INDUSTRY 4.0

GERMAN INDUSTRY 4.0 INDEX 2018

A study from Staufen AG and Staufen Digital Neonex GmbH

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Content

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Editorial

Dear Readers,

A good index is like a good wine - it matures with age. This also applies to the "German Industry 4.0 Index," which has now been surveyed for the fifth year in a row, providing many interesting time series. They uncover the tremendous dynamism of the digital transformation. Supplemented by numerous statements from almost 1,500 companies surveyed for the index over the years, for which I would like to take this opportunity to express my thanks, the study has become an exciting reflection of recent "economic history." For some, the period of 48 months may be a bit extensive. However, it is worth taking a look back at our analysis of the study's 2014 results:

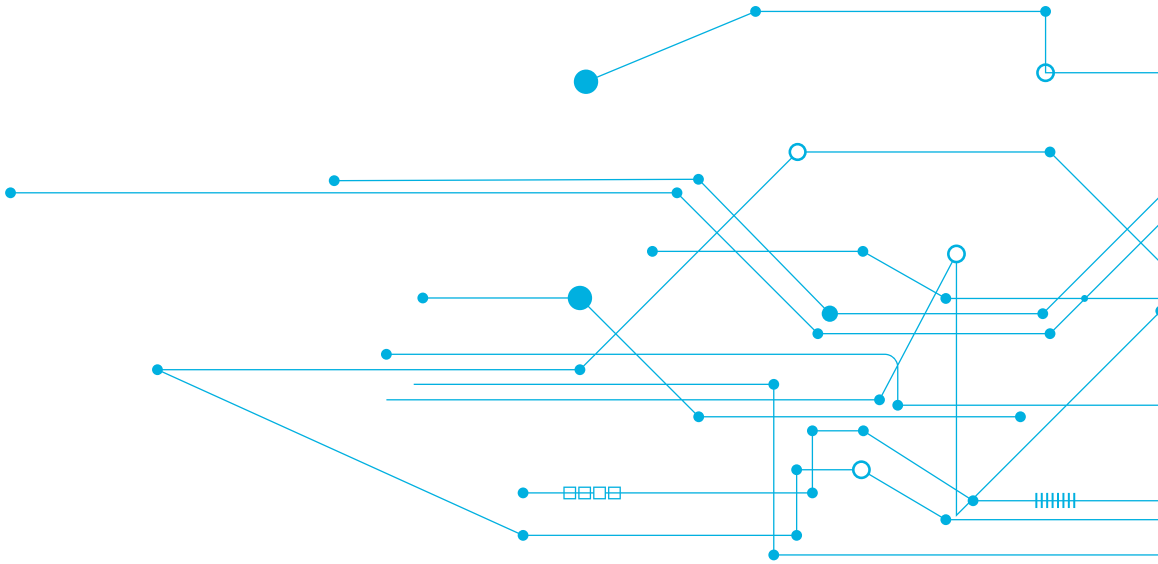
"The clear majority of companies remain in a state of passive shock or fascination as competitors confidently race forward."

From today's point of view, I add either a positive note "Once upon a time" or negative one "If they're still alive, they're still marveling today."

If you are still not convinced of the epochal and rapid phase of change we are currently experiencing, then why don't you determine your "Private 4.0 Index"? Possible questions: When was the last time you booked a vacation at a travel agency? Do you still read a printed daily newspaper? Does your favorite TV series run on ARD or Netflix? Do you invite friends to a restaurant that has an online rating of less than 4 stars?
Like companies, there are, of course, also digital pioneers and analog nostalgics in our private lives. However, there is an overwhelming agreement among the participants of the "German Industry 4.0 Index 2018" that the next chapter of German industrial history will be dominated by terms such as artificial intelligence, machine learning and predictive analytics.

Martin Haas
CEO
STAUFEN.AG

2 About the study



BACKGROUND AND STUDY FRAMEWORK

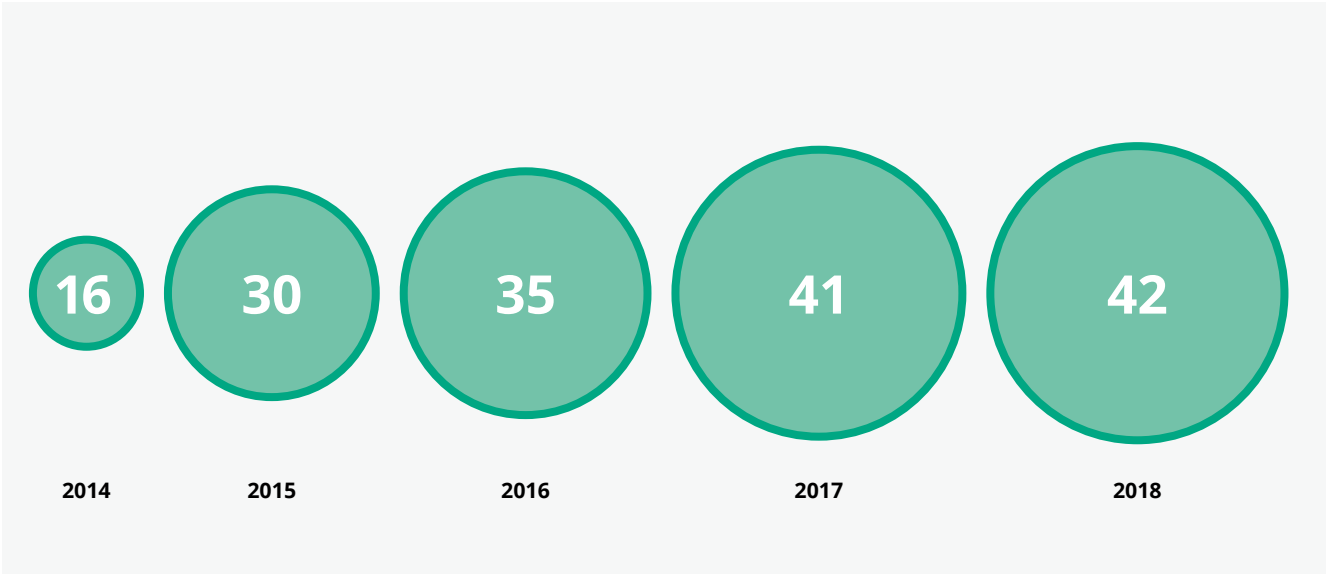
For the "German Industry 4.0 Index 2018," business consultancy Staufen AG and Staufen Digital Neonex GmbH surveyed a total of 450 companies in Germany on the topic of Industry 4.0.
The survey was conducted in mid-2018. A good two thirds of the companies surveyed come from the mechanical and plant engineering, electrical engineering and automotive industries.

3 The Results

OVERVIEW OF THE RESULTS

Digital transformation reached Germany's industrial enterprises in 2018. Even though a consistent smartfactory approach has so far only been implemented by a few pioneers, for the first time since the "German Industry 4.0 Index" has been conducted, the majority of all companies surveyed have practical experience with Industry 4.0. And other companies are about to put this into operation. Less than one in every ten companies continues to reject this trend. This is also reflected in the development of the index: Since 2014, it has risen continuously from 16 points to 42 points today.

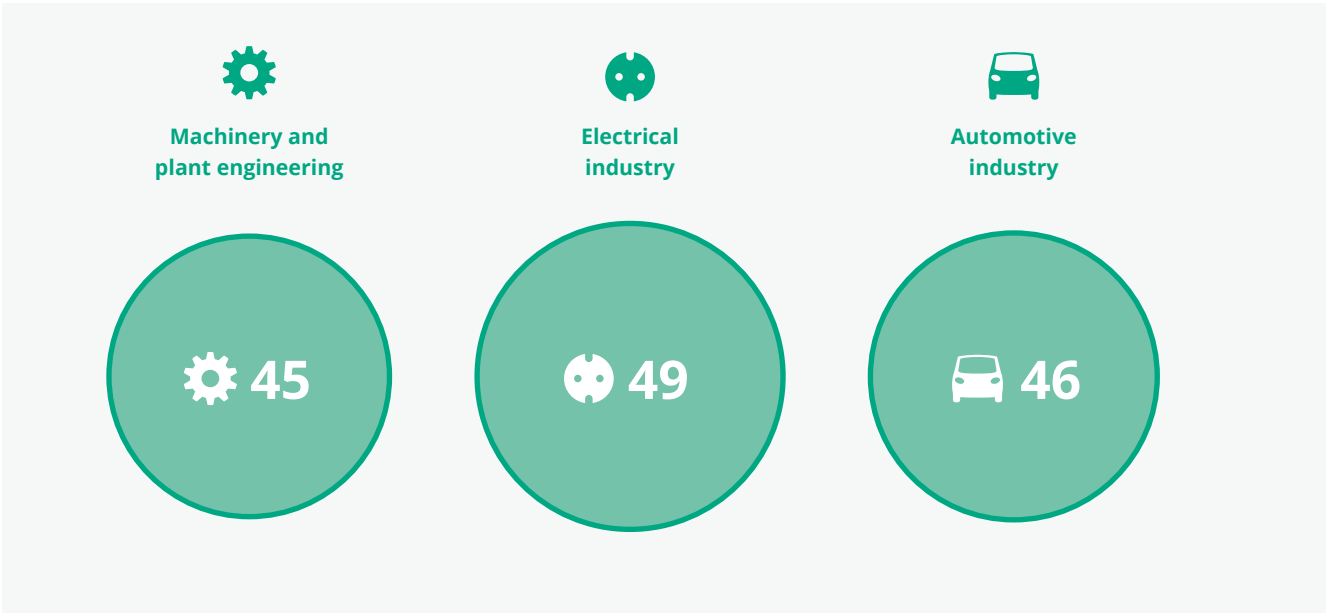
The Industry 4.0 Index is rising at a slower pace than in previous years



