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MHPSTUDY

INDUSTRY 4.0
BAROMETER 2021

Industry 4.0 Barometer 2021
On behalf of MHP Management-
und IT-Beratung:

"Many thanks to all participants who
supported this study by providing their
assessments and opinions, as well as to
the experts who agreed to take part in
our interviews.

A special thanks to the Ludwig-
Maximilians-University of Munich for
their successful and always productive
cooperation."

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Preface

Ladies and gentlemen,

The Industry 4.0 Barometer has gone international. For this year's study, we surveyed not only the DACH region but also the industrial maturity of China, the UK and the USA in the fields of "Resilient Supply Chain" and "Digital Leadership". This has resulted in comparisons of the digital transformation and insights into individual markets.

Developments such as the worldwide chip shortage, which is currently bringing global supply chains to a standstill, clearly show us how important crisis-proof supply chains and prudent digital leadership are. Digital transformation and sustainable business success will only be possible if these components can be mastered – top floor to shop floor, from strategy to implementation, from development to sales, whether independently or with an experienced partner like MHP at your side.

I would like to thank Professor Dr. Johann Kranz from the Ludwig-Maximilians-Universität of Munich, with whom we were able to carry out our Industry 4.0 Barometer for the fourth time. Further, I would like to the more than 700 high-ranking experts and all the interview partners who took part in our study. Together we are working on something crucial for the future – on forward-looking insights and solutions for a crisis-resistant, digital and sustainable tomorrow. With this in mind, I hope you enjoy reading our Industry 4.0 Barometer.

I would like to wish you all the very best for 2022 and hope you find our survey informative.

Regards,

Markus Wambach
Member of the Board of Management
MHP Management- und IT-Beratung GmbH

Executive Summary

The Industry 4.0 Barometer 2021 provides important insights into the level of digitalisation in industrial companies in the DACH region (Germany, Austria and Switzerland) and also, for the first time, for the other MHP locations China, UK and the USA. This year, particular focus was placed on the topics of digital leadership and supply chain resilience.

While digitalisation has been an integral part of corporate strategy in companies for years, its implementation is still not proceeding with the necessary speed and attention. However, especially in today's volatile times, digitalisation is more important than ever. Topics such as remote work, procurement and capacity management, as well as production planning and control, clearly reflect the progress companies are making in terms of digitalisation. This uncovered fundamental problems of a diverse and multi-layered nature in doing so.

Global crises, such as the Corona pandemic and the chip shortage, have revealed shortcomings in digitalisation and the resilience of supply chains. Thus, many companies surveyed complain about the lack of transparency in their supply chains, indicating that efforts to achieve digitalisation have either been insufficient or wrongly prioritised. In this context, the speed of digitalisation is slowed down due to the strong internal culture of competition among individual company divisions, as well as the lack of responsibility for digitalisation at management level. The underlying results of the study suggest that inte-

grating a CIO into the management board can enable to create clear responsibilities and build up urgently needed competencies in top management. To minimise supply chain risks, collaborative solutions should be established along the supply chain. Materials of particular strategic importance and their suppliers should be identified at an early stage. Further, more supply chain transparency should be increased through close cooperation.

All in all, digitalisation is developing differently in the markets surveyed. In an international comparison, the study's results of the digitalisation progress are rather sobering, especially among DACH region respondents. Here, no noticeable improvements could be achieved, despite increasing national and international digitalisation pressure. German perfectionism is proving to be an increasing obstacle when it comes to connecting digital technologies with the physical world and creating new business models based upon them.

In contrast, companies in China, the UK and the USA are moving ahead faster. Chinese companies are setting an impressive pace in the use of digital technologies in an Industry 4.0 environment. However, this speed can only be maintained in the long term, if higher budgets are made available for digitalisation in Chinese companies in the future. This is the only way to remedy serious deficiencies in IT security. In the UK, it will be essential to particularly support small businesses, as otherwise they could lose touch to the country's highly advanced larger

companies. In the USA, companies are also far advanced in the digitalisation of their industrial production, but are developing at different speeds. Long-established companies, in particular, are at risk of falling behind. Consequently, they need to do their necessary digitalisation homework as quickly as possible. In general, more pragmatism and a "get-it-done" mentality are currently required.

The first international Industry 4.0 Barometer 2021 has shown that decision-makers in the respective markets are setting individual priorities to be ready for the digital transformation of their industry and to provide their company with the best possible preparation for this profound change. Consequently, no uniform or global digitalisation strategy can be identified. Nevertheless, the universal relevance of digital leadership and supply chain resilience can clearly be seen. Only those who approach these tasks systematically and are taking into account the market-specific opportunities and obstacles, will prove to be leaders in the fourth industrial revolution in the long term.

Key Findings

from the Barometer 2021

Digital Leadership

Bureaucratic hurdles and a lack of designated responsibilities are slowing down digitalisation. In addition, digitalisation efforts are predominantly focused on internal processes.

A clear prioritisation of digitalisation topics is equally essential as focussing on agility and market orientation.

Supply Chain Resilience

The ongoing Corona pandemic has led to global just-in-time processes losing its popularity. This has resulted in companies increasingly relying on in-house manufacturing and securing production with higher stock levels.

Close collaboration with strategically important suppliers and the establishment of predictive analytics processes are crucial for companies in order to maintain their ability to deliver in the event of a crisis.
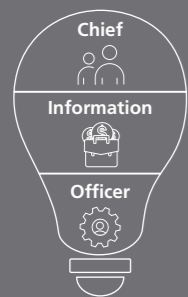
CIO

Internationally, the inclusion of a CIO in the management has proven to be a universal guarantee for success in achieving effective and productive digitalisation.

The integration of a CIO in the management is indispensable for fully comprehensive, structured and economically successful digitalisation.

● DACH

The digitalisation progress in the DACH region is stagnating. In comparison to international markets, the DACH region seems to be losing ground.

This yawning gap must be closed today through targeted investments in a digital future, the development of skilled workers and the establishment of a courageous corporate culture.

● China

Chinese companies are on their way to becoming international leaders in digitalisation, but are neglecting critical and security-relevant factors in the process.

In the long term, they will need to expand their orientation towards the international market, as well as strengthen internal cooperation within companies.

● UK

UK companies are proving to be especially resilient to the turbulence in global supply chains. However, the digitalisation gap between large and small companies is continuing to widen.

The strategic promotion of talent and investment as part of digitalisation initiatives is paving the way for the continued success of UK businesses.

● USA

US companies are at the forefront of various technological innovations, but are being held back by skills shortages and varying speeds of digitalisation.

A clearly defined digitalisation roadmap and the creation of additional capacities are crucial to sustainably maintaining their leading position in the digitalisation race.

1.0

The MHP Industry 4.0 Barometer 2021

Industry 4.0 is still a hot topic and indeed a lot has happened in companies regarding the implementation of Industry 4.0 projects. However, these are often individual initiatives, which is why many companies are interested in the current level of digitalisation in their respective industry. The Industry 4.0 Barometer enables decision-makers to compare themselves with their competitors at crucial levels, in order to identify and close any gaps or extend any leads they might have.

Contents of the study

To provide companies with a well-founded overview, MHP joined forces with the Ludwig Maximilian University of Munich (LMU) to publish what is now the fourth Industry 4.0 Barometer. The results of this benchmark study reveal important insights into the status quo of Industry 4.0 activities at companies in the DACH region. Since this year, the barometer also includes the MHP location countries China, UK and the USA.

Every year, the underlying questionnaire is based on four topic clusters:

- technology,
- IT integration,
- strategy and goals
- digitalisation drivers and obstacles

In addition, current digitalisation topics are included in the study every year. This year, the following focus topics were examined in more detail:

- digital leadership
- supply chain resilience

Expert interviews and success stories

Besides the evaluation of the survey results, each Industry 4.0 Barometer contains interviews with experts from industry and research, as well as success stories on the use of Industry 4.0 solutions in practice. This year, in conjunction with the survey, there are also reports from the DACH region, China, the United Kingdom and the USA.

In addition to the focus topics, the interview partners are also asked about their personal assessment of the industry's current state of development regarding the digital transformation, as well as of application examples and digitalisation initiatives within their own organisations.

Thus, interviews were conducted with the following academics and representative of industry:

- **Albrecht Reimold** (Porsche, Germany)
- **Jörg Menges** and **Claudius Illgen** (FAW-VW, China)
- **Steve O'Connor** (Aston Martin Lagonda, UK)
- **Jim Davis** (SAP, USA)
- **Prof. Dr. Johann Kranz** (LMU, Germany)
- **Prof. Ming Chen, Ph.D.** (Tongji University, China)
- **Dr. George Westerman** (MIT Sloan School of Management, USA)

The success stories highlight cases in which Industry 4.0 solutions and technologies have been applied successfully. In addition to the initial challenges faced by the users, we also focus on the procedure for implementing the solution and examine the most important results. In the course of this study, the success story "FleetExecuter" is presented in detail.

Participants in the study

The results of the Industry 4.0 Barometer 2021 are based on the responses given by 776 participants from the German-speaking region (DACH, 277 respondents) and the international market economies of China (128 respondents), the UK (186 respondents) and the USA (185 respondents).

A look at the sizes of the respondents' companies reveals a very diverse picture. Almost 60 % of the participating companies are small and medium-sized enterprises (SMEs) with less than 1,000 employees. About 25 % of the companies have between 1,000-9,999 employees and 15 % are companies with more than 10,000 employees. The hierarchical levels range from the operational base to board level. However, about three quarters of the respondents can be assigned to the top three hierarchical tiers.

A wide variety of sectors can be identified, ranging from the IT/communications sector to the automotive industry, trade and the chemical industry. However, the largest share, with a total of approx. 50 % of respondents, comes from IT and communications, automotive and mechanical engineering.

Origin of respondents

24 % USA
36 % DACH
24 % UK
16 % China
n=776
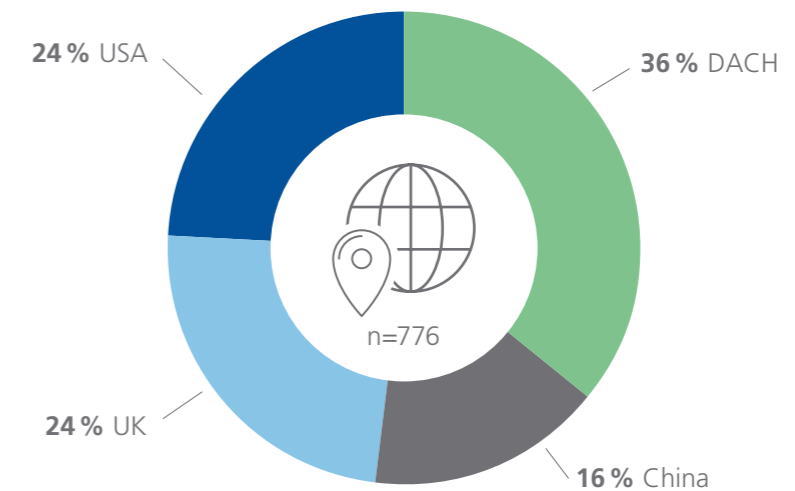
Fig. 1

Participants' company sizes

15 % over 10,000 employees
29 % 1-99 employees
27 % 1,000-9,999 employees
29 % 100-999 employees
n=776
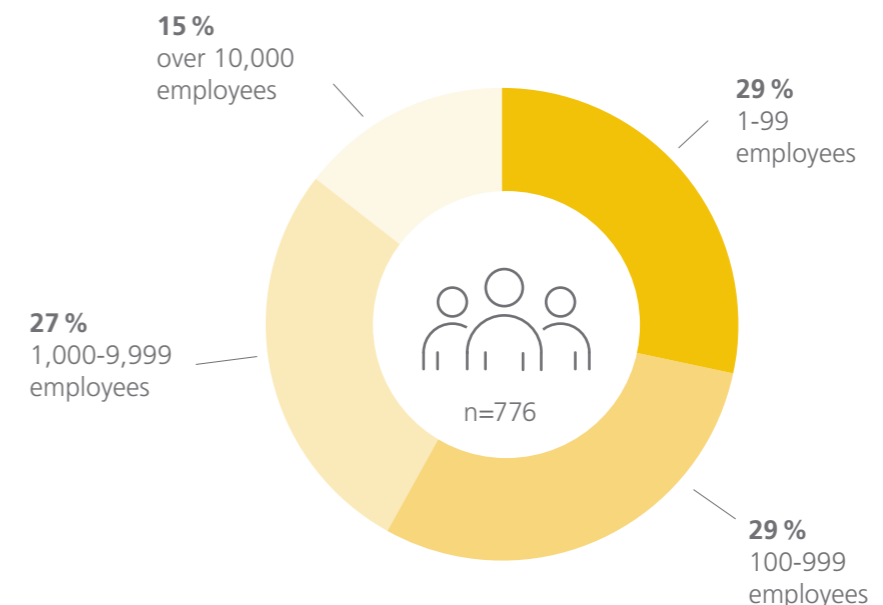
Fig. 2

Participants' hierarchy levels

10 %
Management

20 %
4th tier below
management

19 %
1st tier below
management

17 %
3rd tier below
management

n=776

34 %
2nd tier below
management

Fig. 3

Participants' sectors

23 %
Other

17 %
Construction

4 %
Information &
Communications
technology

12 %
Automotive
suppliers

4 %
Energy & water
industry

n=776

10 %
Retail & wholesale

6 %
Mechanical & plant
engineering

9 %
Transport

7 %
Automotive
OEM

8 %
Consumer goods
(food, drugstore)

Fig. 4

2.0

Results of the study

2.1
Digital Leadership:

Lethargy hinders digitalisation

The pressure for digitalisation meets bureaucracy

For years, the topic of digitalisation has been accompanying companies and it is almost impossible to imagine any high-powered corporate strategy presentation without it. Buzzwords like digital leadership are omnipresent. But there is obviously very little tangible success behind them. The survey results show that 80 % of respondents need to intensify their company's digitalisation efforts. But even those companies that want to digitise often cannot do so. In two-thirds of cases, bureaucracy and internal debates lead to considerable d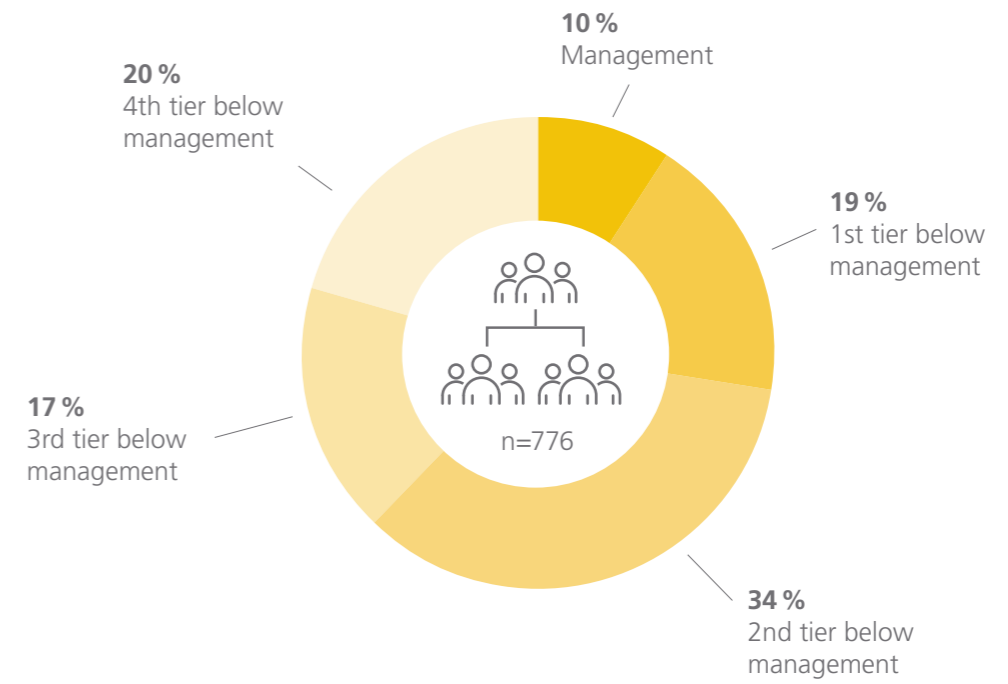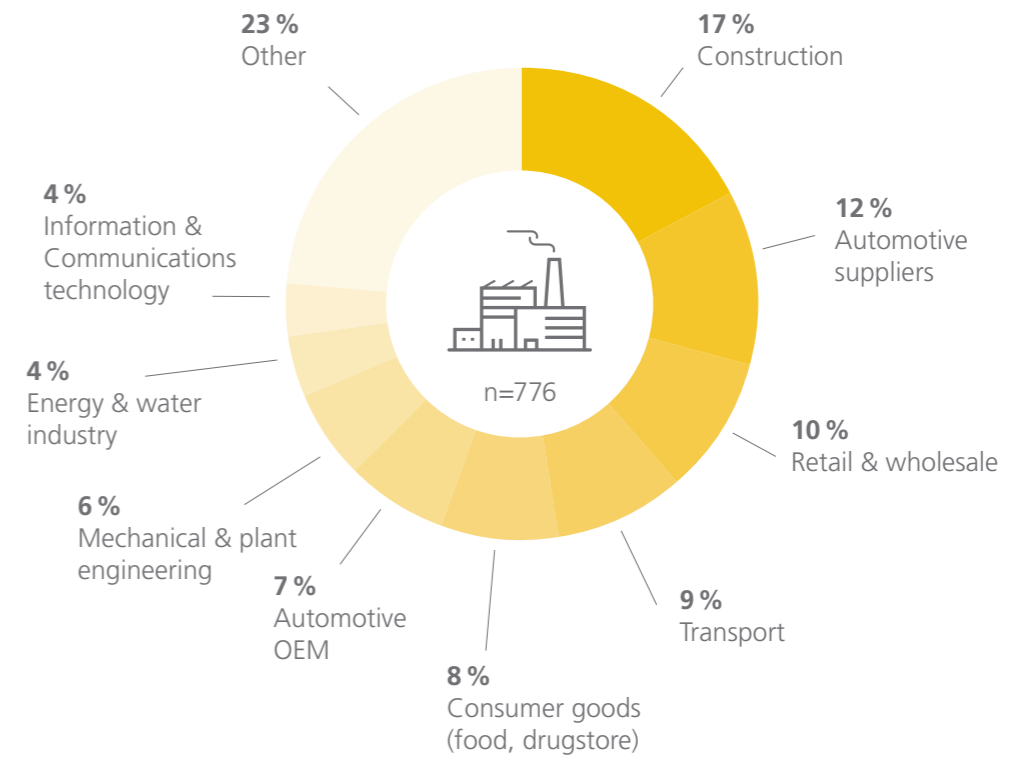elays. In China, budget problems can be added to this in 75 % of cases. Whether this is due to a lack or the wrong use of budget remains an open question.

Lack of flexibility and outward orientation

Science and business never tire of emphasising the importance of keeping up with the rapid pace of digitalisation. But especially when it comes to actual digital topics, the race resembles a marathon with intermediate sprints. Here, driving innovation means reducing time-to-market. Nevertheless, this obviously has not yet got through to all market participants. Almost 60 % of digitalisation efforts are initially used to optimise internal processes. However, it seems that market orientation and time-to-market are now becoming the decisive criteria for success or failure. In addition, almost two-thirds of large companies in particular experience friction and power struggles. Inhibited by bureaucracy, it seems that large corporations often leave the more daring innovations to the start-ups.

