enable highly efficient manufacturing processes in different industries. The Dürr In October 2018, the Dürr Group acquired the industrial environmental technology business

| Paint and<br>Final Assembly<br>Systems  | Application<br>Technology  | Clean<br>Technology<br>Systems   | Heasuring<br>and Process<br>Systems   | Woodworking<br>Machinery and<br>Systems  |  |
|---|--|--|---|--|--|
| • Paint shops<br>• Final assembly systems   | <ul> <li>Paint application technology</li> <li>Glueing technology</li> <li>Sealing technology</li> </ul> | <ul> <li>Air pollution control</li> <li>Noise abatement systems</li> <li>Battery coating lines</li> </ul>  | • Balancing technology<br>• Filling technology<br>• Assembly technology<br>• Testing technology | <ul> <li>Machinery and equipment for<br/>the woodworking industry</li> </ul>   |  |
| € 1,235.7 M<br>Sales  | € 652.6 M<br>sales   | € 226.7 M<br>sales   | <b>€ 456.5 M</b><br>sales   | <b>€ 1,298.3 M</b><br>sales  |  |
| € 58.2 M<br>OPERATING EBIT  | € 68.2 M<br>OPERATING EBIT   | € 5.1 M<br>OPERATING EBIT  | € 61.2 M<br>OPERATING EBIT  | € 94.9 M<br>OPERATING EBIT   |  |
| <b>3,472</b><br>Employees   | <b>2,246</b><br>Employees  | <b>1,472</b><br>employees  | <b>2,279</b><br>employees   | <b>6,593</b><br>Employees  |  |
| DÜRR  | DÜRR   | DÜRR   | DÜRR<br>Ø SCHENC  | HE HOMAG   |  |
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# "THE FUTURE IS UNCERTAIN BUT EXCITING."

DR.-ING. E.H. HEINZ DÜRR, HONORARY CHAIRMAN OF THE DÜRR AG SUPERVISORY BOARD



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