Considered according to industries, the electronic industry leads with 49 points, followed by the automotive industry with 46 points and the mechanical and plant engineering industry with 45 points. So far, however, companies have clearly been focusing on their own enterprise. Whereas production technology and slowly also indirect areas are experiencing the effects of digital transformation, the new product world is gaining momentum - but with hesitation. Only just under one quarter of companies already have Industry 4.0 applications in their service portfolio. Accordingly, the Staufen AG Smart Business Index, which was surveyed for the first time in 2018 receiving 35 points, is significantly lower than the Industry 4.0 Index. But there are signs of movement. Almost a third of the companies are currently developing products with digital added value and others are already being tested by customers. However, the search for new business models is still in its infancy.

The gap between companies' own production technology and customers' offers is also evident in the companies' motives. There, the focus is still on companies' own production facilities: Efficiency is to be increased and more transparency in processes pursued. The truly revolutionary possibilities of new technologies are only slowly becoming the engine of entrepreneurial action. This may be due not least to the currently excellent economic condition of German industry. Order books are still chock-full, leading companies to concentrate on optimizing what already exists. Few resources remain for profound new approaches in 2018. Seven out of ten companies report that their lack of capacity was the main obstacle to pursuing Industry 4.0 goals.

Industries in comparison



"Digitization is becoming a great opportunity for many companies. The challenge will be to digitize the right thing and use Industry 4.0 not only as a "showcase object" but also as an instrument for optimization."

Daniela Schäffer, Murrelektronik GmbH

Nevertheless, digital transformation is a success story. Almost two-thirds of enterprises have achieved success in this area. This is largely due to a targeted development of competencies. The old entrepreneurial adage that money invested in personnel always pays off also applies in the age of Industrial 4.0. What is still somewhat lacking, however, is consistent conviction from employees. Above all, the fear of being driven out of a job by new technologies is likely to cause skepticism among many. This calls for executives who are enthusiastic about taking the lead and who take their employees' needs, knowledge and ideas seriously. Because almost all respondents agree on one thing: Industry 4.0 is not created by machines but rather in the minds of people. The result is fierce competition that could revolutionize existing industries. The fear of disruption is on the minds of companies more than ever before, and most expect an attack not from the agile software industry, but from their own ranks.

As far as concrete technologies are concerned, the main focus is on data-driven applications to monitor or improve production processes. Initial experience has been positive, but many companies believe that concepts such as predictive maintenance are still lagging far behind. All in all, German companies have a broad technological base. The commitment with which various new technologies are pursued is only gradual. Platform economy is still currently of little importance. However, since sales channels account for a large share here, the relatively low level of interest with the current order boom is hardly surprising. Those working at their capacity limit seldom put a great amount of effort into acquisition.

But this will not remain the case, as companies predict a huge increase in the importance of industrial Internet platforms in the near future. And companies expect the relevance of the topic of artificial intelligence to increase even faster. Nothing stands in the way of the further increase of the "German Industry 4.0 Index."

4.1 Experience with smart factory projects is rapidly increasing

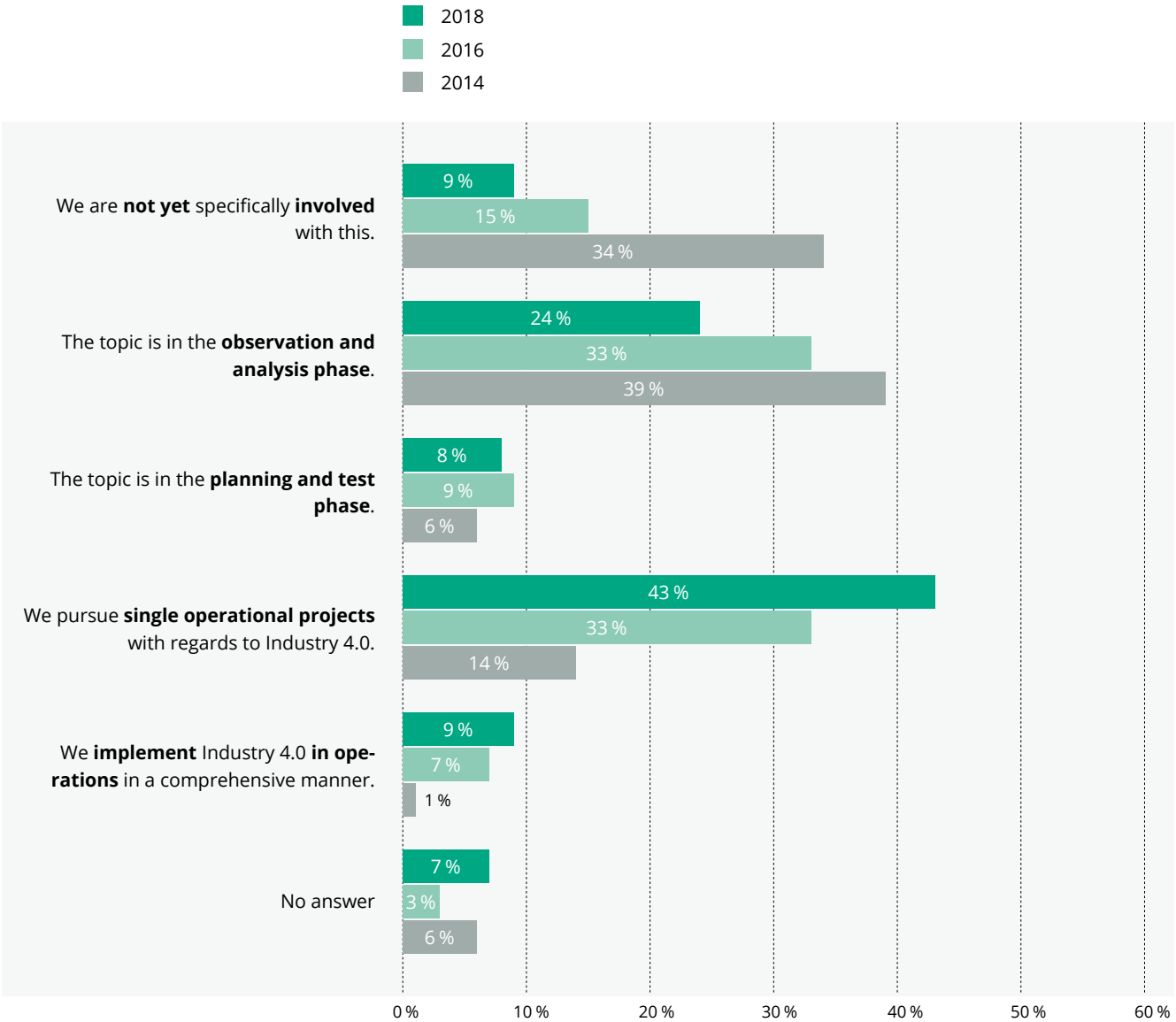
The megatrend of Industry 4.0 will continue to hold its course in 2018. Companies are increasingly moving from the strategic planning phase into the actual use of new technologies. 43 percent of companies are already gaining important experience with digital transformation in individual operational projects, 10 percentage points more than in the previous year. Accordingly, the number of those who still observe and analyze has fallen almost equally from 33 to 24 percent.

The proportion of companies in the planning and test phase is stable but at 8 percent has not experienced any significant change. Those who completely reject Industry 4.0 are becoming a clear minority. In just one year, their share fell from 15 to 9 percent. At the other end of the spectrum, development at the moment is stagnating slightly. Digital transformation has not even comprehensively permeated one in every ten companies. But here, too, there has been slight progress compared with 2017. However, this comparatively slow increase is not surprising, as Industry 4.0 is rarely created on greenfield sites. Generally speaking, companies will adapt their production technology piece by piece, if only for cost reasons.