"Sufficient budget available for digitalisation projects."

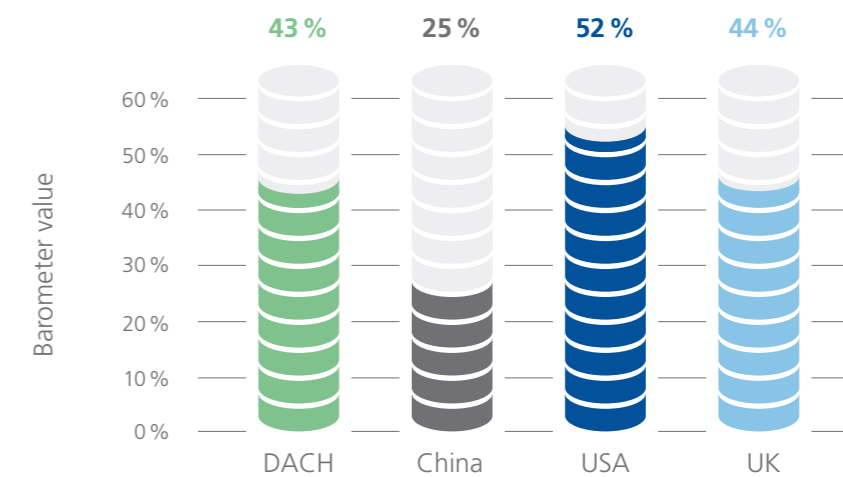|	43 %	25 %	52 %	44 %
	DACH	China	USA	UK

Barometer value

Fig. 5

"Are the company's digitalisation efforts directed more inwards (e.g. improved processes, automation, communication) or outwards (e.g. ecosystem-based innovations, platform business models)?"
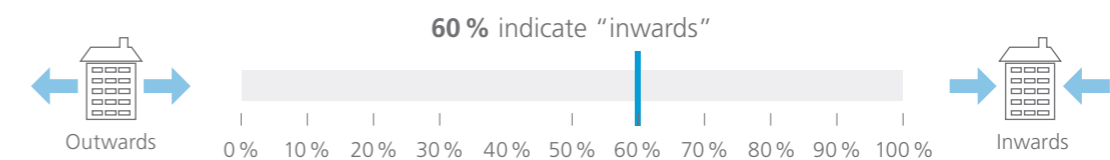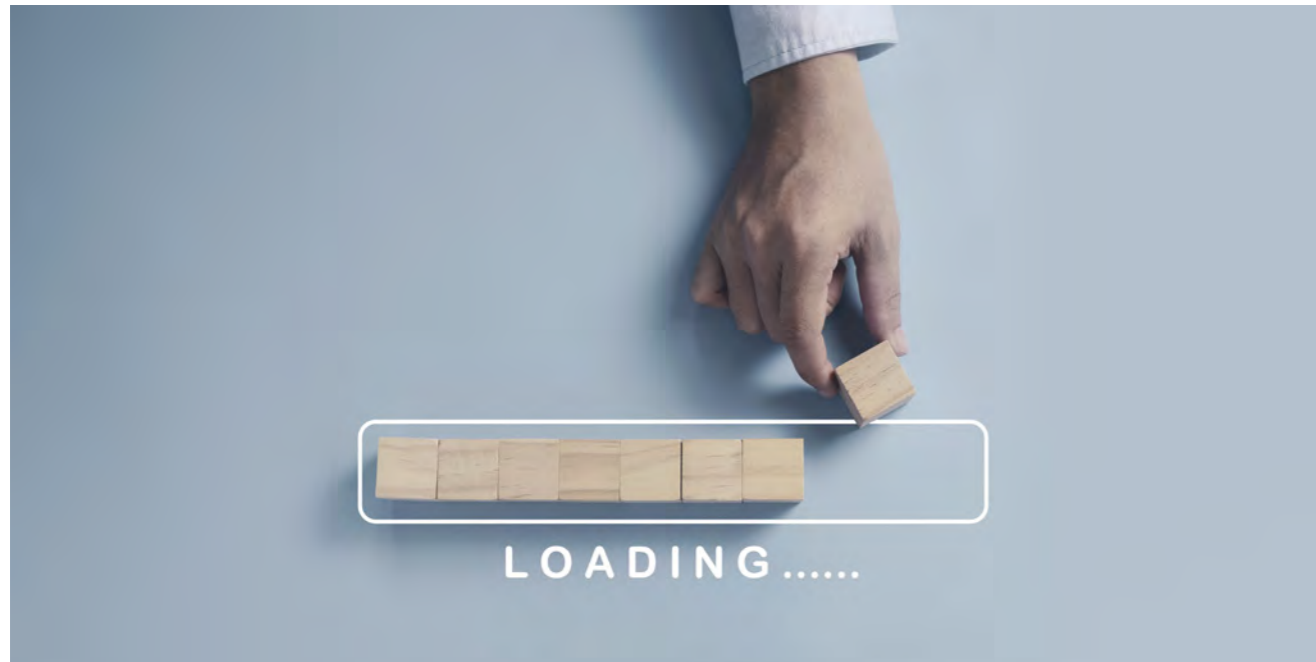
60 % indicate "inwards"

Outwards   0 % 10 % 20 % 30 % 40 % 50 % 60 % 70 % 80 % 90 % 100 %   Inwards

Fig. 6

Origin is a decisive factor for digitalisation progress

Cultural differences, such as openness to new concepts or ideas, risk tolerance, as well as the way hierarchies are dealt with, have serious, far-reaching consequences in many areas. These differences between individual countries that are also noticeable in terms of digitalisation. The very thorough, but risk-averse corporate culture in German-speaking countries is reflected in the sluggish progress of digitalisation. For instance, solely about one in three companies can locate and track parts in the supply chain. In an interview, Professor Kranz from LMU Munich also warns against exaggerating the quest for perfection, as this often prevents quick experimentation and learning. The situation is quite different in China. Chinese companies are fully committed to technological progress. Almost twice as many of the companies surveyed claim that they can locate all parts along the value chain as those in the other markets. The behaviour of companies in the USA is similar, although investments there seem to be even more closely linked to customers' needs and willingness to pay. Two thirds of the respondents state that market orientation is the primary goal and driver of Industry 4.0 activities. Companies from the UK also seem to be closely linked to their Anglo-Saxon counterparts when it comes to digitalisation. However, the Brexit turbulence of the last few years has had a direct impact on the IT security. 60 % of companies increasing their efforts to boost their IT security.

What does this mean for you?

Becoming a true digital leader is tough. First of all, basic problems need to be solved. This includes the appropriate prioritisation of fundamental digital transformation in industrial manufacturing, the reduction of bureaucratic obstacles and the definition of clear responsibilities in companies. Despite these obstacles, innovation should not be abandoned. Especially when it comes to market orientation and the speed with which innovations are marketed, large corporations ought to learn from small companies in terms of agility.

All in all, the country comparison shows the differing energy and focus with which companies are tackling the challenge of digital transformation. On the one hand, specific efforts are necessary to successfully master the transformation depending on the country, industry and company concerned. On the other hand, it is worthwhile to look beyond one's own nose boundaries in order to learn from the experiences of other companies, especially from other countries and industries, and to transfer successful concepts to one's own company.

"We can locate all individual parts of our products as well as our end products along the entire value chain (from inbound logistics to production to customer service)."

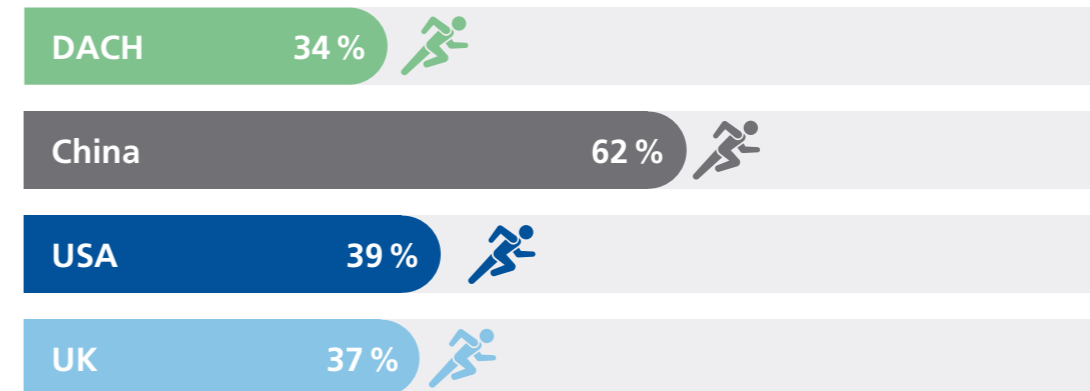|	
DACH	34 %
China	62 %
USA	39 %
UK	37 %

Fig. 7

"To defend against cyber attacks, our company has sufficient equipment and competence (through service providers, if necessary)."

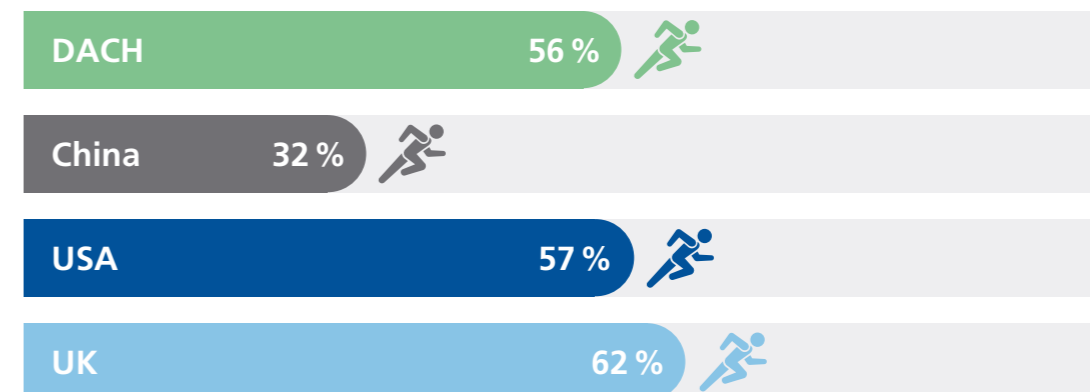|	
DACH	56 %
China	32 %
USA	57 %
UK	62 %

Fig. 8

Interview with Prof. Dr. Johann Kranz, Dr. George Westerman and Prof. Ming Chen, Ph.D.

Prof. Dr. Johann Kranz

Johann Kranz is a Professor of Digital Services and Sustainability at the University of Munich's LMU School of Management. His research focuses on IS-business alignment and governance in the digital age, the multi-level impacts of digital technologies and innovation such as blockchain, and information systems for enabling circular economies, smart grids, sustainable mobility and pro-environmental behaviour.

Dr. George Westerman

George Westerman is a Senior Lecturer at MIT Sloan School of Management and faculty director for two Industry 4.0-related executive courses at MIT. He is also Principal Research Scientist for Workforce Learning at the MIT Jameel World Education Lab, co-chair of the MIT

Sloan CIO Leadership Awards, Digital Strategy Roundtable member for the US Library of Congress, and a strategic advisor for the World Health Organization's new global learning academy. A pioneering researcher on digital transformation, he has written three award-winning books and numerous articles. He works frequently with senior management teams and industry groups around the world. Prior to earning a Doctorate from Harvard Business School, he gained more than 13 years of experience in product development and technology leadership roles. He is now focused on helping employers, educators, and other groups to rethink the process of workforce learning around the world.

Prof. Ming Chen, Ph.D.

Ming Chen is a professor at Tongji University in Shanghai – one of the oldest and most prestigious universities in China. There, he heads the Industry 4.0 Learning Factory Laboratory – a learning factory that serves the transfer of technology know-how.

Dr. Katharina Hölck (MHP): What are each country´s specific key strengths and weaknesses regarding Industry 4.0 and digitalisation?

Prof. Dr. Johann Kranz: Education is still very strong in Germany, especially engineering is one of biggest strengths. Nevertheless, other countries like USA and China are catching up. Of course, Germans have some common characteristics they are known for, e. g. precision, perfection and striving for the best. But **it can be dangerous to focus on perfection, because sometimes starting with an 80 % solution makes you faster in gaining market traction than waiting for 100 %.**

Prof. Ming Chen, Ph.D.: China has two major strengths in terms of Industry 4.0. The first one is the lead in communication technology, e. g. mobile communication technology and implementation of 5G on the shopfloor. The second strength is the enormous amount of data and data collecting devices, which is beneficial to creating learning curves and technological improvements.

Dr. George Westerman: The excellent research of US universities and companies enables the development of advanced technologies with a high level of innovativeness and customer responsiveness. The economic diversity in the US enables a variety of manufacturing use cases, but this diversity can also be a challenge as there is no centralised push to adopt advanced technologies. Therefore, especially small and medium-sized manufacturers tend to not implement those advanced technologies until they see enough revenue to offset the capital risk. Furthermore, while our fluid labour markets provide opportunities for better workers to advance quickly, this fluidity can sometimes cause employers to resist training workers for fear they will take their new knowledge to another company that pays higher wages.

Thomas Klüe (MHP): The last 18 months have been a huge burden to the industry. How did the Corona pandemic affect the digital transformation?

Chen: The Corona pandemic has impacted the 14th 5-year plan of the Chinese government, which aimed for China becoming the global lead in digital manufacturing, as companies had to close and people had to stay at home during the shutdown. In a global perspective, the impact on domestic manufactures was relatively low. Though currently, the Chinese economy is slightly negatively impacted by economic crises of other countries and supply chain bottlenecks, for example the chip shortage. However, the pandemic constitutes a great opportunity to accelerate the digitalisation of working and collaboration methods of companies, universities, and schools.

Westerman: The US experienced the same acceleration of digitalisation as Ming mentioned. Satya Nadella said **we experienced two years of digitalisation in two months**, which also pushed the digital transformation process in the manufacturing sector. Although supply chain disruptions had a serious impact on the manufacturing sector, this was sometimes mitigated by domestic production of components. In addition, Corona became an opportunity to fix two relationships. Leaders in many companies developed a better appreciation for their workers' unique situations. For example, they are showing more flexibility over work hours, and more willingness to enable remote working, even as we have begun to return to our offices. The other relationship that changed is the one between IT and business department, as in many cases IT rescued the company during the pandemic and is now more appreciated.

Kranz: Corona has impacted the German economy in a similar way, as it was also hit by the lockdown and supply chain bottlenecks. An LMU study at the beginning of the pandemic has shown that the budget allocation for digitalisation projects has changed. Projects that enable mobile work have been expanded, whereas new technologies, such as smart factory topics, were put on hold for the time being. On a micro level, it can be observed that many German companies are still working on creating a sufficient IT and technology base for the future – either due to prioritisation issues, insufficient financial resources or refusal to invest. Even worse is the situation on a macro level. Corona has shown that Germany is significantly lagging behind in providing IT infrastructure and digitalisation. These shortcomings have to be addressed fast and in a pragmatic way—which unfortunately is not a German strength these days.

Klüe: The governments of China, Germany and the USA have different approaches to accelerate the digital transformation. In contrast to the USA, China and Germany have initiated a lot of projects. In your opinion, how do these different approaches affect the way Industry 4.0 is rolled out? Has the corona pandemic affected these developments?

Chen: The Chinese government works hard to support the economy and its digital transformation. In the past years, the government made massive investments in technologies and supported a lot of innovative use cases in companies financially. In general, companies can apply for governmental funding for specific projects and technologies. However, it is easier for larger companies to apply and receive this financial support than for SMEs. It is very challenging to determine, which company has the most innovation potential in order to receive

funding. Though, in many cases the effectiveness of the investments in SME projects is not as high as in larger companies.

Kranz: This is an interesting observation. Sometimes, I wonder if all the projects, that were initiated with the help of the German government paid off. Defining KPIs and measuring progress in these projects is challenging. However, it is important to understand that such initiatives are long-term investments and are designed to create awareness among businesses rather than achieve short-term savings or profits. Consider, for example, BioNtech which received government funding for basic research. This support really paid off as it enabled developing the Corona vaccine together with Pfizer. **When I compare the US, China, and Germany, I see a strong, directing, and forward-looking government in China. In contrast, there is a more market-oriented approach in the US and Germany is somewhere in between.** How do you see this, George?

Westerman: I think that is right. Government-sponsored standards just do not happen in the US the way they do in the other countries. Standards tend to emerge in a much less directed way. Whereas, at least in Germany, there are some strong incentives for companies to agree on standards. This allows German companies to coordinate in ways the US cannot, but arguably can restrict innovation that might not reflect the standards. The spectrum ranges from every company does what it thinks is right – like in the US – to big government investments that influence a lot of things – like in China.

Hölck: Companies with a high digital maturity have managed the corona pandemic better than their peers. George, your past research shows that Digital Masters are 26 % more profitable than their competitors. In this regard, what skills does management need in the future to succeed in digital transformation?

Westerman: I have my own version of Moore`s law: **"Technologies change quickly, but organisations change much more slowly."** We tend to forget that digital transformation is as much a transformation problem as it is a digital problem. This means that leadership skills are essential to prepare the capabilities and drive the change in the organisation. It starts with a clear vision – a compelling destination. Then the leaders need to engage the workers, so that they believe in the vision and help to move it forward – that is the engine. In addition, companies need governance to direct the innovation in the right approach and direction – that is the steering wheel – as well as well-structured processes and digital infrastructure and a good relationship between IT and business departments – which are the road you are driving on.

Kranz: I completely agree with George's message. In addition, these days it is extremely important for managers to put all the technologies into perspective, which are pushed into the market in ever shorter time cycles, and to sense the potential of those technologies. Moreover, it is crucial to get rid of the very hierarchical thinking, which is still common in Germany. We should rethink the structure within companies, which in most cases is not suitable to adapt to rapidly changing environments and technology innovation. In general, management roles must change from controller to facilitator and from implementors to seismographs of social and tech trends to provide business direction.

Westerman: According to Moore´s law, technology is doubling in power every 18-24 months, depending on the technology. **This implies that long-term strategies and plans are already out of date in the moment they are developed.** You have to be able to adapt quickly.

Kranz: This constitutes a major challenge for car manufacturing companies now. With product life cycles of five to seven years, they need to find an architecture that integrates digital and physical requirements, which is not trivial.

Westerman: I agree with that. It raises the question for manufacturers whether to keep their digital devices inhouse or to outsource them to leading technology companies. As the life cycle of the physical product is significantly longer than for the embedded digital devices, it is necessary to find a way to update the digital devices much faster. For example, it is fascinating to watch how a Tesla learns new capabilities month by month, without needing a trip to the repair shop.

Chen: I fully agree with Johann and George. In China we have a special understanding about leadership. Primally, digital transformation means getting funds and investments for the different project, which can be challenging in Chinese companies due to their steep hierarchy. Thus, the **top leader should be in charge of IT or intelligent manufacturing, in order to enforce fast digital transformation** top down.

Hölck: In Germany, cash is still important in daily life, while in China and the U.S., mobile payments such as Alipay and Apple Pay are available almost everywhere. Johann, is German culture a big challenge for digital transformation? Chen, George, are people in China and the U.S. more open to digital solutions in the context of manufacturing and logistics?

Kranz: I guess, the German mentality emphasises perfection, stability, and security and is more risk averse than say the American. This limits the rapid adoption of new technologies, where you must be fast, risk-taking, and forward looking. However, I see things are improving. But, not as fast as I hope for.

Westerman: Culture is very important for introducing new technologies and innovations. One good example is Japan. Japanese culture is very advanced in technology. They use many digital solutions in daily life, but not as much e-commerce. When I asked why, they said that this is a culture where you take care of people. Serving people is a sign of respect and therefore, self-service is not natural. **If you want to change something, you need to understand the cultural elements that could stand in the way.**

Chen: Chinese culture is very technology-driven and innovative. For example, we use our smartphones for payment. On the one hand, because it is very convenient. On the other hand, Chinese people are eager to use new technologies. The pioneering role of the Chinese regarding digitalisation in everyday life can be extended to the digitalisation of industry. The hurdle for using digital products is significantly lower than in other cultures. Therefore, the willingness to accept Industry 4.0 is very high and people are open to digital solutions.

Klüe: Digitalisation in companies is proceeding at an ever-increasing pace. As a consequence, the tasks and jobs of employees are changing. How can companies support their employees in the digital transformation?

Chen: Digital transformation will change the working environment significantly. It will change the task area of factory workers. Some jobs will disappear, new jobs will appear and some will remain, but will require a new set of skills, e. g. advanced IT skills. Companies should analyse this job transformation and need to understand what jobs will disappear and what jobs and skills need to be adapted so that they can prepare for this change. There are several ways to support this job transformation: First, provide good training and find suitable employees for all positions. Second, encourage self-learning through incentives and awards. Third and last, ask for financial support from the government for new job training. However, SMUs in particular may be reluctant to train their employees for fear of losing a well-trained workforce to competitors.

Kranz: Companies should also consider that if they treat their employees well, they are more likely to stay and the company has a more educated workforce in the end, even though some might go. Additionally, companies can support their employees by communicating a clear vision and emphasising where the company will evolve and what set of skills will be needed in the future. This is important to decrease uncertainty and keep the motivation high. In addition, employees should be willing to learn and accept fast changes as the new normal. Jobs and skills needed on the shopfloor will significantly change in the next five to ten years. If companies support employee training and employees are eager to learn new skills and willing to change, I am optimistic that digitalisation will create enough new jobs for an up-skilled workforce.

Westerman: It is interesting that you mentioned the willingness to learn. Our workforce learning research shows that some workers – especially those at lower education levels – may not believe that they will see a real return to learning. They may have done poorly in school, or the training they received at work was just for safety or regulatory compliance or new ways to do the same job. The critical question is: How can companies help these workers to see that training will pay off for them? **Technology is not destroying as many jobs as it was assumed, especially in the manufacturing sector. But it is changing jobs and modifying the required skills.** Companies can deal with this by first addressing the way people think about the change, before addressing the skills. Companies should help to overcome the fear of getting replaced and enhance the employee's confidence to adapt the new skills. As well, companies have to be much more systematic in helping people to seek careers instead of jobs and show them a return on investment of learning for their future career path.

Hölck: Technology is a key driver for digital transformation. Nevertheless, its full potential can only be unleashed if it is integrated into business. Last year's Barometer showed a lack of communication between IT and business departments. How can companies improve this relationship?

Westerman: I have been studying this for 20 years. We know that technology only provides value to a business if you change the way the business works. But in too many companies business runs business and IT runs technology and there is a lack of respect and connection. On the one hand, IT people need to learn more about business – not just about the investment priorities, but how to speak their language and how to be a business leader. On the other hand, business leaders need to better understand the value of IT and the importance of including IT in decision-making and conversations, rather than just telling them what to do.

Corona has helped many leaders see that IT is much more important to business than they expected. Now IT people need to use this newfound respect to work with executives in order to change the way they work. There are several steps to transform IT. First, stop talking like a tech geek. **Start thinking and talking like you are enabling the business and not like managing the technology.** Second, show that you are a good leader of your technology function by transparently improving performance and costs. Third, help executives get more value from IT by improving the investment and implementation processes. Helping them meet their goals using IT puts you in a good position to do greater and greater things.

Kranz: I have a rather radical view on that matter. As a business leader, I would get rid of the IT department as an organisational entity in large parts. Almost all IT people should work closer with business people to get rid of siloed structures that are a core inhibitor of progress and innovation. **My research shows that the less boundaries there are and the more fluidly IT and business people work together, the more successful companies are. Departmental logics and incentives need to be eliminated and replaced by cross-functional teams based on BizDevOps logics.** Only high-level IT functions like strategy, security and governance should be centralised.

Chen: I would like to underline George's point that IT and business departments must speak the same language. It is like learning a foreign language. IT people should know the business processes and business people should understand basic technology terms to have a common language and to create trust on both sides. In the last few years, many organisations took a non-technology person who used to run a business and put them in charge of IT. This is a radical approach and IT people hate it, but it helps them to become more customer focused as they make the change happen. It should not have to be that way. We should take technology leaders and turn them into the right people instead, but sometimes such radical measures are needed.

Klüe: Finally, how do you perceive the role of science for the sustainable digital transformation of the industry? How can scientists and universities support the companies on their digital journey?

Chen: The central task of universities is academic research and there are several ways in which universities can support the industry. First, the results from academic research can be transferred from labs into industry. Additionally, companies can approach universities with challenges and get help through research projects. For engineering education, universities can provide support and offer some advanced technology training. This works well the other way around because universities also need industry. So far, industry has often been further along the road to Industry 4.0 than universities. One example: A few years ago, Data Science and Big Data were very popular topics at Stanford University's Summer School. They asked Google's data scientists to give some lectures for the students. I think this is also very popular in Germany and China.

Westerman: I agree with Professor Chen that many businesses are ahead of academia in these advanced technologies. Certainly, academia was ahead in data science, but not anymore and that is a challenge. I am not sure how many companies in the USA would ask an academic scientist or professor to help lead a company's digital transformation journey. They will ask me or another professor to come and give a talk on digital transformation, but then they will continue doing it on their own. Universities still do the most advanced technologies, but it can take a few years to get into industry.

Kranz: All of that has its pros and cons. We try to explain novel phenomena, outcomes, and relationships in depth. In business practice you do not have the time and resources to do that. So, we can support practitioners with solid evidence and new food for thought. But this is not one-way. I frequently discuss current trends and problems with practitioners and invite them to share and discuss their experiences with our students. Also, we have many projects in which graduate and doctoral students collaborate closely with industry partners. These are mutually beneficial exchanges which all sides value and benefit from.

2.2
Supply Chain Resilience:

Transparency as the key to resilience

General satisfaction with Corona crisis management

When looking back over the past pandemic year, many respondents are initially highly satisfied with their company's internal crisis management. 70 % of the study participants are convinced that foresighted and flexible crisis management prevented major disruptions in production. Only the Chinese companies are rather more subdued about their own handling of events related to the Corona crisis. According to this, 100 % of the study participants in China now agree that they must pay greater attention to identifying and remedying possible weaknesses in their supply chains. Respondents from the USA, the UK and the DACH region also identify room for improvement. Particular attention is paid to the topic of supply chain transparency in order to make the supply chain crisis-proof and companies future-proof as a consequence. However, this is no easy task. As Albrecht Reimold, Porsche's board member for production, pointed out in an interview with us, "you are never prepared enough for a crisis". Unexpected effects in any new crisis will always reveal new gaps in business's own processes.

"Due to recent experiences with Corona, geopolitical uncertainties and cyber attacks etc., much greater attention is now being paid to potential supply chain vulnerabilities."
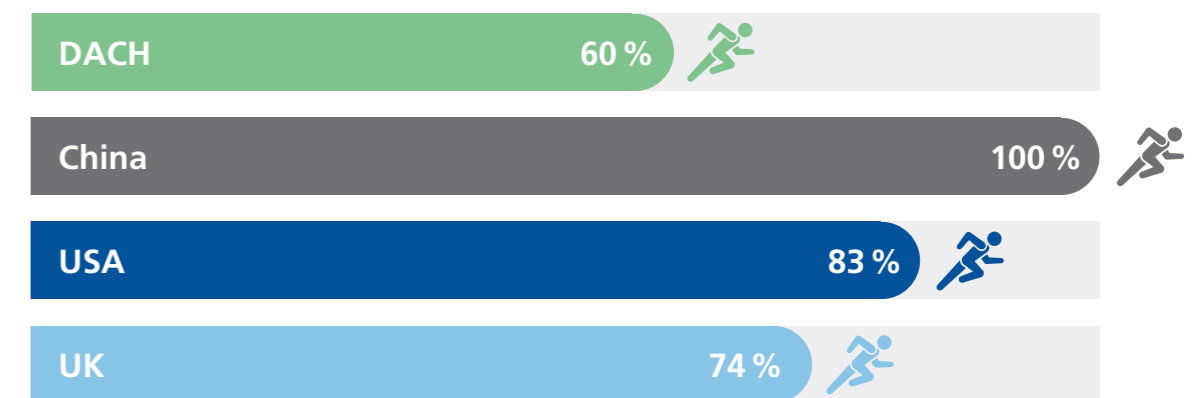
DACH	**60 %**
China	**100 %**
USA	**83 %**
UK	**74 %**

Fig. 9

Corona takes the shine off globalisation

In the last legislative period, the USA underlined the increasing protectionism of its own market with slogans such as "America First". Now, other markets also increasingly began to distance themselves from the idea of global trade during the Corona crisis, albeit for different reasons. In an interview for this study, Jim Davis of SAP in the US has pointed out that the pandemic has exposed the fragility of supply chains. And more than half of our respondents confirm this statement. There is an increasingly critical view taken of the dependence on individual suppliers. Hence, it is not surprising that the survey results show a trend towards in-house production. 40 % of the companies surveyed are increasingly relying on in-sourcing and re-integrating previously outsourced manufacturing stages. Nevertheless, two-fifths of the respondents still do not see any tendencies in this direction. Their observations are confirmed by Albrecht Reimold, who also believes that global trade cannot simply be reversed. "The wheel of time cannot be turned back," says Albrecht Reimold. The crux of the matter, he adds, is that even with an in-house production rate of 100 %, the risk of downtimes cannot be eliminated. "Local sourcing [is] not the silver-bullet solution for the next pandemic," says Claudius Illgen of FAW-Volkswagen in China.

"Due to recent experiences with Corona, geopolitical uncertainties and cyber attacks etc., **we are increasingly relying on in-house production and integration of previously outsourced production stages.**"

26 %

34 %

40 %

0 %   100 %

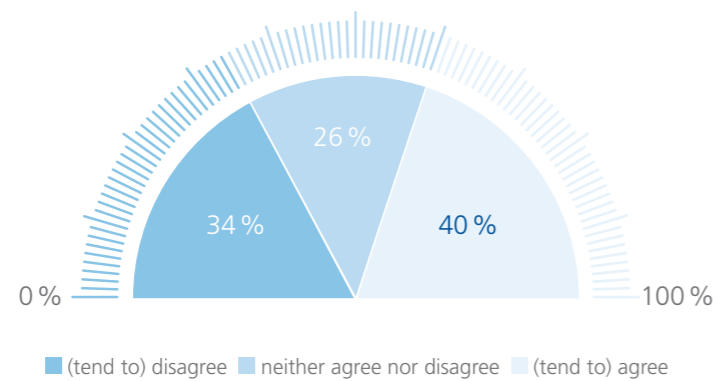■ (tend to) disagree ■ neither agree nor disagree ■ (tend to) agree

Fig. 10

"Due to recent experiences with Corona, geopolitical uncertainties and cyber attacks etc., **we are reducing our dependence on single suppliers (e.g. multi-sourcing, more flexible contracts, modular design).**"
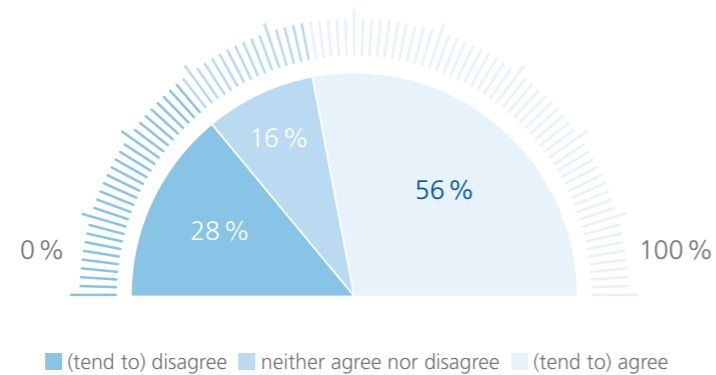

16 %

28 %

56 %

0 %   100 %

■ (tend to) disagree ■ neither agree nor disagree ■ (tend to) agree

Fig. 11

Sacrificing efficiency for security

The global pandemic has provided a crucial test for just-in-time processes. About two-thirds of respondents say they will rely on higher stock levels to safeguard production in future. The proportion of small companies is particularly large here, as their investments in forward-looking risk management of their supply chains are comparatively lower. Only 40 % of the smaller companies have set up an office that systematically deals with possible supply chain disruptions and initiates appropriate measures at an early stage. To keep production running despite a lack of supply chain transparency and predictability, increasing inventory levels is seen as an easier measure to implement. However, this stockpiling impulse is known to drive up the cost of warehouse space and scrap and also ties up cash.

What does this mean for you?

The Corona pandemic has proved a severe test for global supply chains and highlighted the challenges. Despite their largely satisfactory Corona crisis management, companies should critically examine whether they have sufficient contingency plans in place to cope with a crisis. Playing out various crisis scenarios can be used as a means of testing how best to prepare for future crises. Since globalisation cannot be reversed, relying solely on increased in-house production will not be sufficient. Instead of increasing stocks in response to growing uncertainties, strategically important materials and suppliers should be identified, prioritised, and secured at an early stage. Close cooperation with key suppliers should be sought. In addition, it is important to make the entire supply chain as transparent as possible to identify anomalies at an early stage and to forecast future bottlenecks with the help of predictive analytics. Transparency across the supply chain is seen by many as a fundamental requirement for resilience. However, this required that the relevant data is available and regularly updated and analysed. In this respect, many companies in the markets studied are still at the beginning.
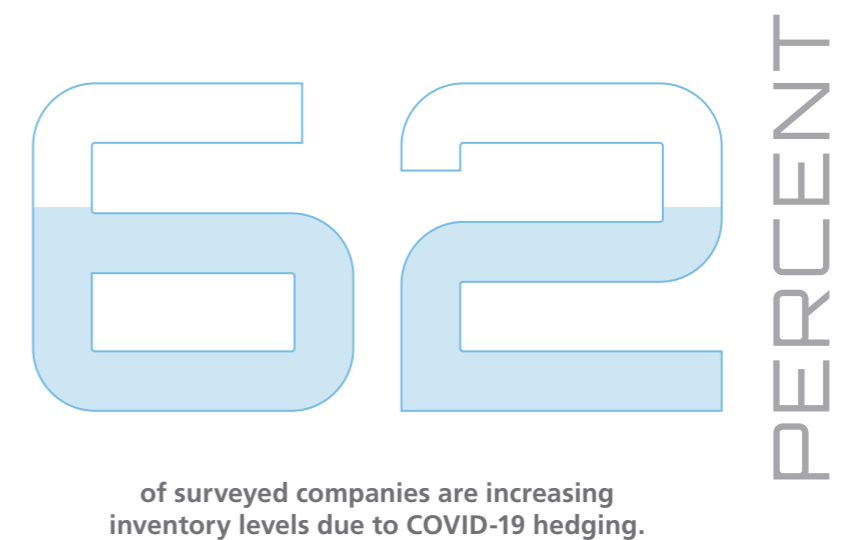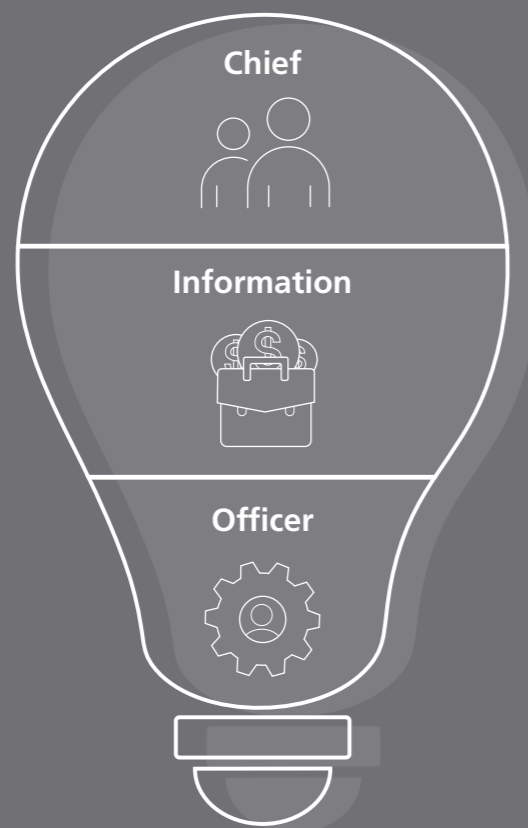

62 PERCENT

of surveyed companies are increasing inventory levels due to COVID-19 hedging.

Fig. 12

2.3
CIO:

Dynamizing the digital transformation

Chief

Information

Officer

CIOs create the technical infrastructure

Reports such as "Massive IT disruption halts production for days" are increasingly causing anxiety among management teams. The dependence on digital technologies has never been as high as it is today and, over the course of the current digitalisation wave, it will continue to increase. This makes it all the more relevant for companies to create the fundamental technological conditions for further digitalisation. Some of them are taking on a pioneering role here. A common feature of many of these companies is the introduction of a Chief Information Officer (CIO) onto the management board. Across nearly all relevant categories of the survey, companies with CIOs are dominant. What really stands out here is the lead in each case of 25 % over companies without a CIO in terms of data analysis along the entire value chain and provision of the modular and service-oriented IT infrastructure required to do this. Companies with a CIO also assign a significantly higher priority to IT security and the IT security officer. Likewise, with a CIO at board level, digital obstacles seem to be a thing of the past, with these companies already almost one third more successful at replacing legacy systems.

A CIO will break down silos and communication barriers

Pulling together and breaking down silo thinking is still a major challenge for many companies. While interdepartmental communication is not usually a problem, there is often room for improvement in communication between IT and other departments. Rightly or wrongly, corporate IT still has the reputation of being a mere provider of IT equipment and services. With a CIO in management, this outdated mindset can apparently be broken down. Two out of three companies with a CIO at board level see an improvement in cross-departmental communication and an increase in knowledge sharing between individual departments. In addition, these companies are almost a third more likely to succeed in breaking down data silos. According to Professor Ming Chen, Ph.D. of Tongji University Shanghai, "IT and business departments must learn to speak a common language". Communication on digitalisation issues is also intensifying among the management itself. With the involvement of a CIO, a cross-company digitalisation strategy is established and the necessary budget for digitalisation projects is secured much more frequently. The close integration of IT and business creates additional economic potential. Companies with a CIO are up to 30 % more likely to succeed in opening up new markets and customer segments.

CIO as a factor for success in times of crisis

"We've seen an increase in dependency on IT and a realisation across the business that IT is not just a cost centre." With this statement in his interview, Steve O'Connor (Aston Martin Lagonda, UK) confirms how important IT is as a success factor in the Corona pandemic. When the assembly lines came to a standstill from one day to the next and employees had to work from home for the most part, companies with established IT systems raced ahead. Again, CIOs in management were the common denominator in the more successful companies. Based on self-reflection, these companies felt they succeeded significantly more often (almost 60 %) in establishing forward-looking and flexible Corona management. And yet, this is not just the subjective perception of the study participants. Even after the start of the pandemic, the production levels of companies with CIOs on the board left their counterparts without CIOs behind. On average, the former were able to return to normal production after two months at the latest. Companies without a CIO in top management took three to six months. The closer cooperation between IT and business enabled decisions to be made and implemented more quickly. However, not only during the corona pandemic companies with a CIO in top management perform better. They also generally exhibit higher supply chain resilience. For the focus topic "Resilient Supply Chain", these companies are ahead in five out of seven categories. The lead is particularly clear in the use of systematic problem analyses along the supply chain and the much greater synchronisation of production and sales planning.