A striking feature of the industry comparison is the high degree of penetration of integrated Industry 4.0 concepts in the automotive industry. Almost one-fifth of companies reported a comprehensive operational implementation. The automotive industry, which has been focusing on homogeneous processes and trouble-free supply chains for decades, likely finds it comparatively easy to implement consistent Industry 4.0 approaches. This interpretation is also supported by the relatively low value of 4 percent for mechanical and plant engineering in this category. Compared to mass production in the automotive industry, this industry is far more focused on meeting individual customer requirements. The challenges that arise when it comes to bringing a company's own production technology to a new level are correspondingly complex. However, the high proportion of companies in the development phase of operative individual projects with an Industry 4.0 focus suggests that mechanical and plant engineering is also making rapid smart factory progress. The situation is very similar in the electrical industry, which is even a step further with regards to the comprehensive use of Industry 4.0.

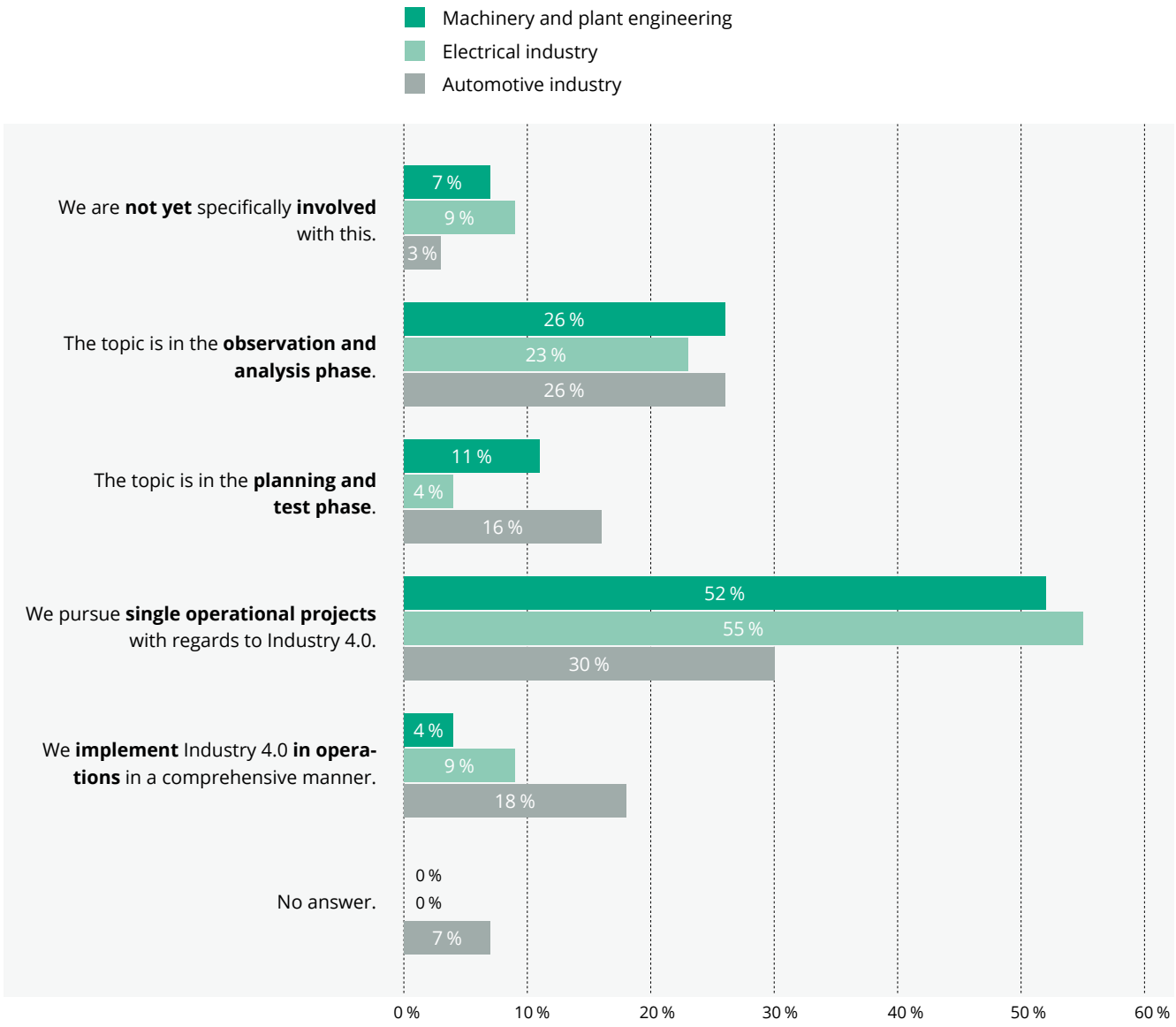
Industry 4.0 / Digitization continues to be the top topic. How close is your company to implementing a "smart factory"?

Comparison according to **year of survey**



Industry 4.0 / Digitization continues to be the top topic. How close is your company to implementing a "smart factory"?

Comparison according to **industries**



"The very versatile and continually developing megatrend of digitization has a great effect on the automotive industry, so that our company as a supplier in this sector must ensure that it keeps pace with these developments, in order to continue to be seen as a modern and professional partner."

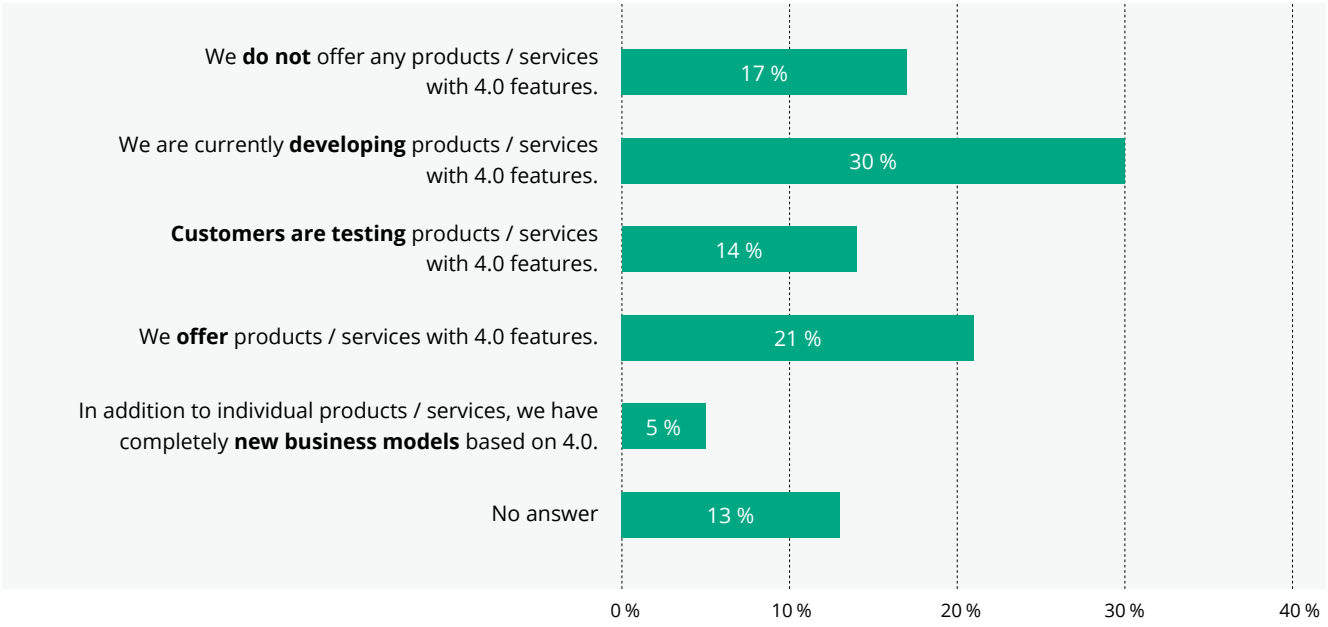
Dennis Künkel, CEO, Arnold Umformtechnik GmbH & Co. KG

4.2
Smart business is only just beginning

While numerous industrial companies have already gained considerable experience with digital transformation in their own companies, companies that offer Industry 4.0 solutions to their customers are often still only at the beginning. 17 percent do not yet offer any services or products in this area. Around a third are currently developing corresponding offers. 14 percent are at a point where their customers are already testing their solutions.

More and more companies digitize their products and services or develop 4.0 business models. How is this in your company?