What does this mean for you?

In recent years, the role of IT has evolved from a cost factor to a value-adding factor. With increasing digitalisation, it has become a decisive competitive advantage. Therefore, if the digital transformation is to be driven forward, two important IT settings urgently need to be adjusted: the technological prerequisites and the obstacles from the past. CIOs will play a vital role in these adjustments. They should therefore be provided with sufficient influence, as well as direct access to top management. It is also advisable to break down silo thinking and promote active exchange between IT and business. Now at the latest, every company should be asking itself whether it has enough competence and experience in digitalisation at the highest management level. The integration of a CIO into the top management team is proving in many respects to be an important lever for driving digitalisation forward and making it economically successful.

"Our IT security officers have a high standing and are able to influence fundamental decisions (e.g. cooperation with other companies)."

54 % with CIO
39 % without CIO
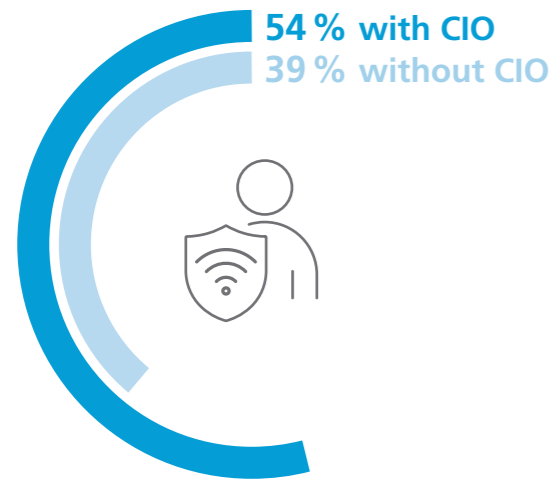
Fig. 13

"Established, historically grown IT systems are no obstacle to the introduction and integration of Industry 4.0 technologies in our company."

54 % with CIO
37 % without CIO
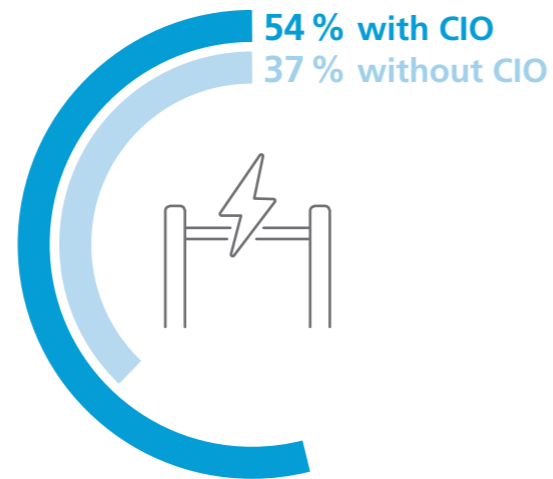
Abb. 14

"There is sufficient budget available for digitisation projects."

50 % with CIO
31 % without CIO
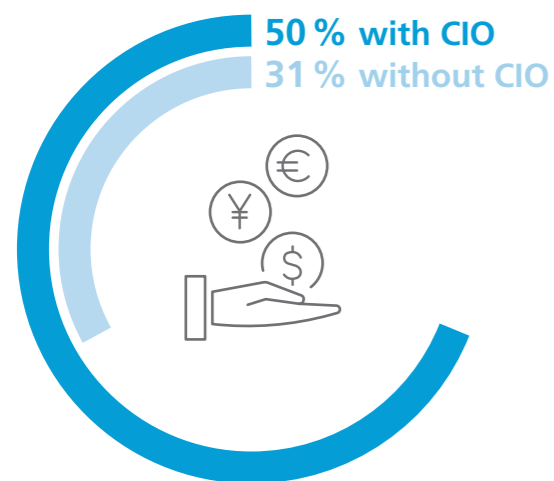
Fig. 15

"For digitalisation, my company pursues a clearly recognisable and comprehensive strategy (across the entire company)."

56 % with CIO
38 % without CIO
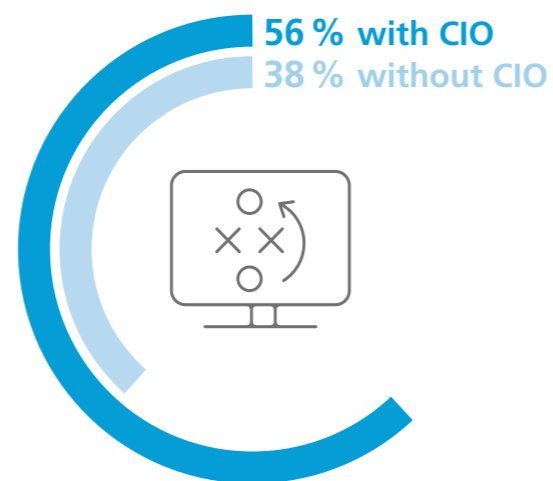
Fig. 16

"Top leader should be in charge of IT or intelligent manufacturing, in order to enforce fast digital transformation top down."

Prof. Ming Chen, Ph.D. (Tongji University in Shanghai)

"Corona crisis management in my company was forward-looking and flexible; this was the only way to prevent major disruptions in production."

62 % with CIO
56 % without CIO
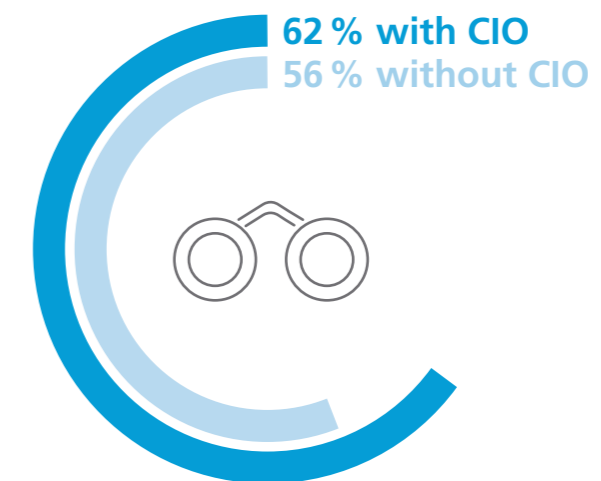
Fig. 17

2.4
Case Study

faurecia
inspiring mobility

Controlling AGVs at Faurecia with the MHP FleetExecuter

In a project initiated by the automotive supplier Faurecia, production logistics at the Plzeň site in the Czech Republic were to be automated by using autonomous transport systems. To do so, MHP used FleetExecuter, a fleet manager software developed by the company itself.

Initial situation and challenges

A central challenge in production logistics is the high fixed costs incurred by, among other things, large numbers of forklift drivers. To establish the most sustainable logistics possible at Faurecia, complex systems, as well as simple pr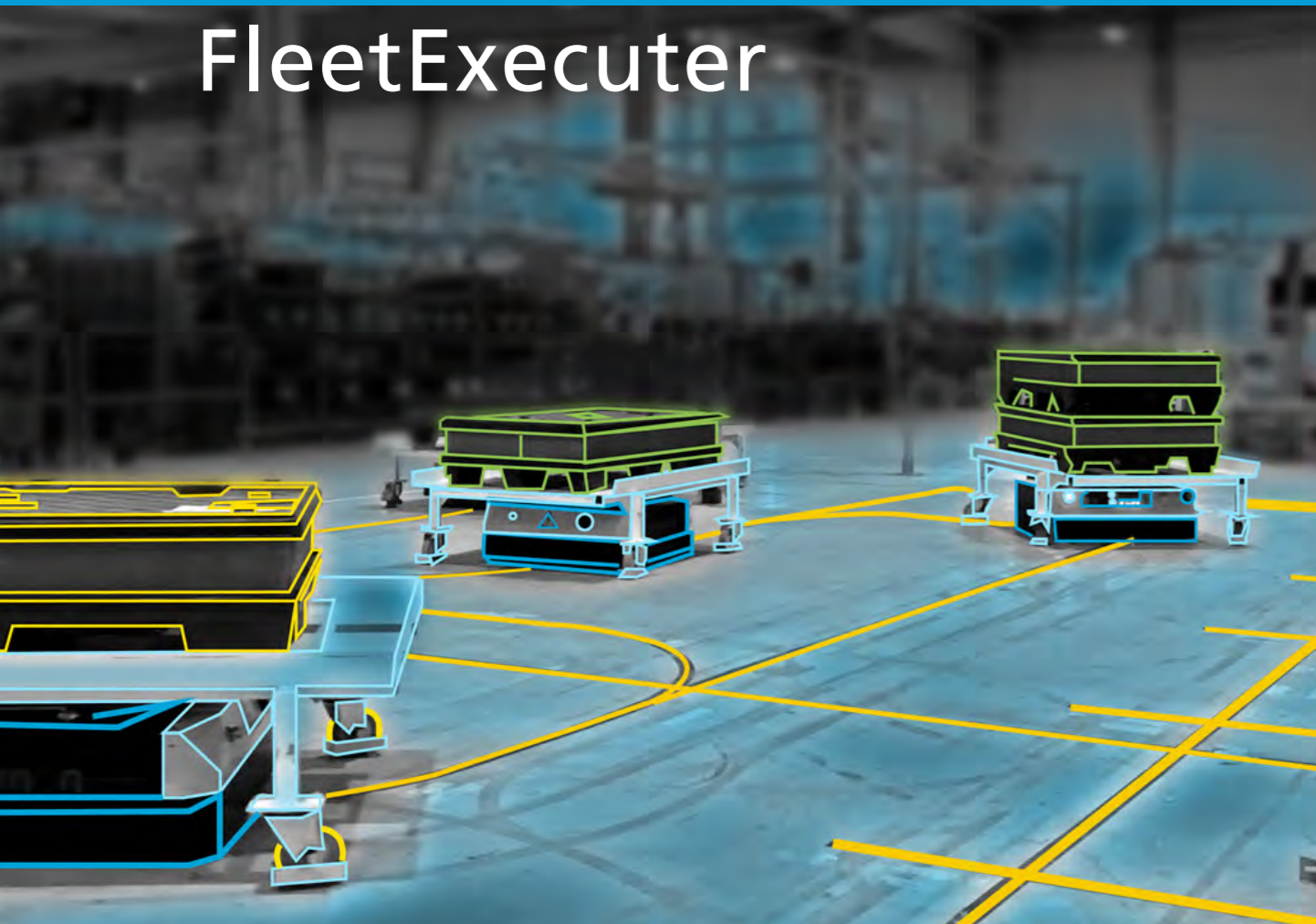ocess optimisations are needed. Such systems can automatically keep track of the material flow and control it accordingly. MHP was asked to implement its fleet managing software "FleetExecuter" to control Automated Guided Vehicles (AGVs). With FleetExecuter, the full potential of AGVs can be utilised within the plant and production lines can be supplied just-in-time, in accordance with demand.

Approach and operating principle

First, a proof of concept (PoC) was carried out as a physical test in the factory. The objective was to deliver 120 material sequences in the correct order to an imaginary production line within two hours. It was important to keep to the required cycle time of 60 seconds.

In doing so, MHP determined in simulations that the long distance between the warehouse and the production line required intermediate storage positions. This special feature had to be taken into account in the layout. These buffer positions had to be set up close to the production line so that short-term fluctuations in material needs as well as increased demand for certain material variants posed no problem for the guaranteed cycle time. The next step was to move to a larger layout, running parallel to the production line. This enabled realistic general conditions regarding the line itself, the energy consumption and the time required to travel along the line to be taken into account. Via an interface connected to the Manufacturing Execution System (MES), the next predefined sequences are transmitted to the FleetExecuter. As a basis for optimised route allocation, the production plan is checked and optimised every few seconds. In addition, the FleetExecuter also takes on container management. In addition to the control logic, the FleetExecuter also includes Graphical User Interfaces (GUIs). Among other things, these GUIs support employees in replenishing material supplies from stock and indicate which material they have to provide next for an automatic AGV collection process. If new material is provided, FleetExecuter calculates whether the material should be collected directly. Another GUI is needed at the production line and, similar to a Kanban button, is used to confirm the material pick-up. The last GUI is a higher-level control unit through which, among other things, signals can be sent manually in case there is a sudden signal loss in the factory. In this way, deadlocks can be alleviated with a single click. To guarantee system availability, it is important to keep the AGVs' batteries sufficiently charged. After simulative analysis, MHP has therefore set up opportunity charging. Here, the AGVs have the opportunity to charge their battery at several points in the layout until they are returned to the plant by the user or by FleetExecuter.

Results and outlook

With an ROI of less than 18 months, the project led to a 20 % increase in efficiency with system availability of 99.98 %. At the Faurecia plant in Plzeň, using the AGVs resulted in a significant increase in both performance and the stability of the flow of goods. Connecting the FleetExecuter to the ME system guarantees delivery of the right materials in the right quantity to the right place. One of the lessons learned is that in all areas of the plant that are relevant for employees, WLAN coverage should always be checked at the beginning of future projects. In addition, planned updates to the IT operating environment should be communicated to the project team with sufficient advance notice to avoid disruptions during project work.

The project was a great success and Faurecia is already planning to roll out the concept in other plants.

2.5
DACH:

Is the industrial internet leaving German-speaking countries behind?

More stagnation than progress

In terms of digitalisation, German-speaking companies are increasingly being left behind. This is clearly evident in the international comparison of the study results. In almost all technology categories surveyed, such as automation, digital production technologies, digital twin and supply chain transparency, the values polled remain at the same level of previous years or have fallen even lower. The results show that these companies are missing out on one important future topic after the other, such as artificial intelligence or data analysis. Solely about one fifth of the respondents state that their company processes operate with partially and fully automated decisions based on artificial intelligence processes. This means that DACH is performing worse than in 2020. In terms of IT integration and scalability, there are also more signs of regression than progress. This year's survey values are lower than last year's for both the use of cross-company API connections and the use of cloud solutions. New mindsets and business models are only being adopted reluctantly.

The lack of digital expertise

The reasons for the hesitance to implement digitalisation in German-speaking countries are many and varied. As in the UK and the USA, the "war for talent" can be identified as a potential starting point. Almost two-thirds of respondents in the DACH region cite this. More than 60 % of the study participants also rated their training measures for Industry 4.0 and the exchange with external experts in this field as being insufficient. Hence, it is no surprise that, in international comparison, staff in the specialist departments have a lower understanding of IT systems. However, this problem does seem to be made in Germany. During the Corona pandemic, it was observed that not only a large number of companies imposed a hiring freeze on themselves, but that many also held back on further training. Professor Kranz also emphasises in his interview just how crucial it is for a company to define and communicate a clear vision of the future. This not only reduces uncertainty among the workforce, but also has a positive effect on motivation, because the roots of trust lie in openness and clarity.

"For our production facilities, we have a digital twin, which contains process and status data and enables simulations to be carried out."

44 % 2020*
44 % 2019*
40 % 2018*
32 % 2021*

15 %
12 %
44 %
21 %
8 %

0 %   100 %

■ Not deployed ■ Deployment planned ■ Tests in progress
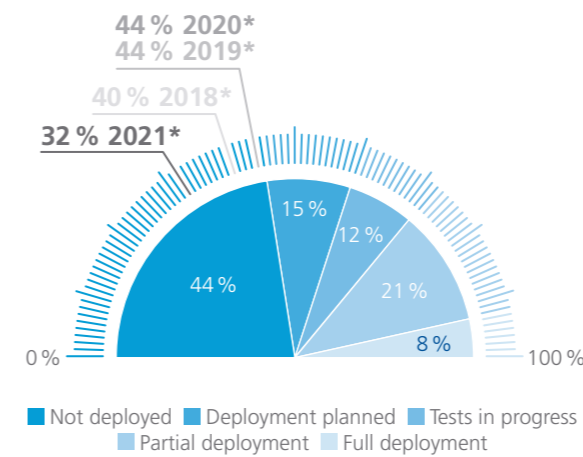■ Partial deployment ■ Full deployment

Fig. 18

"Please assess your company's capabilities compared to competitors in terms of: company processes with partially and fully automated decisions (e.g. through artificial intelligence or machine learning processes)."

54 %   26 %
20 %

0 %   100 %

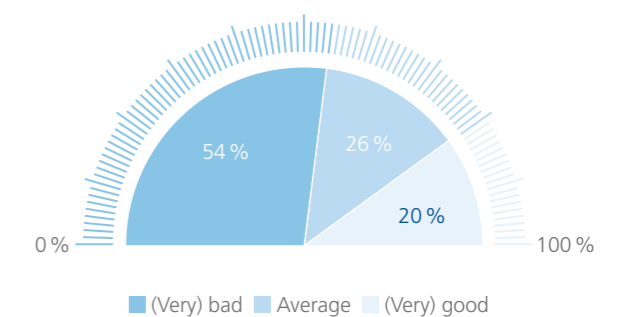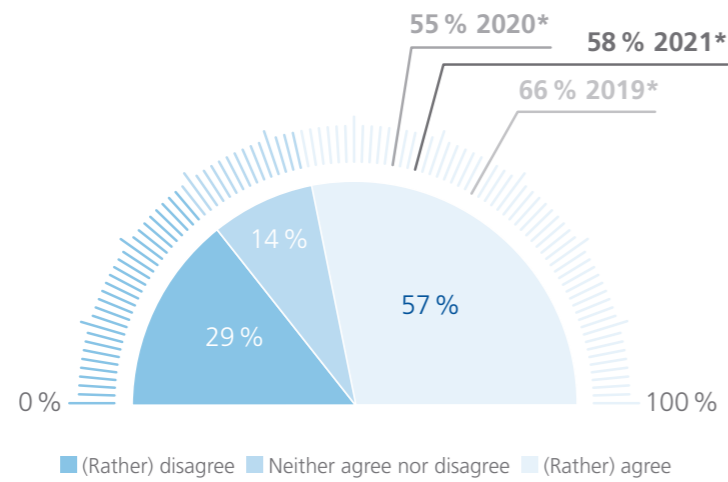■ (Very) bad ■ Average ■ (Very) good

Fig. 19

* Barometer values

"In our company, the introduction of Industry 4.0 technologies is being delayed, due to difficulties in recruiting qualified staff ("war for talents")."

55 % 2020*
58 % 2021*
66 % 2019*

14 %
29 %
57 %

0 %
100 %

■ (Rather) disagree ■ Neither agree nor disagree ■ (Rather) agree

* Barometer values

Fig. 20

"Staff in our specialist departments have a good understanding of the IT systems in use."

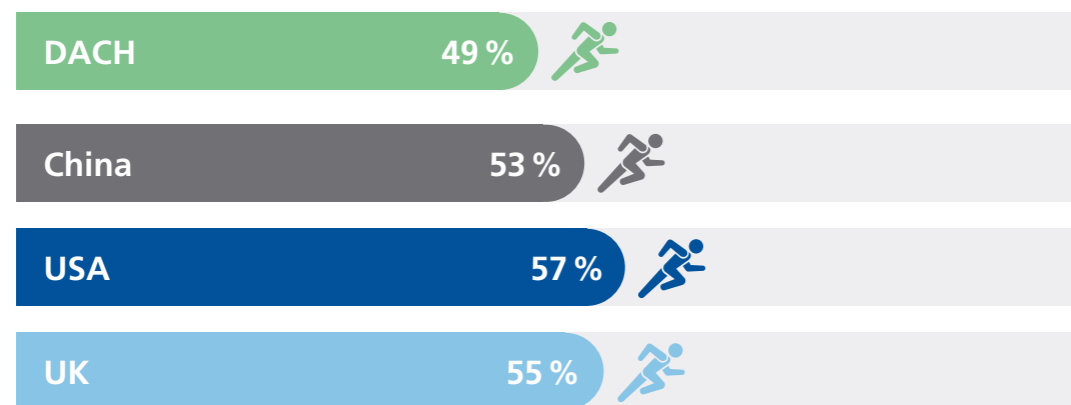| DACH | 49 % |
China	53 %
USA	57 %
UK	55 %

Fig. 21

A light at the end of the tunnel

The fact that the survey results in the German-speaking region are far behind those of the other markets is undisputed. However, a closer look at the figures reveals an unsurprising trend: the automotive industry stands out clearly from the other industries. In his interview, Mr Reimold answers the question for Porsche of whether the Corona pandemic has acted as an accelerator for digitalisation with an unequivocal "yes". Among car manufacturers and their suppliers, crisis management shows itself to be particularly well established. But they have also leave other industries far behind when it comes topics such as IT integration. With a lead of 13 % in each case, the respondents from the automotive industry stated that they had implemented powerful communication architectures, such as 5G, as well as had sufficient equipment and competence to defend against cyber-attacks. The reason for this could be the strong digitalisation pressure, which car manufacturers and suppliers say is more pronounced than in other industries.

What does this mean for you?

In terms of digitalisation, the gap between DACH region companies and their international competitors seems to be widening and it is the implementation of digitalisation efforts that is particularly lacking. It is not too late for German industry to transfer its strengths to the networked cyber-physical age. However, this will require enormous efforts, including both considerable investments and a change in corporate culture. To close the gap in expertise, companies must invest today in building up the skill sets and competencies needed for tomorrow. In the DACH region, the automotive industry is seen as a digitalisation pioneer. It is no great consolation, but this industry could yet prove to be the driving force behind a significant acceleration of digitalisation in German-speaking countries. Nevertheless, all industries should see the relevance of following the automotive industry's example and putting the necessary resources into driving digitalisation forward.

"To defend against cyber attacks, our company has sufficient equipment and competence (through service providers, if necessary)."

68 %
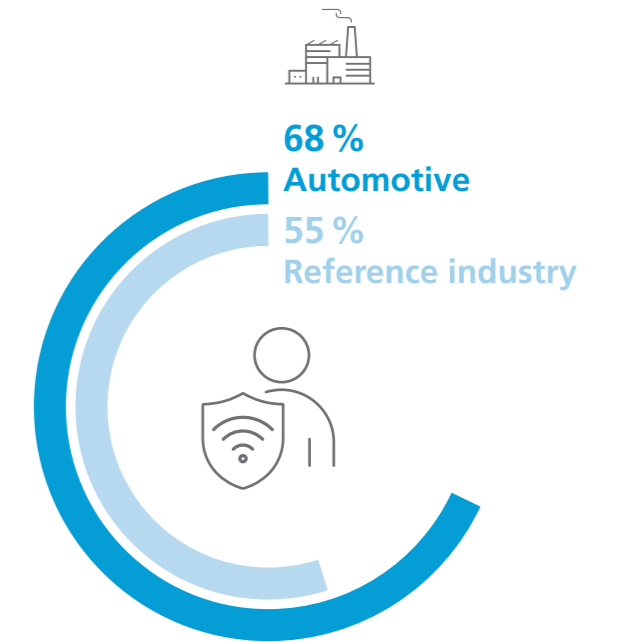**Automotive**
55 %
Reference industry

Fig. 22

"We have powerful communication architecture in and between our production plants (e.g. 4/5G, Enterprise WAN)."

64 %
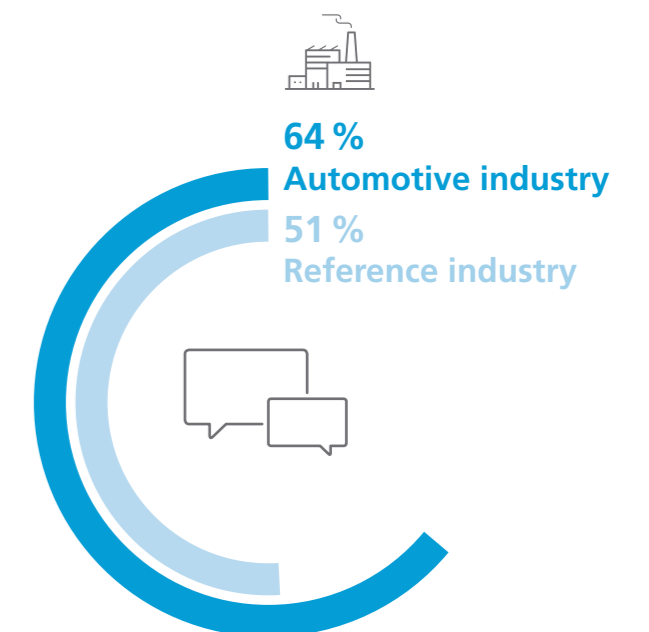**Automotive industry**
51 %
Reference industry

Fig. 23

Interview with Albrecht Reimold, Porsche

Brief Profile of Porsche

Dr. Ing. h.c. F. Porsche AG, based in Stuttgart-Zuffen-hausen, is one of the most profitable car manufacturers in the world. In 2020, Porsche delivered a total of more than 270,000 vehicles of the 911, 718 Boxster, 718 Cayman, Cayenne, Macan, Panamera and Taycan models to customers worldwide, resulting in an operating profit for the sports car manufacturer of 4.2 billion euros. Porsche operates plants in Stuttgart and Leipzig and a development centre in Weissach. The company employs around 36,000 people. Porsche is committed to innovation, with many of its technologies having their origins in motorsport. Porsche is fully aware of every aspect of its corporate responsibility: economical, ecological and social. By 2030, the company aims to be CO_2-neutral across the entire value chain and the life cycle of all new vehicles sold.

Brief Vita of Albrecht Reimold

After apprenticeship as a toolmaker, **Albrecht Reimold** studied production engineering at Heilbronn University of Applied Sciences. In 1987 he joined Audi AG as a trainee and over the years has held various management positions within the Volkswagen Group, including international posts. Key stations: from 2009, plant management at Audi in Neckarsulm. In 2012, he moved to Volkswagen Slovakia a.s. as management board chairman. Since 2016 he is board member responsible for production and logistics at the Dr. Ing. h.c. F. Porsche AG

Dr. Katharina Hölck (MHP): Mr. Reimold, could you please introduce yourself to our readers and explain how you personally come into direct contact with the digital transformation in your capacity as board member for production and logistics

Reimold: Well, I've been working in the automotive industry for about 33 years now and have been able to experience and follow various stages of automation in my career. After my apprenticeship as a toolmaker at a time when CNC machines were being introduced, I got to know the Fortran programming language while studying to become a graduate engineer for production technology. During my time at Audi, I was first allowed to store and transport the Siemens telephone for my boss, and it weighed 3.5 kg at the time. Later I was responsible for introduced aluminium technology into series production and for that I was awarded the Professor Ferdinand Porsche Prize by the Vienna University of Technology. You can say I was lucky to have always been in the right place at the right time – which was where innovations have been implemented and actually been used.

Since 2016, I have been the member of the Porsche management board responsible for production and I've been able to pursue my passion: the profitable use of efficiency-enhancing technologies. In doing so, I always question what benefit applying a new technology will bring. Technologies must be used in such a way that people can add value using their own special skills, while the remaining automation is covered by AI, control or data transparency and access.

Prof. Dr. Johann Kranz (LMU): The Corona pandemic caused many companies and their supply chains to falter. In retrospect, what is your assessment of how prepared your company was for the crisis?

Reimold: You can never be prepared well enough for any crisis. Although you learn something from everything happens, the effects of new events always reveal the gaps where no measures had been in place beforehand. However, being "overprepared" by having warehouses way too full, for example, is counterproductive. **What is effective above all is transparency along all your supply chains and being able to see where which input materials, sub-processes, semi-finished and finished products are located, so that you can control all your processes in their entirety.**

The example of the corona pandemic has shown that even a single supplier can paralyse us. In the end, it is of no use if the majority of suppliers have sufficient capacities and lead times, because as soon as even one of them

fails, the effects are the same and our entire production comes to a standstill because one single part is missing. That is why it is so important to map all your supply lines and process chains in a clear, holistic and transparent manner to make them as harmonious as possible. **Also, I advise actually stopping the production and not squeezing every last bit out until stocks are completely empty in order to maintain harmonisation and the pull system.**

It was the same with Brexit. Everyone said that stocks had to be built up. Instead, we focused on bottlenecks and breaks in the supply chains, such as border crossing points or air transport. We concentrated our measures on these areas, instead of optimistically allowing for two to three days more lead time. This would have led to nothing but delays and inharmonious processes. **Harmonisation and transparency of processes are two of the most elementary issues, and digital systems help us to keep track of this.**

Kranz: Have you been able to increase your level of transparency even further, or rather; have you now reached the level of transparency you want?

Reimold: No, we have not got there yet, because we only have transparency in tier 1 and tier 2. We have initiated a lot more action on primary materials, even if it is not our very own responsibility. We are currently also noticing this with semiconductors. We cannot just rely on the big suppliers; we have to know the sub-steps that make up the supply chain and how it really operates. This is the only way to act holistically. We've created much more transparency in our procurement and logistics, but we are still not where we want to be. There is still a difficult road ahead of us.

Hölck: The Corona pandemic is often seen in the media as an accelerator of digitalisation. Is this true for Porsche?

Reimold: Yes, that is true for Porsche and I would like to emphasise that. When working from home was significantly extended at the beginning of the Corona pandemic, you could see how quickly our IT managed to generate thousands of VPN connections. Before, there were concerns about data protection etc., but necessity is the mother of invention. **I think innovations are often born out of necessity, and in my opinion the pandemic provided a real boost. The ones who have not really kept up are the public sector, the municipalities and authorities.** But they have not faced the same pressure as business has. Every day, companies have to think about how to generate turnover, and this entrepreneurial approach forces us to take action that then results in progress.

Climate change is also currently creating a boost. Meanwhile, everyone has understood that sustainability is essential. At Porsche, we want to be pioneers, operate sustainably in a way that is credible and actually implement measures. I myself started rethinking at an early stage and am the sponsor for sustainability on the Porsche executive board. This is not something that is driven by regulations and laws. The desire to preserve the world has to come from the heart. We've already been using renewable electricity at Porsche since 2017, worked a lot with technical development and pushed the circular economy. The goal "CO_2 balance neutrality by 2030" was incorporated into Porsche's strategy. This is not an easy task that you can just write down on a piece of paper and it happens by itself. You have to fight for it year after year, and digitalisation helps. My dream is to be able to say: **"Yesterday we had CO_2 emissions of X tons and tomorrow we will have less because of the measures we have taken." That's still a very long way off and we will need all our employees to achieve it.** To quote Mahatma Gandhi: "Be the change you wish to see in the world."

Kranz: Besides the Corona pandemic, Brexit or economic wars also pose challenges for the economy. What other conclusions does Porsche draw from these crises for its future supply chains?

Reimold: First of all, we have to show our agility in grasping the situation, analyse the causes and causal chains as quickly as possible and then define measures that will alleviate the situation or lead us back to the original path. This is also what the emergency doctor does at the scene of an accident – he does not just start sticking plasters everywhere, but takes a systematic approach. Corona led to a lot of debate and questions about why we globalised our supply chains in the first place. Globalising suppliers was said to be a mistake. But it is not a mistake at all, as we could see again and again in Ahrweiler or with the train drivers' strikes. A tree falling on a main supplier's production hall in Stuttgart is just as bad as a snowstorm causing havoc thousands of kilometres away. That's why you always have to assess the situation, create transparency, identify causes, draw up measures and adapt your course of action accordingly. Even if all our suppliers were based around Stuttgart or if we did everything ourselves, there can still be sub-process failures that paralyse us. **That's why continuous reorientation and an end-to-end view of the process chain are indispensable.** For example, injection moulding a plastic component in Spain, painting it in the Ukraine, assembling it in Northern Italy and then bringing it to Zuffenhausen is not an optimised approach. This process flow makes no sense, not least in terms of sustainability. **A stringent and continuous supply chain**

is the key. If you have this, then distance no longer plays a major role. We are not going to turn back the clock so that everything happens around Zuffenhausen.

Hölck: Porsche summarises the Factory of the Future concept under the title Porsche Production 4.0. What is your vision for Porsche Production 4.0?

Reimold: Porsche Production – smart, lean and green, as I like to say. My vision is to leave the individual dreams that Porsche designs for its customers completely unchanged. We do not want to become a mass producer. We want to build highly individualised sports cars that make our customers' dreams come true. That's why we have to master this complexity. To do this, we need a network of suppliers, because it is simply impossible to do everything ourselves. Porsche's in-house share of production is about 20 %. The supply chain has to be controlled – the right materials have to be in the right place at the right time in the right quantity and of the right quality. Ultimately, we need technologies to keep us at the forefront in performance, quality and functions. This huge process has to be managed transparently in all its sub-areas and with the least possible use of resources. In the event of deviations, we have to use the right tools to be able to initiate countermeasures in time, so we can always get back onto our harmonious course.

In the smart, lean and green factory, people will increasingly focus on their manual skills and consequently they will drive innovation and optimisation processes. It is important to remember that the recognition of their work is what makes people innovative and efficient. This interplay of craftsmanship in the best and original sense, supported by technologies and digital tools, is my vision of Porsche production for the future.

Kranz: What challenges do you see at Porsche in the digital transformation of production and logistics?

Reimold: In my area, there is one main department where I deal with future topics in particular – from technology to people and methods, like problem-solving skills. We work in bi-monthly innovation meetings, in which clear goals are formulated that we want to implement. This is not just strategy, but also closely linked to the operational areas. It is particularly important to us that all innovations are revenue-generating and contribute to our 15 percent return on sales. Innovations are not purely enablement, but must also generate income. I do not want to have a digital shift book that only shows me a different graph but otherwise does not generate any added value. **Innovations must be geared to the business process, increase data consistency and enable end-to-end processes.**

In addition, managers must lead their employees with a vision for the future, so that we will be better off tomorrow than we are today. Success is addictive and leading by nudging animates the staff. For example, we recently received the Lean & Green Award. Minor successes like that are extremely important and have to be rewarded, because everyone needs recognition, as children and later as adults.

Hölck: What measurable successes (e.g. turnover or net profit) have successful digitalisation projects already achieved?

Reimold: In production, our productivity progress is about 6 to 10 % every year, with the help of our ideas programme, the Porsche improvement process or Porsche process optimisation, for example. Each main department has to go through this process again and again with an optimisation target of about 10 %. It is for things like this alone that we need to have this striving for improvement in production cemented in our minds. We have a profit improvement programme that requires a nine-figure amount of money. It is important to keep asking ourselves what progress, efficiency gains and resource savings are being generated. With the Smart Factory, for example, we have generated a potential of almost 80 million euros, a third of which has already been saved in real terms. That is why investments in new technologies provide a boost.

The Group works on the Digital Production Platform (DPP), which consists of different layers, such as the data lake and the application layer. Applications that are developed today must be DPP-compatible. Here at Porsche, we were development pioneers and have, for example, developed an application for label recognition that is now used internationally throughout the entire corporation.

Kranz: Porsche is putting people at the centre of Production 4.0. How will employees be involved in this transformation process?

Reimold: It is important to get away from the myth that the factory of the future is devoid of people. People will still be needed to control and use the technologies. If you can make people aware of this, you can alleviate many fears. This was also the case with electromobility, when people initially feared job losses. In the process, new fields have emerged that have generated new jobs – in charging equipment, for example.

At Porsche, on the one hand, we pay attention to the fact that technologies enable employees to do things they were not able to do before and relieve them of certain tasks. On the other hand, the use of today's technologies can simplify the interplay between highly complex factory processes, which in turn creates new opportunities for employees. The digital transformation means people can devote themselves to innovative and creative areas. To enable them to use their full potential, they should be trained and empowered accordingly. Since certain processes will be automated in the future, it is important for employees to get involved. Those who do so will have significantly more opportunities and possibilities than before.

To guide employees through the transformation process successfully, it is important to take away their fear of change. Things were not always better in the past. Every era is good in its own way; you just have to make the best possible use of the available technologies. On the other hand, it is important to lead and to coach employees properly. Managers should act like coaches – cushioning setbacks and continuing to motivate people after successes to bring out the best performance. Any complacency rooted in prosperity or success must be avoided, because otherwise it takes a setback to get people motivated again. In addition, managers today must be able to react much more flexibly to changing conditions.

Hölck: In 2020, Group CEO Herbert Diess announced the goal of taking the lead from Tesla within the next five years. Where does Porsche stand in this race to catch up and what factors do you think will be decisive for its success?

Reimold: We still have a lot of work to do regarding vehicle architecture, software and connectivity. With our products, such as the Taycan or the 911, we've proved that we are pioneers in the field of hardware. No one holds a candle to us. But if we think we can overtake Tesla with our conventional ways of thinking and methods, we are wrong. We have to find partners who can support us with vehicle architecture and help us to raise our profile in the market in the long term. We still have great potential there, for example in user experience, simplicity of operation or response behaviour. There are a few competitors around the world that we have to be careful not to let them get the upper hand, because they are gradually approaching the subject of the vehicle's hardware rather faster than we are approaching the software architecture.

The strengths of our brand, the Porsche legend and our experience remain the focus of Porsche buyers. This is reflected in the elegant design, the performance of the vehicles and their functionality. These attributes are still dominant, but we have to look at how we can bring them into the future and transfer them to the vehicle as a smart device. This is noticeable in customer feedback, especially in new markets. The typical sixty-year-old will not be disappointed if the vehicle does not have all the latest technology, because he is not used to it and does not expect it. But younger customers who drive a Porsche will notice the difference. From using mobile phones, they are used to connecting up everything and working in seconds. It is a manager's task to build on strengths and eliminate deficits. We are building on our very clear and well thought-out Strategy 2030 with topics such as electrification and sustainability, oriented towards putting the focus squarely on the customers.

2.6
China:

Playing roulette with digital transformation

Leadership in digitalisation at any price

Nowhere have more massive technological advances been achieved in recent years than in China. Meanwhile, the region managed to outstrip its Western competitors in many respects. Gone are the days when China was seen primarily as the world's extended workbench. Instead, Industry 4.0 has taken hold in its factories. China's use of technologies is exemplary, putting it far ahead in comparison with other countries, as shown by a 20 % higher use of digital twins, twice the supply chain transparency and twice the rate of automation and remote control of production plants. A clear growth strategy is being pursued impressively. For technologies such as additive manufacturing or autonomous robots, up to 90 % of Chinese companies are already conducting at least field tests. These technologies will be integrated into current production sooner rather than later. Higher labour costs and quality requirements have led the People's Republic to leave its role as a low-budget country noticeably behind and modernise their manufacturing sector technologically. Although Chinese companies have already made progress, this is only the beginning.