Only participants who are already specifically **involved in Industry 4.0**

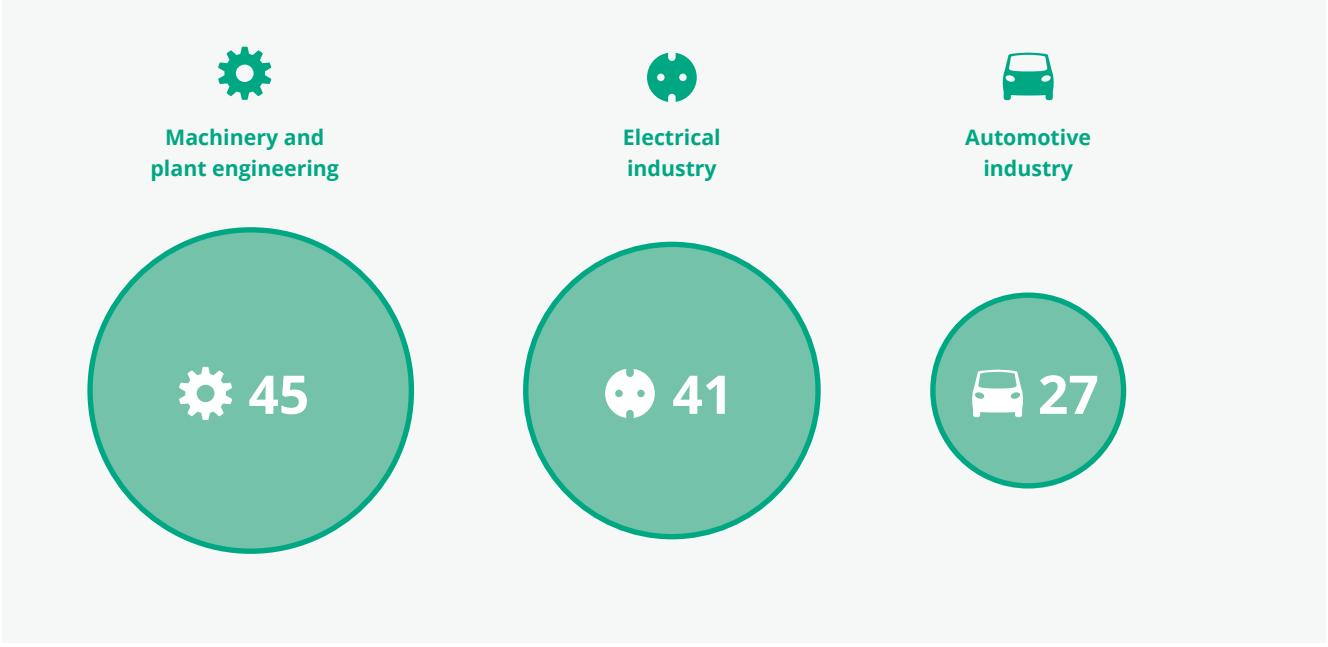


Compared to this, a quarter of the companies have already firmly integrated Industry 4.0 into their product portfolio. Nevertheless, digital transformation is in large parts an untapped terrain. Only 5 percent of companies have developed new business models based on this - which is precisely where the great value creation potential of the fourth industrial revolution lies. It therefore seems difficult for companies to convert their extensive experience with new technologies in their own operations into innovative concepts for their customers. There is great uncertainty here, which is also reflected in the large proportion (13 percent) of companies that do not see themselves as capable of making any statements at present.

In the Smart Business Index, mechanical and plant engineering leads with 45 points. Only 6 percent of the companies in this industry do not yet offer any Industry 4.0 solutions at all. Digital transformation, however, has found its way into the product range at 26 percent, as is the same with the electrical industry. Both industries are also on a par with new business models at 5 percent and provide an overall comparable picture, albeit graded in degrees of development.

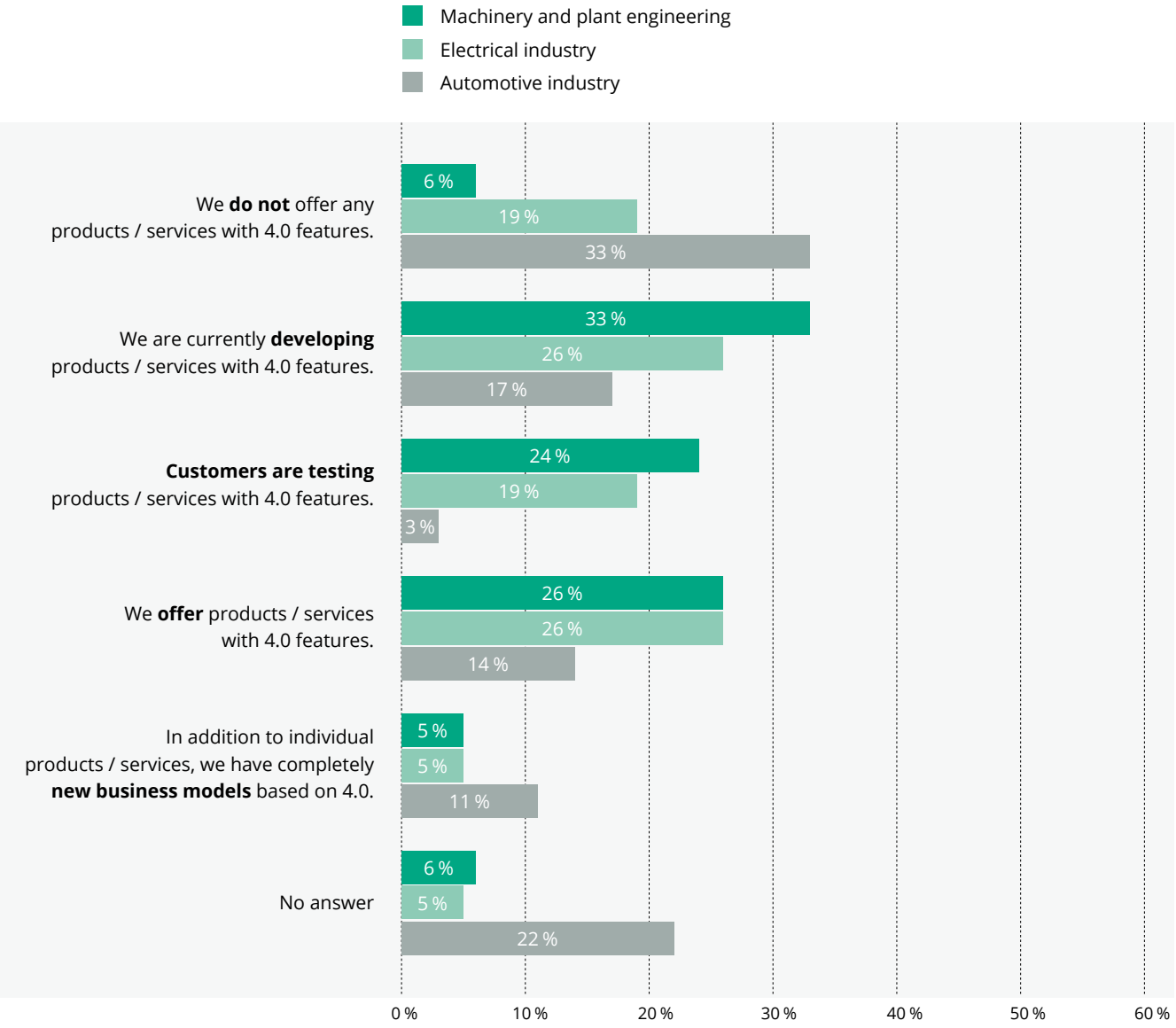
Staufen AG has been calculating the **"German Industry 4.0 Index"** since 2014 to determine the degree of transformation of German industry on its way to becoming a Smart Factory. Now that more than half of the companies are now using Industry 4.0 in their operations, this year an additional survey was conducted together with the experts from Staufen Digital Neonex GmbH to find out how many companies operate smart businesses, i.e. have already digitized products and services or even set up completely new business models based on 4.0.

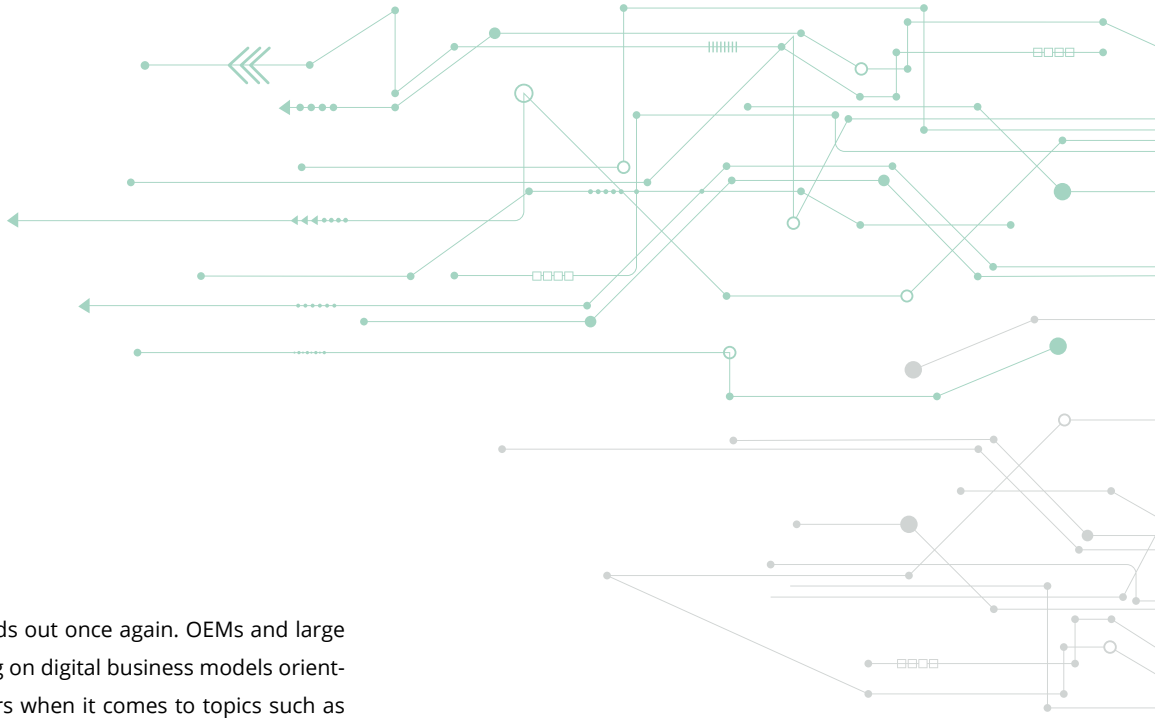
Industries in comparison



In addition to increasing their own efficiency through Industry 4.0, more and more companies are also digitizing their products and services or even developing entire 4.0 business models. How is this in your company?

Comparison according to **industries**; only participants who are already specifically **involved in Industry 4.0**





The automotive industry stands out once again. OEMs and large suppliers are strongly focusing on digital business models oriented toward their end customers when it comes to topics such as connected car or autonomous driving, but, like many of their upstream suppliers, they take advantage of what Industry 4.0 has to offer.

Despite this common ground, the automotive sector has more high-tech companies than other industries that exist alongside small, medium-sized companies, which supply comparatively simple mechanical parts in close cooperation with their customers. For various reasons it is more difficult for such suppliers at the lower levels to attract high potentials as employees and use them to drive technical innovations forward. Many of these companies are characterized by their self-image as extended workbenches for OEMs, who react above all to the direct requirements of a limited customer base instead of developing the market themselves.

22 percent of companies in the automotive industry do not provide any information about digital products or services. In addition to the reasons mentioned above, this indicates considerable uncertainty among subsuppliers. In addition, the traditionally high need for secrecy in the industry also plays a role that should not be underestimated.

While mechanical engineering, for example, tends to awaken interest at an early stage with upcoming innovations – not least because of the much longer-term investment planning – the automotive industry, which is geared towards private drivers, keeps a comparatively low profile in the run-up to the market launch of a new model, in order to conceal its strategy from competitors.

4.3 Conservative motives continue to drive companies

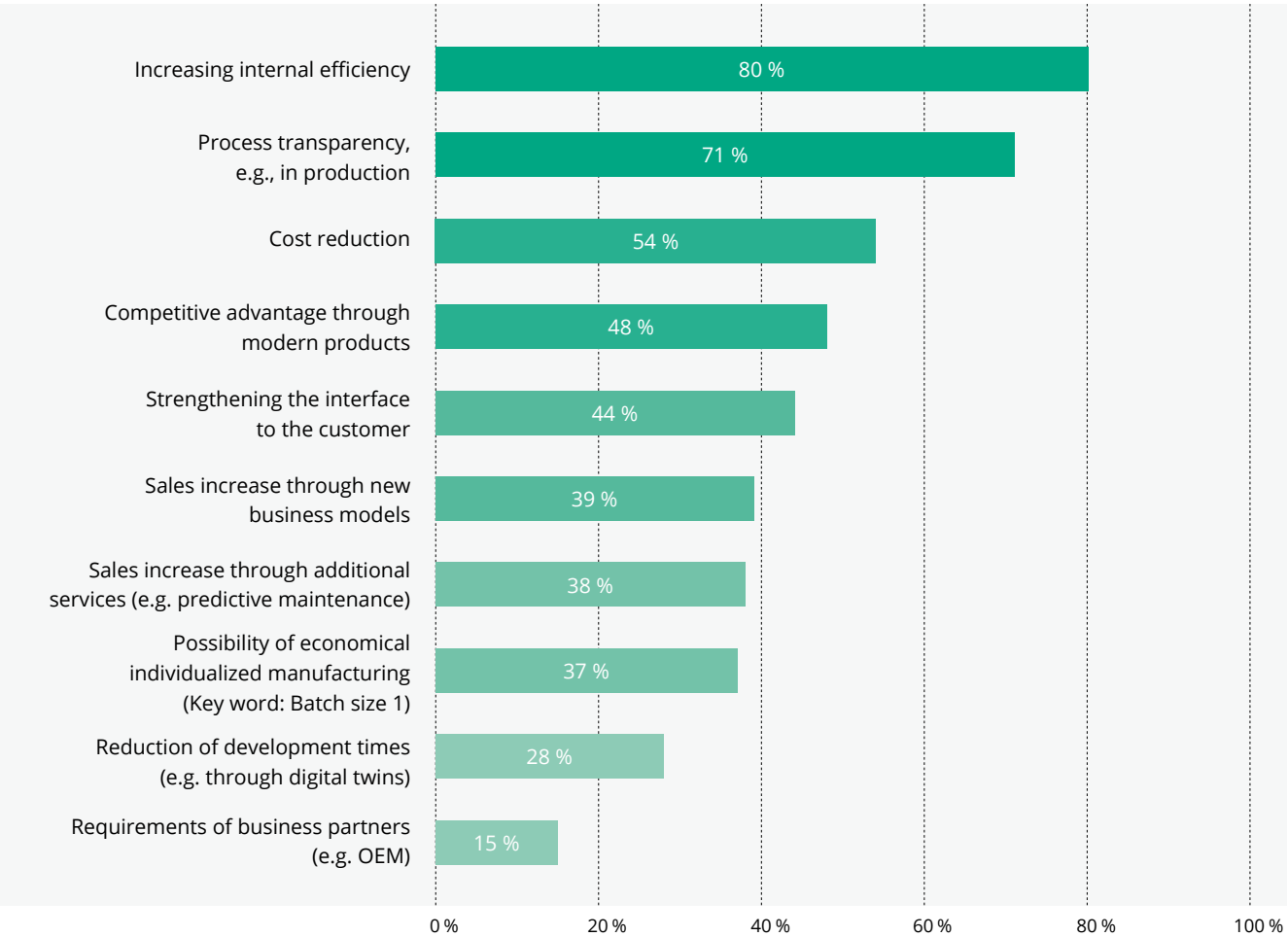
Companies that are already specifically involved with Industry 4.0 were asked about their motives and experiences as part of the study. The results show that the "classic" expectations continue to be predominate. Increasing efficiency due to further automation and autonomization of a company's own production technology is listed at the top. 80 percent of companies hope for improved efficiency from new technology, closely followed by process transparency, for example in production, which can be achieved by digitally tracking processes. The target of lower costs, on the other hand, is a driving force for only 54 percent of companies. Here, savings through increased efficiency will probably be offset by unavoidable high investment costs in new machinery and equipment.

Further down the hierarchy of motives an area of tension can be seen, which encompasses the concepts of smart factory and smart business. While companies welcome Industry 4.0 with open arms as a further development of automation technology, many are comparatively helpless about its potential as a technological paradigm shift. A competitive advantage through innovative products is a convincing argument for only half of the companies. And even less are enthusiastic about an improved network with customers. Less than 40 percent of companies are convinced of the value creation potential of new business models and services or individualized manufacturing - and even less are convinced of a new dynamic in research and development, for example, through digital twins.

All in all, German industry currently still relies on the most obvious option: Further optimizing its own production with new technological opportunities. This is likely also due to the current economic situation. With order books full, companies have been working at the edge of capacity for years now. Efficiency is therefore the order of the day; for a comprehensive technological paradigm shift and fundamental strategic reorientation, free resources are simply lacking in many places.

What are the motives for Industry 4.0 / Digitization measures at your company?

Only participants who are already specifically **involved in Industry 4.0**

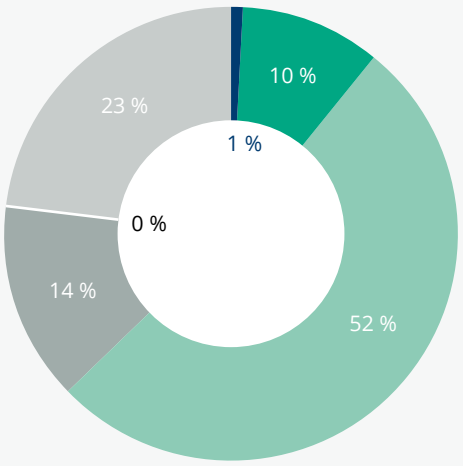


4.4
Industry 4.0 meets expectations

Experience with digital transformation in the industry has been predominantly positive. Almost two thirds report that the new technologies have met or even exceeded their expectations. At 23 percent, the number of those undecided is comparatively high, which is partly due to the fact that technological shifts take a certain amount of time for companies to feel their tangible effects. So far, only 14 percent of those surveyed have had clearly negative experiences with Industry 4.0.