"For our production facilities, we have a digital twin, which contains process and status data and enables simulations to be carried out."
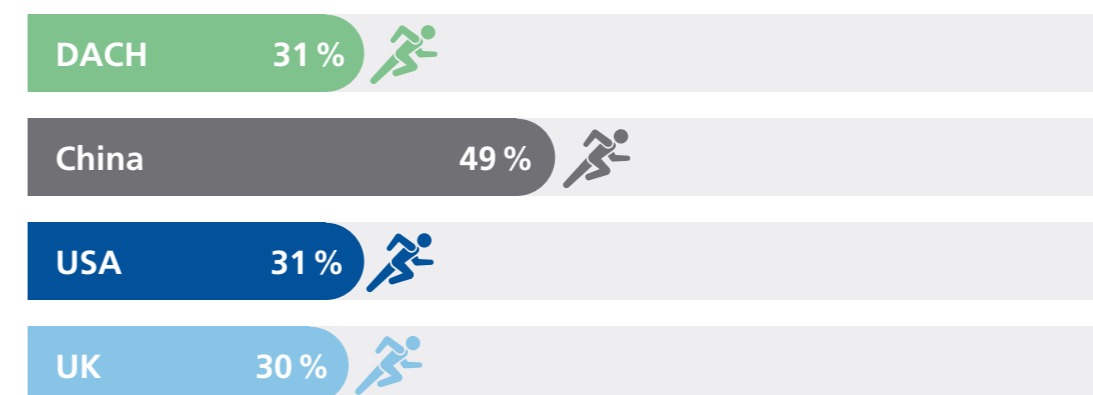
DACH	**31 %**	
China	**49 %**	
USA	**31 %**	
UK	**30 %**	

Fig. 24

The growing pains of digital transformation

Attacking digitalisation at such a blistering pace means some issues have to be put on a back burner. While outpacing competitors in terms of speed, China is falling far behind in security. In 90 % of cases, regulations on data access are being neglected. This lack of focus on IT security is tarnishing China's image as a digital leader, especially since insufficiencies in this field can cripple entire corporations. Further, there are still problems regarding intra-company communication. Nowhere else is there so little internal cooperation and trust. In both criteria, China is far behind the competing DACH, USA and UK markets. The lack of trust, in particular, is a recurrent theme running right through Chinese corporate culture repeatedly creating impediments.

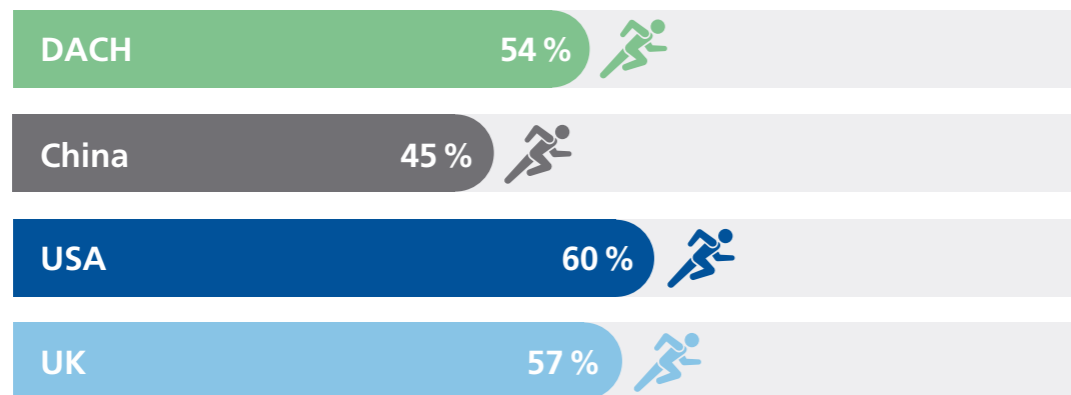"The IT department and other specialist departments exchange information on a regular basis."

DACH 54 %
China 45 %
USA 60 %
UK 57 %

Fig. 25

Digitalisation strategy: "China first"

With the severe disruption in supply chains triggered by the pandemic, many companies and even entire countries began to rethink their globalisation strategy. On the one hand, a global market offers gigantic growth potential. On the other hand, heavy dependence on other markets can cause economic problems in times of crisis. Therefore, as seen in the 14th Five-Year Plan, China seems to have been focusing on the domestic market for several years, thus building a foundation for the future. Critics cite a lack of focus on other markets. Compared to other countries, China only places half as much emphasis on opening up new markets as the front-runners and is even prepared to sacrifice companies' economic success to some extent in order to adequately supply the domestic market.

"With Industry 4.0, our company is primarily striving to open up new market and customer segments."

DACH 55 %
China 33 %
USA 63 %
UK 62 %
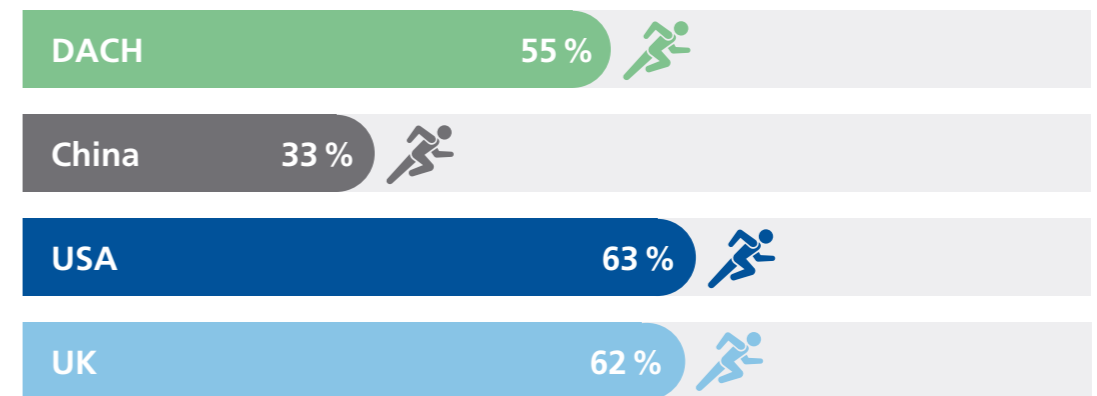
Fig. 26

What does this mean for you?

To secure digital leadership, Chinese companies should continue to maintain the current pace of their digital transformation. In particular, the high proportion of prototypes already in use implies that China is boldly moving towards digitalisation. The task now is to make these prototypes suitable for practical use so that the high potential can be converted into commercial success. Chinese companies currently seem able to compensate for the considerable deficits in IT security, internal cooperation and trust. In the future, the lack of cooperation may cause significant performance losses. These shortcomings must be remedied as quickly as possible, otherwise digital leadership will be on shaky ground. In addition, the strength of the domestic market seems to be able to conceal the problems very well. However, in order to maintain the rapid pace of growth, Chinese companies should, sooner or later, strengthen their orientation towards international markets.

Interview with Jörg Menges and Claudius Illgen, FAW-Volkswagen

Brief Profile of FAW-Volkswagen

FAW-Volkswagen is a joint venture between German car makers Volkswagen and Audi and the Chinese automobile manufacturers FAW and Volkswagen (China) Investment. Launched in 1991, it is now one of the largest car manufacturers in the People's Republic with a total of eight production sites – in Changchun, Chengdu, Foshan, Qingdao and Tianjin.

FAW-Volkswagen's production uses a wide range of modern technologies that enhance the high quality and reliability of its vehicles. In addition, the company uses the Volkswagen Group's manufacturing platforms – the Modular Transverse Toolkit MQB for vehicles with combustion engines and the Modular Electric Drive Toolkit MEB for electric vehicles.

FAW-Volkswagen's vision is to be the most outstanding automotive company in China for customers, employees and partners, and to shape the future of mobility. To achieve this, the company focuses not only on the high quality of its own vehicles, but also on innovative services for its customers and on ecological and social sustainability.

Brief Vita of Jörg Menges

Jörg Menges has been responsible for the FAW-Volkswagen plant in Changchun since 2019. He had previously spent 20 years at Audi, holding various management positions in planning and production. During his career, he has therefore had numerous points of contact with innovative and digital production technologies in design and implementation. His activities also included the development of digitalisation strategies for the Changchun plant.

Brief Vita of Claudius Illgen

Claudius Illgen has been with FAW-Volkswagen since 2017 and also previously worked for Audi in Ingolstadt. He is responsible for logistics planning at the plant in Changchun. His tasks include the strategic, but also short-term operational realignment of logistics, as well as the sustainable optimisation and digitalisation of processes, systems and employees through the use of new technologies and solutions.

Anna Nägele (MHP): At the beginning of 2020, many companies and their supply chains were taken by surprise and really put to the test by the Corona pandemic. Looking back, how do you assess the situation for your company? How well prepared were you and how did you react to the events?

Claudius Illgen (FAW-Volkswagen): We were not prepared for such a pandemic – hardly any company was. However, during the pandemic, logistics was able to play to its traditional crisis management strengths. Emergency processes were introduced very quickly in warehouses and in transport. Material pipelines were thinned out to the maximum degree possible. At the same time, domestic and international shipments were accelerated by switching from sea to air in many places. In addition, the production program and thus production logistics as well were adapted to the new situation very flexibly – sometimes even on a daily basis. All this involved a great deal of manual and personnel input.

Thomas Klüe (MHP): The large number of manual processes provides a nice transition to our next question. The Corona pandemic is often portrayed in the media as an accelerator for digitalisation. What kind of digitalisation boost did Corona trigger at FAW-Volkswagen?

Illgen: The course of the last year illustrates this very well. In the middle of 2020, there was a strong increase in demand in the Chinese market. For many suppliers, this was unexpected so soon after the Corona crisis, as pandemic measures had led to capacities which were previously reduced in many places. As a result, more critical suppliers became visible in many supply chains, which is why robust logistics processes and transparent supply chains were needed in the short term.

Fortunately, we had already worked intensively on digitalising the supply chain before the pandemic, and during this process we introduced a new delivery system that uses tracking & tracing to enable the accurate time tracking of material deliveries. This solution was a great benefit when supply chains were ramped up again. Nevertheless, we were able to identify optimisation potential here through Corona, **because the period for delivery call-offs, fixed at two weeks, was simply too long to be able to react to short-term fluctuations or failures**. In general, it is important for the supply chain to create the perfect balancing act between plannability and flexibility, and this has been underlined once again by the Corona pandemic.

Menges: There is something I would like to add. **Corona has shown us how volatile our environment is and that we need solutions for such changes. And the way to get them is to increase the flexibility of our processes. Digitalisation is an important enabler for this**. I would therefore say that it was not directly the digitalisation that was pushed by Corona, but rather the need for adaptation and this can be achieved through digital solutions.

Klüe: Besides the Corona pandemic, other events, such as the chip shortage, demonstrated that companies can improve their responsiveness and speed of action by using digitalisation. What concrete effects will these developments have on your company's future supply chain?

Illgen: Supply chains were already very complex before the pandemic – chip manufacturing is a good example – but the pandemic and the other crises certainly posed particular challenges for supply chains. Their complexity, resulting from the multitude of suppliers, parts and processing steps, now really needs to be managed by digital solutions. However, these solutions only deliver added value, if they have access to all relevant supply chain information. This ranges from a supplier's past performance to current raw materials and material stocks to possible bottlenecks in the future, as well as many other environmental influences that can impact the supply chain. Only if all this information is available to all actors – in high quality and in real time – will we then be able to react better to unforeseeable events in the future. That is why I think and hope that past crises will have a positive impact on the exchange of information along the supply chain.

Klüe: In this context, are concepts like local sourcing likely to gain more importance again?

Illgen: On the contrary. Just because I rely on local suppliers does not mean I'm safe from the next crisis. If a supplier fails, I have a problem – regardless of where the supplier is located. That is why local sourcing cannot be the silver-bullet solution for the next pandemic. **It really comes down to comprehending and mastering the overall complexity of the supply chain itself, and that is no longer possible with classic methods and concepts.** That's why the solution also lies in digitalisation.

Nägele: What role do you think people will play in the digital transformation in the future?

Illgen: A system is only as good as the person who operates it. Systems can create transparency and generate solution proposals, but in the end it's still employees who make the decisions. In my view, complex decisions will not be taken away from us by artificial intelligence in the future, and that is why employees will continue to be an important factor.

Menges: I agree. **In our opinion, employees are at the centre of the digital transformation, because they are both implementers and users.** Moreover, digitalisation is not an end in itself. Instead, it should benefit the employees as well as the company.

Klüe: What challenges do you see in your company in the transition to digitalisation?

Menges: The biggest challenge and at the same time the most important contribution to a successful digital transformation is the active involvement and the enthusiasm of employees at all levels. That is why digitalisation cannot be imposed from above. **It is important to establish processes of innovation and change that involve all areas and levels and motivate them to actively participate so that a kind of organic momentum can develop.** Corporate culture and organisation play a central role in this.

Another major challenge is the technical implementation of digital solutions between the conflicting areas of standardisation and dynamics. On the one hand, innovative solutions should be implemented quickly and be directly available. On the other hand, they should ideally be reusable across departmental or site boundaries as well, in order to maximise their potential. It is therefore important not to curb enthusiasm by imposing standards and regulations, but at the same time successes should be achieved quickly and then transferred to other places of application, with no loss of quality. This trade-off is by

no means child's play, but it never ceases to be an exciting challenge every time.

Nägele: Do you already have any measurable success to show for your digitalisation initiatives?

Menges: We have planned a total of 186 individual projects for 2021, the majority of which have already been implemented. However, it is not the number of projects that is decisive for successful digital transformation. For us, it is important to create a healthy mix of large-scale long-term strategy programmes and small, quick wins at operational level. Of course, big transformation programmes are needed at a strategic level. But smaller initiatives driven from the shop floor are just as important for achieving short-term successes and thus for motivating the staff.

Klüe: How do you evaluate the impact of the individual digitalisation initiatives? Can success be quantified, in terms of cost savings or increases in turnover, for example?

Menges: I do not think it is possible to quantify the overall effects of digitalisation. Lots of digital solutions have positive influences that only materialise in the long term and so cannot even be taken into account at the beginning of a project. For this reason alone, it is important to admit that when deciding on a digitalisation initiative, not everything can be quantified. Instead, the focus should be on the meaningfulness and the tangible benefits of any solution. It is also important to be convinced of the

solution and to be able to defend it against critics objectively and comprehensibly. **A purely economic view is not helpful and usually not possible, especially with digitalisation projects. You have to be convinced of them!**

Illgen: I totally agree. For smaller applications, such as our picking robots or our new retrieval system, we can demonstrate and prove their cost-effectiveness. Of course, we benefit from the low costs for development and hardware in China. But here, too, there are certainly other effects that we may not yet be able to assess, but which will have a positive impact on our processes – either now or in the future.

Nägele: To conclude the interview, we would like to touch upon the Chinese government's current five-year plan. Among other things, it aims to accelerate digitalisation and build a digital China. How do you rate China in an international comparison, especially with Germany and Europe?

Menges: My perception of the employees at our Changchun plant is that they are very quick to implement things. New solutions are put into practice quickly, pragmatically and above all with an agile mindset, by that I mean, instead of planning a perfect 100 % solution down to the last detail, an 80 % solution is introduced quickly, which they then develop further and optimise together. On top of this, our colleagues in China are very tech-savvy.

Illgen: There are of course different requirements in China when it comes to data security and protection for example. One example is the tracing app that all truck drivers have installed on their own smartphones, so that their location or their arrival at the plant they're supplying can be seen at any time. **In Germany, debate about such solutions is much more diverse and controversial, and extensive regulations and requirements sometimes make them difficult to implement. These debates do not happen in China, which of course speeds up implementation.**

Menges: Another important factor for success is the great willingness of all employees at all levels to deal intensively with digitalisation and to drive it on themselves. To encourage this, we have, for example, developed an app that informs employees about what new digital solutions are being used in our company and what current trends there are on the market. It's a very good way to get employees excited and ultimately enthusiastic about digitalisation.

Klüe: So, now you have listed so many advantages of China as an industrial location. Are there perhaps any areas in which Germany or Europe are still ahead?

Menges: It is in the design and implementation of holistic digitalisation strategies that I see Europe's strength in particular.

2.7
UK:

Navigating through tough times

Weathering storms and overcoming crises

Though Brexit and the associated turmoil have taken quite a toll on British businesses, it also seems to have taught them a thing or two about dealing with crises and supply chain disruptions. The results show that UK companies are particularly well-versed in dealing with turbulence in global supply chains. The precautions taken before leaving the European trading union arguably proved highly valuable for crisis management during the Corona pandemic. When the global economy began to falter, the early warning systems established on a large scale ensured proactive and flexible crisis management for eight out of ten of the companies surveyed. The security of IT systems was given equally high priority. The results show that over 60 % of UK companies rate their own skills and resources for defending against cyber-attacks as being sufficient. This puts them at the forefront of the market comparison. This result can be explained not least by the fact that IT security managers are given a great deal of say and responsibility. In more than half of British companies, particularly high esteem is attached to this role – a top result internationally.

No queues for highly skilled jobs

However, the exit from the European Union also had negative consequences for Britain's industrial companies. Two effects in particular stand out here. After Brexit and the abolition of the free movement of labour, UK businesses are finding it difficult to find enough qualified employees for Industry 4.0 projects. This means that the UK is one of the countries most affected by the "war for talent". Around half the respondents state that their company has difficulties finding qualified staff. Exiting the EU may also have made the recruitment process more complicated, something that also applies to investment budgets. For one in two companies, Brexit seems to have torn a hole in their digitalisation budget. Only in China are budget problems more pronounced than in the UK.

"My company's Corona crisis management was forward-looking and flexible; it was the only way to prevent major disruptions in manufacturing."