How successful have your Industry 4.0 / Digitization activities been so far?

Only participants who are already specifically **involved in Industry 4.0**



Positive (∑ 63 %)

Results ...

- ... are well above expectations
- ... are above expectations
- ... meet expectations

Negative (∑ 14 %)

Results ...

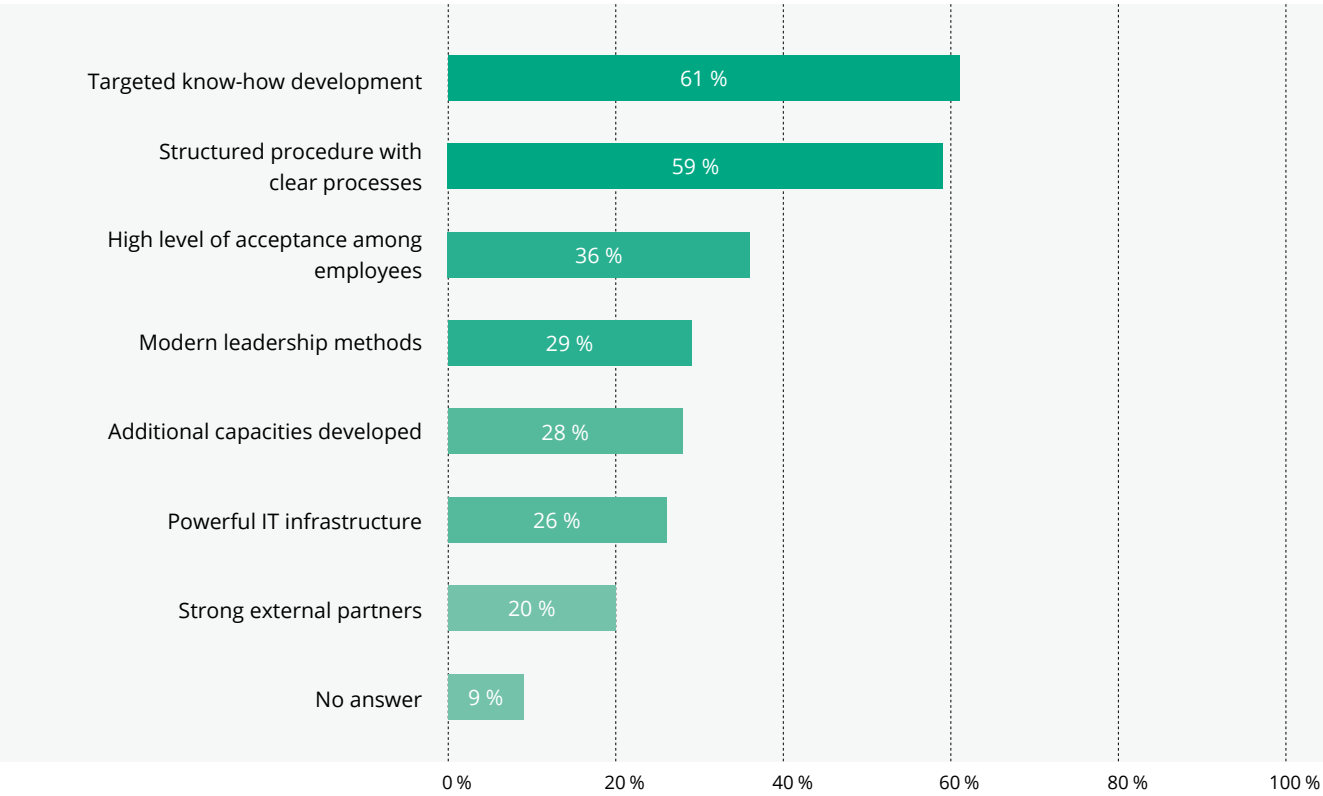
- ... are below expectations
- ... are well below expectations

Neutral (∑ 23 %)

- I am not sure

In your opinion, what are the reasons why you have not yet achieved or exceeded your goals?

Only participants who are already specifically **involved with Industry 4.0** and evaluate industry 4.0 / Digitization activities as **positive**



Those surveyed are convinced that the number one success factor is the targeted development of competencies. This suggests that the technology spiral could turn even faster in the future. Based on newly acquired know-how, specific Industry 4.0 approaches will be implemented much faster than in the previous testing and evaluation phase.

The majority (59 percent) of the companies also rely on a proven strength: Even in the age of Industry 4.0, the basis for entrepreneurial success is a structured approach with clear processes. Companies that have already transformed themselves into Lean Enterprises in recent years are thus likely to have ensured an excellent starting position for digital change. For all others, the time has come to build lean and resilient organizational structures, otherwise a homogenous IT landscape with smooth interfaces – a decisive requirement for holistic Industry 4.0 approaches – will only be achieved with the utmost effort.

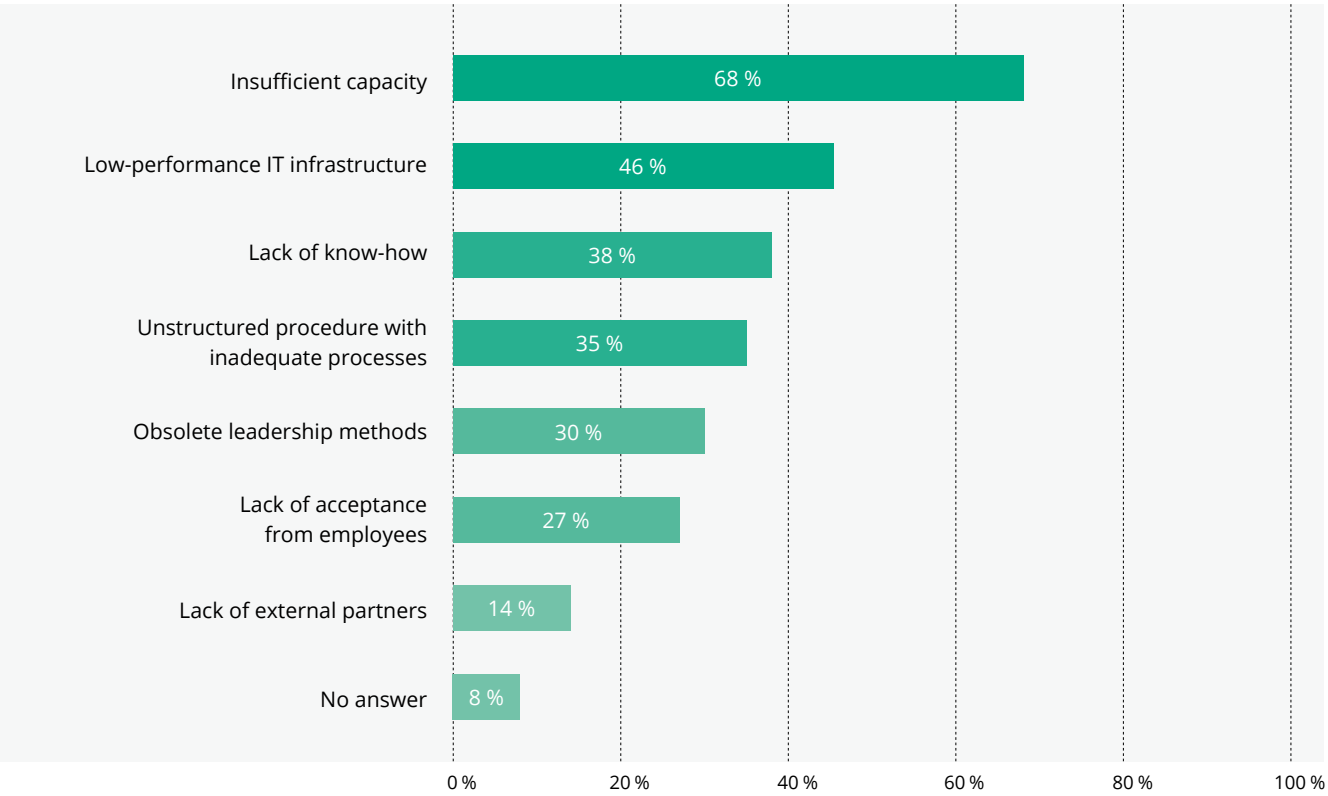
Employees are still largely skeptical about digital transformation. Only around one third have expressed a high level of acceptance. Far-reaching changes generally lead to uncertainty among staff, especially as there is a widespread fear that jobs may be lost. Here, it is up to executives to apply the opportunities of digital change to their companies – and create an understanding that it will not work without a general rethinking. With regards to competition in the near future, those who refuse to accept Industry 4.0 will find it extremely difficult to survive.

But executives in particular must continue to work on themselves. Not even a third of companies are implementing modern leadership methods in digital transformation. But such volatile and complex changes as those brought about by Industry 4.0 cannot be mastered by a single decision-maker in the executive office. Rather, the competencies, ideas and commitment of all employees must be involved. A classical understanding of hierarchy is thus rapidly falling behind.

28 percent of companies have developed additional capacities and been successful in doing so, almost as many attribute their positive experiences to high-performance IT. In general, success factors can to a great extent be found in-house. Only one-fifth of those surveyed consider cooperation with external partners to be a decisive pillar in the digital transformation of their company. Those who have so far experienced failure with their Industry 4.0 activities attribute this primarily to a lack of capacity. 68 percent of these companies lack resources – not least due to the excellent order situation mentioned earlier, which ties up all available funds. It is therefore not surprising that companies are not able to realign their IT infrastructure during this phase. Almost half feel that they are poorly positioned in this area.

In your opinion, what are the reasons why you have not yet achieved your goals?

Only participants who are already specifically **involved with Industry 4.0** and evaluate Industry 4.0 / Digitization activities as **negative**



However, it is not only the lack of resources that is slowing down companies on their path toward Industry 4.0. The real challenge in coping with complex digitization projects is very often the structural and organizational framework. It is often the heterogeneity and interface problems that have grown over decades at the divisional boundaries that now stand in the way of uniting and networking.

According to the Industry 4.0 Index, four out of ten companies lack the right know-how and 27 percent have a lack of acceptance among their workforce that inhibits innovation. Even more suffer from poor structuring and inadequate processes. In total, it can be seen that not only technologies are the cornerstones of digital transformation but also human factors.

Lack of capacity, poor structuring and managing human factors are clear leadership issues. But even here, 30 percent of the companies are not with the times. If the right leadership and structures are not available to support employees in their work instead of hindering them, then the enormous innovation challenge cannot be met.

4.5 Technological vision vs. economic reality

Among the numerous new or emerging technologies, predictive analytics and smart data are considered the most important. In each case, 49 percent of the respondents attach great importance to these data-driven approaches. Flowing closely behind are artificial intelligence and machine learning, which can certainly be understood as a further development of the data technologies mentioned above.

Technologies that are primarily aimed at new product forms, however, are of lesser importance: digital product features or completely digital products as well as augmented or virtual reality. For 35 to 37 percent, these concepts already play an important role today. This also reflects the current state of the German Industry 4.0 development. Improvements are still being made predominately in inventory and mostly in relation to companies' own production lines.

Also additive manufacturing, which has become well known under the keyword 3D printing, in addition to digital transformation, which is often praised as an industrial revolution, reaches a comparatively low value with 37 percent. This is where technological vision meets economic reality: It is far from profitable for every company to now switch from classic machining processes to additive manufacturing.

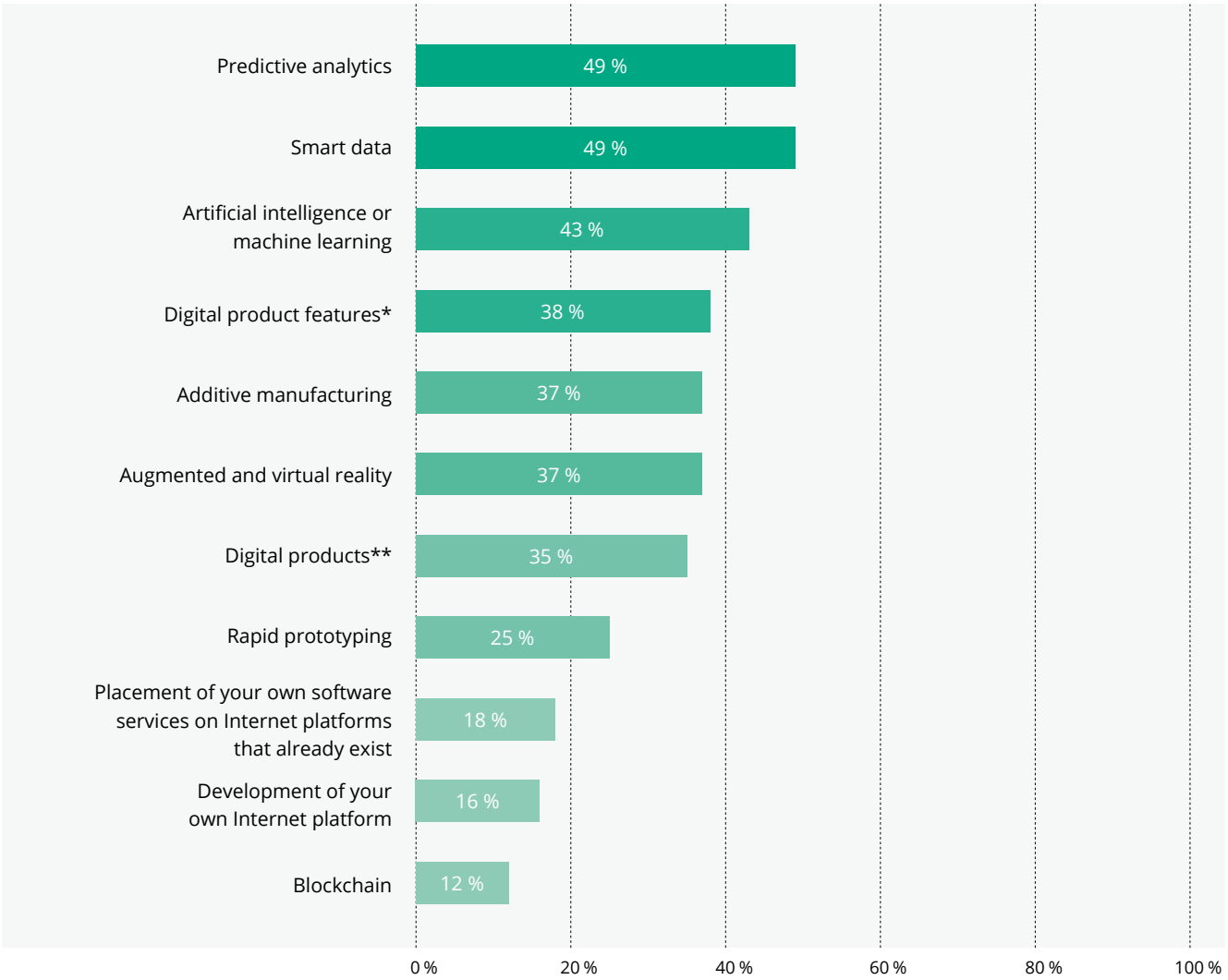
After all, most companies not only have a considerable investment portfolio but also decades worth of expertise in other production processes. A rapid switch to additive manufacturing is therefore unlikely to become the standard in many industries, even in the coming years. In many cases, companies limit additive manufacturing to special products. The pioneers in mass production will be those who can contribute their previous technological expertise to additive manufacturing, such as manufacturers of laser machines for metalworking.

Not even one in every five companies considers it important to have software services on Internet platforms, and the development of their own platform offerings is even less important. A clear contradiction to the often propagated trend? Or another consequence of the filled order books: Digital industrial platforms are if nothing else distribution channels and there is currently no lack of new orders and customer requests in the German industrial sector. On the contrary, many companies work at the edge of their breaking point in order to fulfill their obligations.

Rapid prototyping is relevant for 25 percent of those surveyed, and here too, there is a clear connection with the motives of the companies: New technologies in research and development currently play a minor role. However, blockchain technology has the lowest level of approval. This may be due to the fact that the ideas about this technology are still rather vague even among industrial insiders.

There is a lot of discussion about the following technologies. Which are the most important from your point of view?

Only participants who are already specifically **involved in Industry 4.0**



* e.g., electronic nameplate, unique product ID, connectivity module, remote service,...
**e.g., software services, software platforms, "as-a-service" products