64 % 2021*

0 % — 7 % — 12 % — 81 % — 100 %

■ (Rather) disagree ■ Neither agree nor disagree
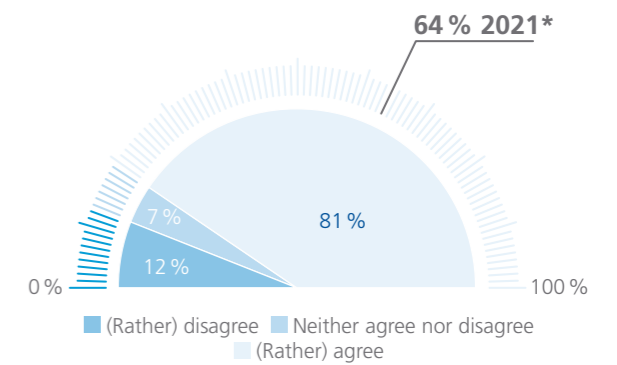■ (Rather) agree

Fig. 27

* Previous year's barometer values

"The introduction of Industry 4.0 technologies is being delayed in our company, due to difficulties in recruiting qualified staff ("war for talents")."
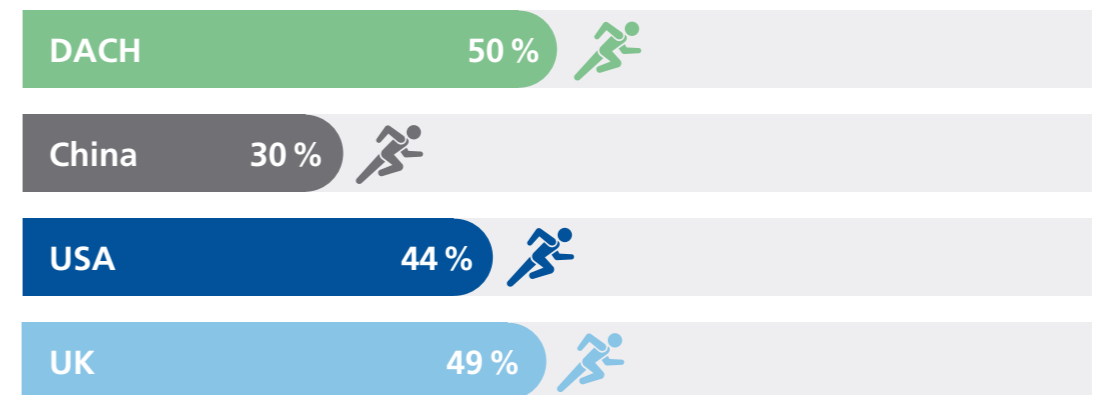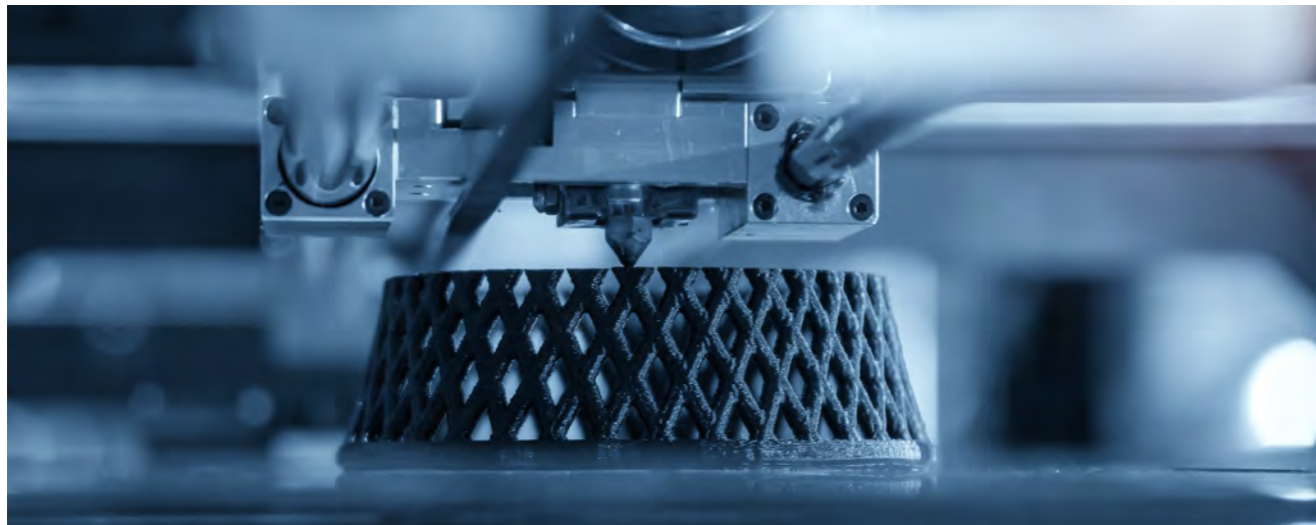
DACH 50 %
China 30 %
USA 44 %
UK 49 %

Fig. 28

SMEs falling behind

Compared to other countries, the United Kingdom is well positioned in terms of industrial digitalisation. However, a more differentiated analysis shows a widely differing picture. The SMEs are falling far behind large companies. In companies with fewer than 100 employees, the number which has set up additive manufacturing processes is just about half in companies with 100 or more employees. A similar picture emerges for supply chain transparency. Tracking options for individual parts, sensor-equipped systems and even autonomous robots are not being used in up to 75 % of SMEs. It seems that the use of innovative digital technologies is being left to the big players. They are also setting the standards when it comes to market orientation, as Steve O'Connor from Aston Martin describes in his interview. Thus, there is the risk of smaller companies falling behind when it comes to technological change. The great majority of companies in the UK are SMEs. If they fall behind technologically, UK industry will lose its manufacturing foundation. Small businesses have considerable difficulty in meeting the capital requirements for digitalisation compared to their larger counterparts. To address this problem, the UK has set up so-called catapults[1], a system introduced by the state to promote the commercial use of operationally applicable technologies.

[1] More information at https://catapult.org.uk.

What does this mean for you?

The United Kingdom is well positioned in an international comparison regarding industrial digitalisation. However, despite its leading position, especially with regard to cyber threats, the UK should not start resting on its laurels. The prevailing budget problems in particular tarnish the overall image of the country as a digitalisation pioneer. Faced with such budget problems, the initial instinct would be to save money and make up for the investment delay at some time in the future. This may turn out to be a glaring error. It is advisable for UK companies to take risks now and continue investing in talent development and digital leadership. The Catapult network was set up to support the commercialisation of the developed technologies. Nevertheless, the effectiveness of these Catapults should be reconsidered for SMEs. Those must not be left behind technologically, as they could slow down the rest of the economy. On the one hand, the support programme provides incentives to invest in new technologies, but on the other hand, for small enterprises, a major investment hurdle still remains. Consequently, higher and more targeted financial support for small enterprises could be considered as a first step.

"We can locate all individual parts of our products as well as end products across the entire value chain (from inbound logistics to production to customer service)."

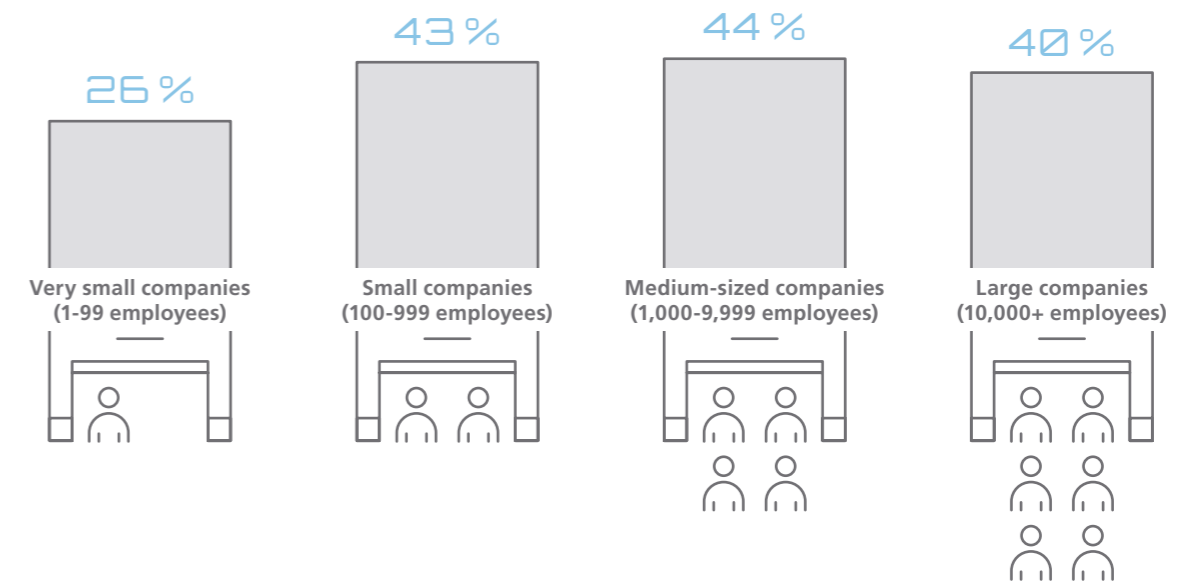| Very small companies (1-99 employees)	Small companies (100-999 employees)	Medium-sized companies (1,000-9,999 employees)	Large companies (10,000+ employees)
26 %	43 %	44 %	40 %

Fig. 29

"We integrate additive manufacturing methods into our production (e.g. 3D printing of spare parts)."

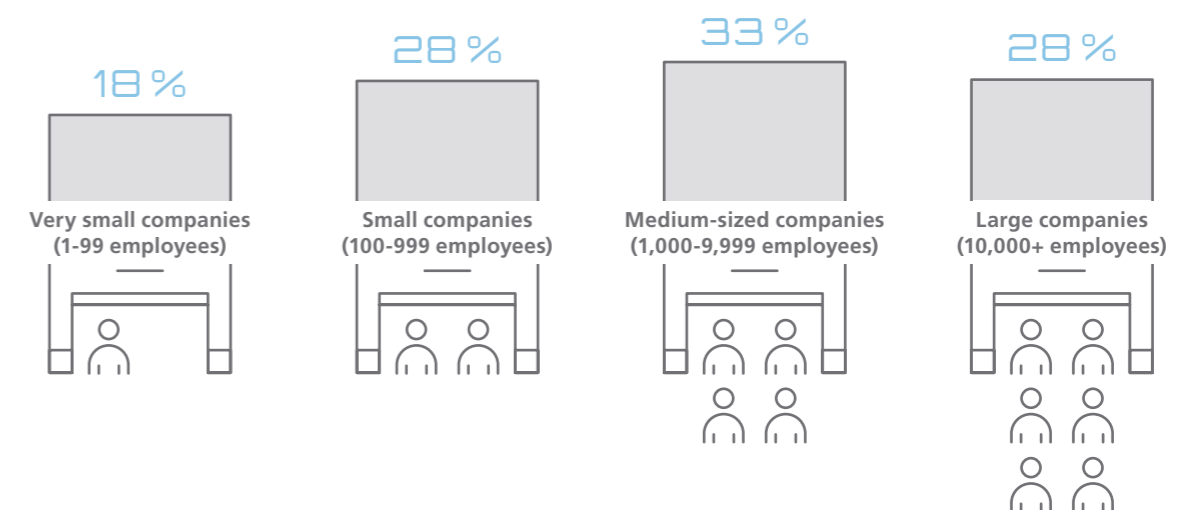| Very small companies (1-99 employees)	Small companies (100-999 employees)	Medium-sized companies (1,000-9,999 employees)	Large companies (10,000+ employees)
18 %	28 %	33 %	28 %

Fig. 30

Interview Steve O'Connor – CIO Aston Martin Lagonda

Brief Profile of Aston Martin Lagonda

Aston Martin is a globally recognised luxury brand and a leader in the high luxury sports car market. For more than a century, the brand has symbolised exclusivity, elegance, power, beauty, sophistication, innovation, performance and an exceptional standard of styling and design. Our cars sit primarily within the HLS car market and our market leadership position is supported by award winning design and engineering capabilities, world-class technology and modern facilities, creating distinctive model line-ups. Our rich and prestigious heritage of delivering beautiful awe-inspiring cars defines Aston Martin as something truly unique within the automotive industry.

Brief Vita of Steve O'Connor

Director of IT at Aston Martin Lagonda, **Steve O'Connor** is responsible for end-to-end IT within the business. As technology transforms every facet of the automotive industry, Steve created and leads the digital transformation strategy in order to become the most efficient, agile, technology driven luxury car manufacturer.

The digital revolution puts the focus on the business's Information Technology systems more than ever before. Now in his tenth year with the brand, Steve has used his strong technical background and business skills and rebuilt the IT function from the ground up.

A married father of two young girls, Steve has a real passion for motorsport, technology, and the Aston Martin brand. He believes strongly that investing in people and technology is the path to sustainable competitiveness, motivated team members and satisfied customers.

Johann Kranz (LMU): Hi Steve, could you introduce yourself please?

Steve O'Connor (Aston Martin): I'm director of IT at Aston Martin. I've been in this role for 2 years and with Aston Martin Lagonda for 10 years. My role is to lead the digital transformation, which is part of the overall business transformation, Project Horizon. I sit within operational excellence to enable us to deliver platforms and the technology to allow the business to transform, become more agile and become more innovative.

Kranz: How do you assess Aston Martin's preparation for the crisis or what was your role in adapting to the pandemic?

O'Connor: The pandemic came along when we were a lot closer to our supply chain than maybe other organisations would have been. So, we were managing the supply chain very tightly. This meant we had a safety net setup within the supply chain. Therefore, when COVID hit, it was a case of modifying some of the processes that we were currently using and adapting them to create a better safety blanket.

Supply became less of a challenge with less demand across the industry. Nevertheless, when production started again last year, we started to face the same sort of challenges that other businesses were experiencing. Some suppliers could not operate and other suppliers were not able to operate at full capacity. A lot of work went into balancing the supply and demand. **By getting closer to those suppliers, understanding what was coming, what we could get and then changing our demand profile, we were able to 'weather the storm'.**

Kranz: With the benefit of hindsight, how did COVID affect your digitalisation plan?

O'Connor: COVID has been the perfect storm for what we want to do as a function. The business suddenly became remote, and you can only do this if you have got a solid technology platform to allow you to have that continuous communication and keep running as a business. For us it has increased the reliance on IT and throughout the company it has been recognised that IT is not just a cost center. I do not think we would have been as fast at realising that without COVID. The whole business was working remotely and that was an enor-

> "[The corona-pandemic] has increased the reliance on IT and throughout the company it has been recognised that IT is not just a cost center."
>
> Steve O'Connor (CIO Aston Martin Lagonda)

mous challenge for my team to deliver that first step in an exceptionally short space of time.

We achieved this massive change all within a weekend, so the organisation was able to continue the following Monday. We used COVID as an accelerator of digitalisation and as an example of what we can do when we are challenged.

Joshua Neidus (MHP): How do you plan to manage demand and also keep the supply chain and production going especially with trade tensions?

O'Connor: We are looking at moving away from the traditional model that we have used for years, moving away from our current warehouse operations towards predictive systems and operations. That gives you that supply chain visibility as a business, we are not there yet. We've got several steps to get to where we want to be, but we know where we are going with it. We plan to move from a volume of 6,000 to 10,000 cars a year. In short, it is the predictive technology that gives that visibility to achieve our aim.

Kranz: You mentioned that your vision is to have a virtual warehouse. You also mentioned that it is going to be data driven and that you want more predictive analytics. How do you intend to do this? Can you tell us a little bit more about the tech platform that you are using?

O'Connor: This year has been a massive year for us in the tech transformation part to start off with. If you look at what we are trying to do, to build an ecosystem and a platform approach with a best of breed solutions plugged into a central core. **In the future, we want to plug in the supply chain that feeds that single source of truth and gets more enriched with predictive modelling.** That is the main challenge, how we develop predictive modelling and stop being so reactive. We are currently building towards that vision with our technology partner.

Kranz: What is your current transformation agenda and its vision? And what are the core building blocks of Project Horizon?

O'Connor: Project Horizon is probably the first real look internally to see what the business needs to look like going forward. My challenge is to deliver that digital transformation and allow technology to be innovative within manual type processes and leverage that technology. It is a huge challenge because some of our tech processes are from the last century, literally. We are going to build this platform to allow them to operate more efficiently and reduce reliance on manual inputs.

Kranz: You already mentioned the huge legacy that you were facing at Aston Martin. Let's move to the people and organisational side of your transformation agenda. Through my research I have established that silos and misaligned incentive structures in large organisations can be problematic. I'm pretty sure that you also have had such problems and challenges at Aston Martin. So how did you solve that and how did you go about addressing those problems?

O'Connor: We are addressing these. We literally have wiped away all existing business processes and moved towards a new business process model. We have worked with our ERP vendor as a starting point on the core business processes, so introducing things like order-to-cash ideas by offering these new concepts. These processes that go right across different teams have been an amazing challenge. We have ensured we have buy-in from our top executives to drive the changes through.

We have separated the digital transformation into two parts. One is the technology part. The second part is the business process overhaul. And that is where all the change for the people is being managed. Taking those, and I think it is ten new end-2-end business processes, you bookend this process as a starting point. Some of them are the core ERP ones, but some of them go into things like our engineering.

It is breaking out in building those processes that bring value to the organisation. Our executive team have been fundamentally involved in building and creating that new blueprint for the business community and it is having that kind of team that has been part of the journey as well.

We also have the key users building some of the training for the end users. It is within a system that steps people through the process as well and tells them what they are doing, why they are doing it and what the outcomes are, as well. Has the change been well received in some areas? Absolutely. In some areas it is more of a challenge, and that is where we spend a lot of our focus. It is a work in progress.

Kranz: Why do you think some areas are more receptive than others?

O'Connor: I think it really depends on the area of the business you are working with. When you look at some areas and things are regularly not working the way they are supposed to, you are not getting the outcomes that you want. People tend to be more receptive to things where there is more chance of getting the thing to work.

I think, Tobias [Moers, CEO] has said several times, the way that this business operates is like an F1 team. Almost everybody is integrated, and everybody is working at pace and together as well.

Part of the transformation also is in the training environment which we made today, for lots of people in manufacturing and production. For later phases we are discussing with our CEO & COO what Industry 4.0 means to Aston Martin and how we will get there.

Those discussions are very early stage, but they are happening a lot. That is what we want to move towards. The difference in the executive we have today is the realisation that you cannot do this on your own. And it is the same as those for the last 114years where you try to do things because we have known best.

Kranz: How do you plan to make the customer experience more digital, for example the recent MHP car configurator project?

O'Connor: The car configurator is the first glimpse of what to do and where we want to go. And the thing that is really driving that as well, is obviously customer buying behaviours have had to change over the lockdowns, for instance, so dealers were closed. You did not have that route to market. You soon realised that we needed to do something digital to offer as well.

We need to be clear that not all our customers are going to suddenly embrace digital, so the dealer experience is also very important. But the other part of it is we need to be attracting new customers as well, in order to build a customer base to sustain that 10,000 models of cars per year. We have already started out with the DBX, for instance, is a completely new direction for buying behaviors to the traditional DB11 buyer. The understanding of that new customer journey is in its infancy. There is still a lot of work going on around it. There is not much I can say without spoiling what they are doing, but it is that digital experience and how it all hangs together that actually gives the real benefit to the customer.

Kranz: What is the typical customer journey of an Aston Martin customer? You mentioned that sports cars today are different. How are they different and how do you support that digital journey?

O'Connor: We are aiming for an omnichannel experience. We still need to be special, and we need to be special irrespective of the customer engagement channel. This is what is going to be challenging. How do you make that special? Attract new ideas that are coming along as well. The new cars and types of cars will obviously attract different customers. As I said, that is aimed at opening up an area of customers that we have not been into before, although other models will come in the future as well and start to address some of those gaps. Some of the things we have been into before, we need to give them better tools to be able to get them going, such as buying a vehicle just by clicking a button.

Kranz: Your recent motorsport comeback, what do you see? How does this inform the digital transformation of Aston Martin as a whole organisation or your organisation?

O'Connor: Overall, we are too early to know what we are going to get from F1. But if I take my function, for instance, we integrated with the F1 team very early. We discussed at the start that they are two years ahead on the transformation. And they have been on a very similar transformation journey as well. We immediately integrated between me and Bill Peters as the CIO of the F1 team to understand how they did it and how they faced similar challenges. And we are already seeing some of the learning between our two functions. As soon as we get closer together, that will be something that will become natural to the business.

2.8
USA:

Facing change
with confidence

No half measures

The land of unlimited opportunity remains true to its name when it comes to providing resources for digitalisation. US companies are at the forefront of many technological innovations. They are leaders in the field of data analysis, with more than half of companies already having an advanced technological infrastructure in the form of a company-wide data platform, enabling the use of artificial intelligence. In four out of five Big Data categories, the US has the lead, ahead of UK companies in second place. The US also shows where the trend is heading in terms of IT systems' scalability. Seven out of ten companies have flexible cloud solutions and can link up with business partners via application programming interfaces (APIs). These survey figures support the US industry's reputation as a "hyperscaler". Here, the high budget available for digitalisation really pays off, exceeding that of competitors from the UK, China and DACH by up to 15 %. Although these survey results paint a positive picture in an international comparison, the US should not feel too safe, according to Jim Davis from SAP. He has observed that while some of the frontrunners are world leaders, a large proportion of established corporations are not keeping pace with change. He believes, that the gap between highly innovative companies and old industry is widening.

Market orientation pays off

For almost two-thirds of the respondents, the focus of Industry 4.0 activities in US companies lies squarely on their products' end users. While elsewhere companies are trying to use the new possibilities to optimise what they already have, the motto in the USA is "Think Big, Think Different". Nearly 70 % of US companies agree that now is the ideal time to establish new business models, open up new markets and attract new customers. The US does not seem to be holding on to the past. Competitors from the UK, China and DACH markets are finding it difficult to keep up with the fast pace the US has set. Success is proving the US right: two-thirds of the respondents have achieved significant additional success with digital products.

"My company has achieved significant success (net profit and/or additional turnover) with digital products and services."
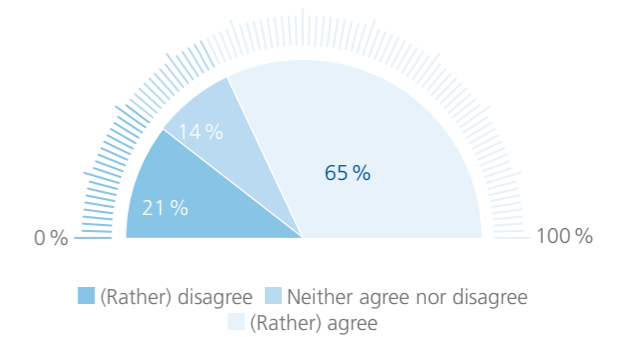

14 %
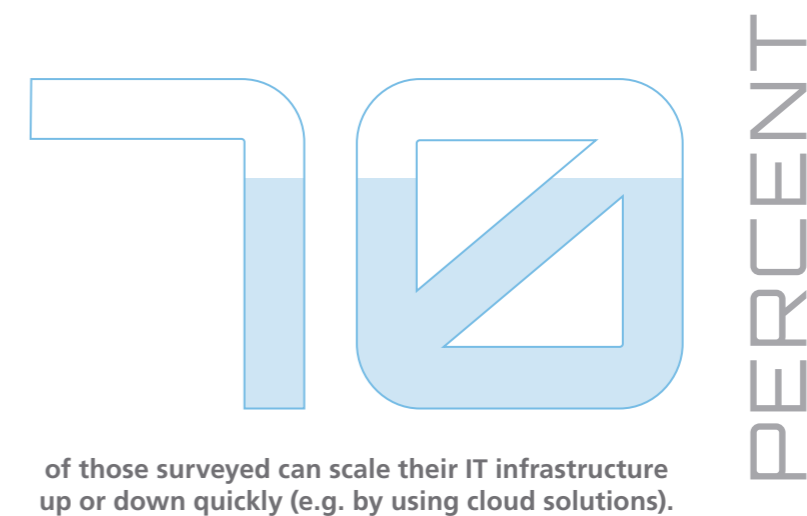21 %
65 %
0 %
100 %

■ (Rather) disagree ■ Neither agree nor disagree
■ (Rather) agree

Fig. 31

70 PERCENT

of those surveyed can scale their IT infrastructure up or down quickly (e.g. by using cloud solutions).

Fig. 32

Change as a chance

US companies are focusing on the future, not allowing themselves to be held back; and they are doing so very successfully. While mainland Europe is still hesitant in embracing change, the US is increasingly able to say goodbye to the legacy systems or silo thinking of the old industrial world. Among the US companies surveyed, barriers such as lack of capacity or resources are the least widespread. But even in the land of unlimited opportunity, not everything is running smoothly. The "war for talent" is also raging in the USA. Jim Davis, Director Automotive Industry Business Unit (IBU) at SAP, noted in an interview: "Attracting and retaining talent is increasingly more and more difficult." Therefore, companies need to invest in their employees, by offering training and flexible work models, for example. Even the exemplary IT systems are no protection against the shortage of skilled staff. This human factor still plays a decisive role. In addition, approximately one in two companies surveyed shows a lack of synergies and a common approach.

What does this mean for you?

In digitalisation, the USA is at the forefront of our international comparison, but not all companies can keep up with the rapid pace. These companies need to be digitally strengthened, by promoting inter-company collaboration for example, and not left behind; otherwise, they could act as a brake on digitalisation for the rest of the economy. Great flexibility is the stand-out feature of the digitally advanced companies and in all probability, they will be the ones to shape the future. Nevertheless, there are also obstacles to digitalisation in the USA. The talent shortage in particular could well jeopardise US companies' pole position. They would therefore be well advised to hone and develop the skills and know-how of many employees much better and provide continuous training. Likewise, more attention should be paid to ensuring that employees have sufficient capacity for dealing with digitalisation topics in addition to their everyday business.

"The introduction of Industry 4.0 technologies in our company is not being slowed down by historically grown IT systems."
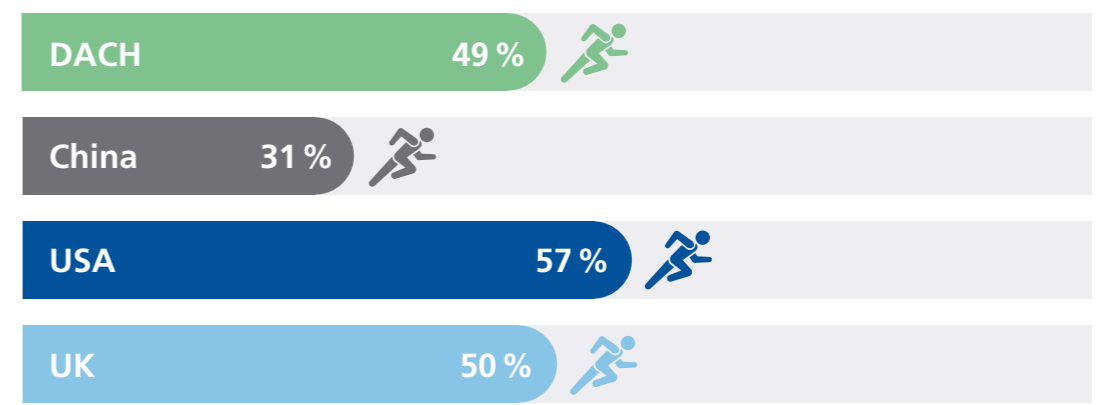
DACH	49 %
China	31 %
USA	57 %
UK	50 %

Fig. 33

Interview
with Jim Davis SAP US

Brief Profile of SAP

SAP is the market leader in enterprise application software, helping companies of all sizes and in all industries run at their best: SAP customers generate 87 % of total global commerce. SAP's machine learning, Internet of Things (IoT), and advanced analytics technologies help turn customers' businesses into intelligent enterprises. Their end-to-end suite of applications and services enables their customers to operate profitably, adapt continuously, and make a difference.

Brief Vita of Jim Davis

Jim Davis, Director of the SAP Automotive Industry Business Unit (IBU) joined SAP in February of 2010, coming to SAP with a diverse history in automotive, aerospace & defense, and professional services industries – with hands-on experience in manufacturing and supply chain, program management and government contracting.

His personal fascination with all things automotive started from the jump-seat of his father's 1962 Austin-Healy 3000 Mk II – continued with his tenure at Honda of America Mfg. and continues to this day with connecting his family's vehicles to explore the possibilities and use cases of the connected automobile.

Marcus Bohlemann (MHP): What is your role at SAP and what touchpoints do you have with Industry 4.0 and Digital Transformation?

Jim Davis (SAP): In the Industry Business Unit (IBU) we coordinate all things automotive from the centre of a triangle – with Automotive Customers, SAP Industry Development, and SAP's Salespeople at the points of the triangle. Coming from an industry background, we engage with customers, keep tabs on industry trends and needs. We then translate those trends and customer needs into requirements for our Developers. And once those requirements are developed into software, we work with our Sales colleagues to make sure they understand the industry context, and know how to make the overall solutions relevant to our Automotive customers.

In this role, I have multiple touchpoints with Industry 4.0 as we see how our customers need to transform their companies and what challenges they face during this process. Currently, it is really a great place and time to be in the industry because it is at such a tipping point driven by technological innovations. **New technologies and capabilities are not only transforming the product, the car itself. It is changing the way how the product is produced and enables companies to work in more efficient and flexible ways. Technology and new ways of applying those technologies are breaking long-standing trade-off paradigms like the trade-off between efficiency and agility.** Breaking down the barriers between planning and execution – with more information, coming directly from the shop floor and machines – combined with the ability to do this in real-time enables manufacturing to be both flexible and efficient at the same time with minimal trade-offs.

Andreas Stangl (MHP): SAP has many customers from multiple industries. How do you see the market evolving after the COVID-19 crisis? What learnings can we take from the pandemic?

Davis: Pre-pandemic, some companies had already started their digital transformation and those companies had a significant advantage during the pandemic. **The pandemic exposed the issues and challenges of companies across all industries. The most critical one, which is still present, is the disruption of supply chains, for example due to material shortages. These effects are not caused exclusively by the pandemic, but they are also symptoms of inflexible supply chains.** Especially for just-in-time supply chains, there is only a very small window of disruption that companies can compensate. This does not mean we need to throw out JIT – but it does mean that we need to take

advantage of Industry 4.0 principles in the context of real-time connectivity with our suppliers, transportation providers and 3PL providers. Time is the critical resource in JIT, so getting that notification of disruption sooner, and in real-time can preserve options for re-planning, expediting and re-routing. That gives you your best chance to keep things running. Without sufficient time to react and re-plan, those options start to close out, and you are stuck. So getting disruption information early is key.

Bohlemann: How should companies transform their supply chains in order to be better prepared for such crises in the future?

Davis: It is crucial to integrate technologies and leverage their potential in order to increase the visibility and transparency of all processes along the supply chain – in the planning phase as well as during the execution, for instance through real-time tracking of material flows. A transparent supply chain with real-time information enables a company to react early to unexpected events like material shortages or delivery delays and to initiative alternative measures.

Another key learning from the pandemic is the importance of specialised know-how and expertise within a company. Attracting and retaining talent is increasingly more and more difficult. Therefore, companies need to invest in their employees, for example through training offerings and flexible work models. And digitalisation is an important enabler for such measures as there are different expectations for the role that technology should play within a company. **Lots of employees have a high degree of digitalisation in their private life and they want to see this in their workplace. Thus, companies need to digitalise themselves to meet the expectations of their employees and to be able to keep talent in the company.** Unfortunately, the importance of good talent and expertise is often ignored or overseen when it comes to decisions about digital transformation.

Bohlemann: SAP is the global market leader for enterprise solutions. How does SAP support and enable the digital transformation of its customers?

Davis: Digital transformation and Industry 4.0 sounds like it is all about technology, but it starts with the focus on the business processes. SAP is able to support its customers – whether it is a traditional automotive OEM or a new mobility start-up or scale-up. It is the focus on the business process: What needs to get executed? How is it executed consistently and efficiently in a way that the rest of the business can accomplish its goals?

Innovative technologies can be a key enabler to optimise the business processes and reduce reaction time to occurring events. However, besides technology and real-time analyses, people with the right capabilities to take countermeasures are essential.

Technology comes into play for things like real-time data, intuitive user interfaces, seamless user experience as well as data analytics and connectivity. And that is where SAP shines: having a deep industry-based understanding of the business processes and being able to apply the technology to these processes, in order to ensure efficiency and visibility along the entire value chain. We can assume that this is one reason why so many new EV scale-ups have chosen SAP. They are incredibly innovative on the product front – but many do not have much experience in building cars and working within automotive industry practices, and therefore can benefit from SAP's industry experience that is embedded in our solutions. Through that, SAP is not only a trusted provider of technology, but also a trusted advisor for digital transformation and running an automotive business.

Stangl: Many companies are struggling with complex IT infrastructures, legacy systems and low data quality. What advice can you give such companies to resolve these challenges in order to become a digital leader?

Davis: From our perspective, it is very interesting because we can observe and compare both types of customers – traditional OEM's and suppliers as well as EV scale-ups. To sum it up: OEMs should stop waiting and start their digital transformation now. Of course, it needs an individual approach for each case, but traditional carmakers should not lose more time and start acting. Otherwise, they will be overtaken by new players that do not have to deal with "how we have always done it" and can start on a clean sheet of paper.

Nevertheless, the roster of big players in the automotive industry will not be the same in a few years. In the past, the paradigm of competition in the automotive market was stable and easy to understand. It was all about speed, efficiency, comfort and up to a certain degree luxury. Therefore, carmakers were, and still are, confident in the way they play this game. But in the past years, the game has changed completely, because there are a lot of new criteria a car is measured with – digital services, new electric drivetrains, new customer touchpoints and new ways of using a car are only a few examples.

Not every existing player will be able to hold the position it holds today and other brands that are small today will become the new market leaders. The success factor for this industry shift is the ability to adapt fast to

"The pandemic exposed the issues and challenges of companies across all industries. The most critical one [...] is the disruption of supply chains [...].
These effects are not caused exclusively by the pandemic, but they are also symptoms of inflexible supply chains."

Jim Davis (Director for the SAP Automotive Industry Business Unit (IBU))

new trends and changes in the market and this is the main advantage of scale-ups because they can adapt and adopt very fast. **In the end, traditional carmakers need to improve their agility and flexibility in order to survive in the volatile automotive market.**

Stangl: SAP is a trusted partner of many companies for Digital Transformation and Industry 4.0. Therefore, it is important for SAP to transform itself continuously. What challenges are you facing in this process?

Davis: The biggest change in recent years is the shift from a largely on-premise model to transforming to a primarily cloud software company. This required a lot of investments – not only to deliver the technology side pieces, but also to fulfill the expectations of our customers, who are the main innovation driver for our company. Customer-centricity is our highest principle. Customers expect short update cycles, high delivery quality and high reliability and continuous quality improvements for the products they use. It is a different, a much higher pace of development and innovation. Ensuring all of that, guaranteeing a reliable product with short innovation cycles is where we have been focusing a lot of our efforts – and I think we've been successful in making that transition.

Another big challenge for a large company like SAP is the change management process. When you change your business model and the way you provide your solutions, you must change your organisation as well – this includes not only structures, but also things like the mindset of your employees and the way of communication. However, since SAP has a customer-centric work ethic, SAP can change quicker than one would usually expect.

Bohlemann: Business-driven solutions will have to assume even greater responsibility for the success of companies in the future. How do you see the future of technology-enabled solutions?

Davis: A digital and technological foundation should be the core of every company in order to keep up with shorter innovation cycles and fast changing customer requirements. The pace of change is not going to slow down. Therefore, the technological foundation must enable a company to go with the flow. ERP Systems deliver a stable foundation for the business to deal with an otherwise chaotic and dynamic environment. On the manufacturing level, business solutions should be established in modular frameworks that allow frequent changes of schedules, for example. The cloud enables you to innovate incrementally and continuously.

Further, understanding where to focus is important as well. Increased effectiveness of basic tasks and indirect processes will not necessarily deliver competitive advantage. However, the implementation of innovative solutions that address the core operating models – and add visibility, through real-time connectivity can be a game changer and significantly help the company transform where it matters and blow the doors off of the competition. Therefore, the focus must be on value creation and how transforming elements of the operations drive the value. Again, speed is a critical element. If you have not started, it is pretty likely that your competition is ahead of you, and worse yet – it is not necessarily a competitor that you know that will be the one to disrupt you, but one that may not even exist yet and is just starting with a clean-sheet, a new/better idea, and the ability to execute with the support of the new connected technologies that make it possible. Again – my recommendation is to dare to disrupt yourself, otherwise someone else is sure to!

Stangl: Thank you very much for this interesting interview, Jim.

3.0

Conclusion and outlook

"To remain competitive, DACH companies need to promptly catch up in matters of digitalisation. Internationally, a CIO on the management board, a customer-focused approach, and a successful collaboration have proven to be universal guarantees of success."

Tom Huber (Head of Operations Performance & Strategy MHP)

The Industry 4.0 Barometer 2021 provides essential insights into the current state of industry's digital transformation in general, as well as market-specific features in the DACH, China, UK and USA regions surveyed.

The study has shown that companies internationally are under great pressure to implement digitalisation and have similar digitalisation barriers to deal with. The problem of high investment costs and lack of qualified employees with digitalisation skills apparently know no national borders. Only in Chinese companies is the "war for talents" not an issue. Internal friction and insufficient regulation of digitalisation responsibilities are also slowing the process down.

With regard to the Corona pandemic, crisis management is generally assessed as forward-looking and flexible. Nevertheless, clear potential for improvement can be seen especially in terms of identifying weak points in the supply chains and synchronising production and sales planning. A strong trend towards in-house production, expansion of multi-supplier relationships and an increase in stock levels can also be observed. There is also an increasingly negative impact on the crisis resilience of supply chains due to a lack of supply-chain transparency. The survey has shown that a CIO in management is a factor for success and can mitigate with these challenges.

The international comparison has shown that digitalisation is taking completely different directions in the markets that were observed. It has to be stated that the DACH region is losing touch with the digitalisation leaders in the other countries surveyed. From the respondents' perspective, Chinese and US companies are the frontrunners. Chinese companies are careless about the danger of cyber-attacks, while US companies are struggling with the lack of skilled workers. The United Kingdom still seems able to keep up with the two front-runners, partly due to the early course set for Brexit. US and UK companies are particularly strong in market and customer orientation and are also technologically advanced. SMEs and long-established companies are in danger of losing touch with the digitalisation leaders here.

It is now crucially important to take on the challenges of digitalisation. Any lack of skills should be built up, not only by hiring new staff, but above all through education and training. The mistrust still prevailing in some companies must be countered by maximum transparency. This can only succeed through active communication, and especially through the involvement of the staff. Additionally on the system-side, cooperation is vital for tackling problems such as data silos. For greater progress in digitalisation, these should be actively addressed and broken up. To counter these problems, it is first necessary to build up and establish an open and transparent corporate culture. A key role in achieving digitalisation success could well fall to CIO. Since the CIO can systematically and holistically drive digitalisation forward, companies would be well advised to integrate his or her role into the management.

It will remain matter of great interest to observe how the individual challenges of digitalisation are addressed in individual countries, industries and companies in the future. Stay curious and await the Industry 4.0 Barometer 2022 with great anticipation. Finally, we would like to thank all the participants in the Industry 4.0 Barometer 2021 survey, as well as the experts in the interviews and success stories who, despite their heavy workloads and responsibilities, took the time to share their experiences and insights with us.

4.0
Further
information

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Evaluation methodology

The responses to the questionnaire are based on five-point or seven-point likert scales. For a clear evaluation the participants' responses were clustered. In addition to the distribution of the responses, the weighted arithmetic mean was calculated as a percentage and is referred to as the barometer score in the study. For calculation purposes, the five-point and seven-point Likert scales were transformed into metric scales with the values 0–4 and 0–6 respectively. After multiplying the metric scale values by the respective relative frequencies from the responses to the individual questions, the weighted arithmetic mean was divided by 4 and 6 in proportion to the scale, to obtain a barometer score between 0 and 100 per cent. Given that the Industry 4.0 Barometer is a periodic survey, the barometer score can be used as a benchmark.

In addition, the results were compared on the basis of different characteristics of the participants and their companies. On the one hand, responses by participants from the automotive sector (manufacturers and suppliers) are compared against those from other industrial sectors (the reference industries). The departments to which participants belong (IT department or specialist department), the size of their company and whether their company's executive management team includes a CIO are used as further comparison criteria for evaluating results.

The responses were collected and evaluated anonymously.

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