4.6
From big data to quality manager

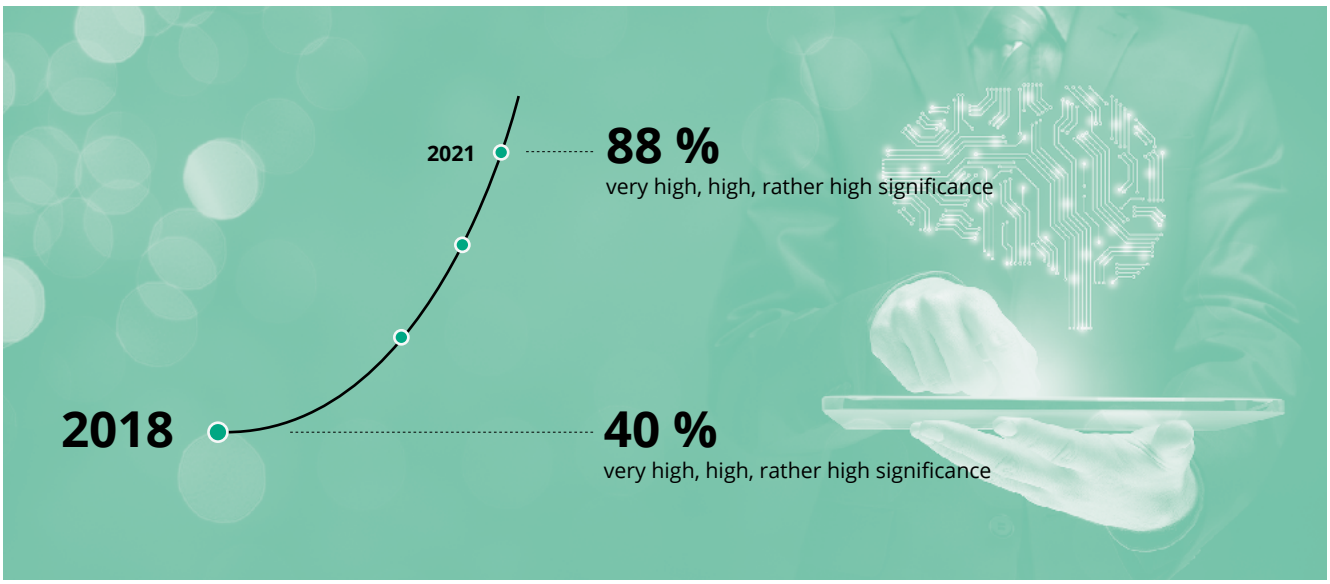
Technologies that can be implemented with obvious opportunities and can be integrated comparatively easily into ongoing operations typically find concrete applications. Around four out of ten companies provide products with digital added value or offer entirely digital products, such as service platforms for existing machines and other goods. They optimize their production or offers with smart data solutions and predictive analytics. Accordingly, quality management is the main focus for 69 percent with regards to evaluating their own data. Concerning product development, on the other hand, only 44 percent use big data analyses, 29 percent optimize sales on this basis and 18 percent improve links with suppliers. Big data assessments are not only characterized by the speed at which massive data sets are processed simultaneously, but also by the possibility to analyze very different types of information.

What do you use big data evaluations for in your company?

Only participants who are already specifically **involved in Industry 4.0**

What significance does the topic of artificial intelligence have for the industrial sector – today and in three years?

Only participants who are already specifically **involved in Industry 4.0**



Artificial intelligence and machine learning play a lesser role, which only 19 percent are currently developing. This is not surprisingly, because at least in the industrial day-to-day, intelligent machines are still in their infancy. Some critics even doubt that highly complex, real experiences in industrial production can be adequately digitally represented in the near future. Without question, however, artificial intelligence will find its place in factories. Those surveyed also expect the same: Whereas 40 percent currently attach great importance to the topic, the figure is at 88 percent for 2021.

Technologies that require completely new approaches or compete with existing ones are used less. Augmented and virtual reality are still the most strongly represented at 30 percent - although it should be noted that this is a broad field of application. It ranges from simple service support via smartphones to the sophisticated development of virtual realities. The former are most likely to already be in use, which partly explains the strong positioning of the topic among respondents.

Additive manufacturing is being promoted by about the same number of companies. Existing machinery for traditional production will likely keep this technology at a distance for some time to come. But with the next investment cycles that share is expected to increase. With increasing practical experience, the topic of rapid prototyping is also likely to attract attention, which is currently only being pursued by 23 percent.

For which of these technologies does your company already have specific projects?

Only participants who are already specifically **involved in Industry 4.0**

* e.g., electronic nameplate, unique product ID, connectivity module, remote service,...
**e.g., software services, software platforms, "as-a-service" products

"We must integrate the opportunities that Industry 4.0 offers into our strategies for the next two to five years at an early stage."

Katja Berghahn, Global Lean Manufacturing Manager, Kiekert AG

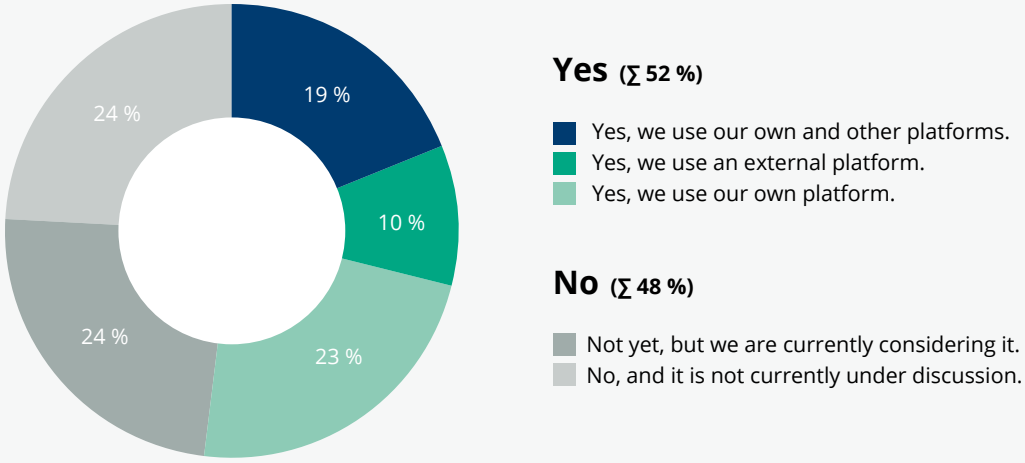
4.7
Platforms with significant future potential

Although proprietary software solutions on platforms are still relatively insignificant in industry at the moment, Internet platforms are developing strongly overall. 52 percent of respondents are represented on these channels, mainly to buy or sell goods.

Do you use industrial Internet platforms in your 4.0 activities?

(e.g., for selling hardware, software-based services or digital support of a value chain)

Only participants who are already specifically **involved in Industry 4.0**

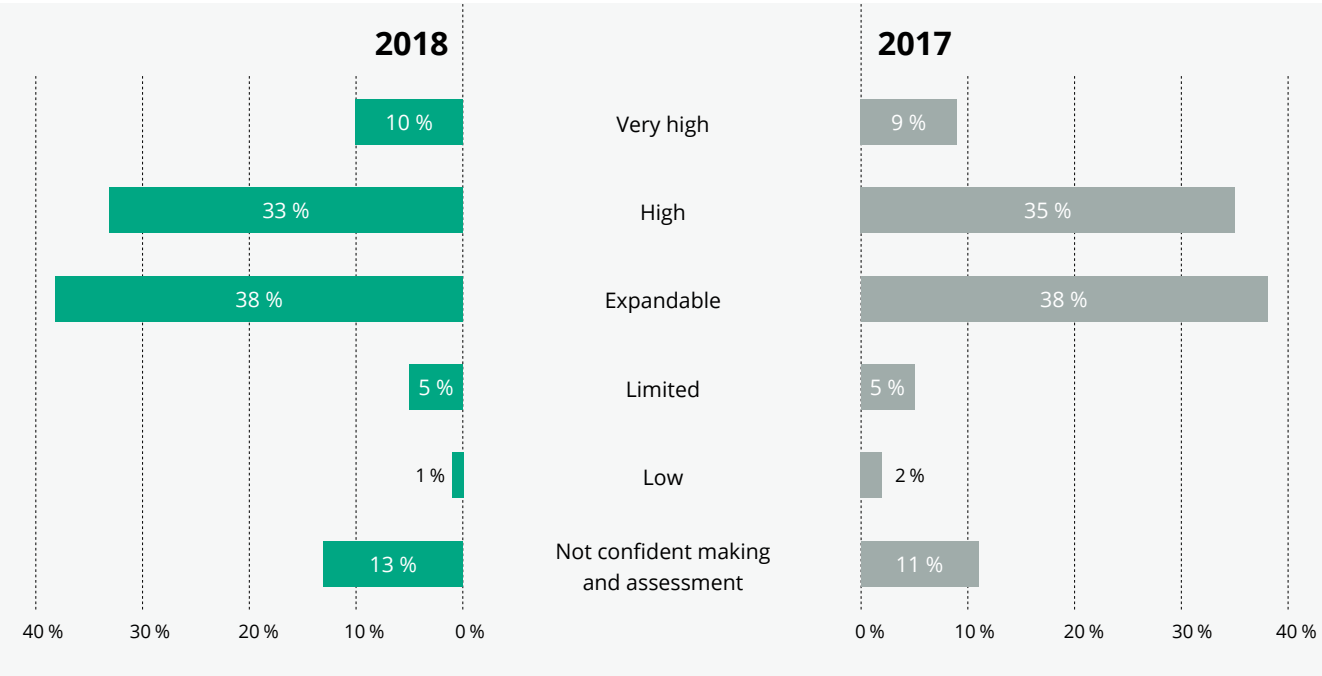


In 2018, however, industrial Internet platforms have yet to develop their full potential. 38 percent of companies consider the offers to be expandable; 13 percent do not feel confident making an assessment. Compared to the previous year, this is only a minor development.

How do you generally assess the relevance of industrial Internet platforms for cost savings

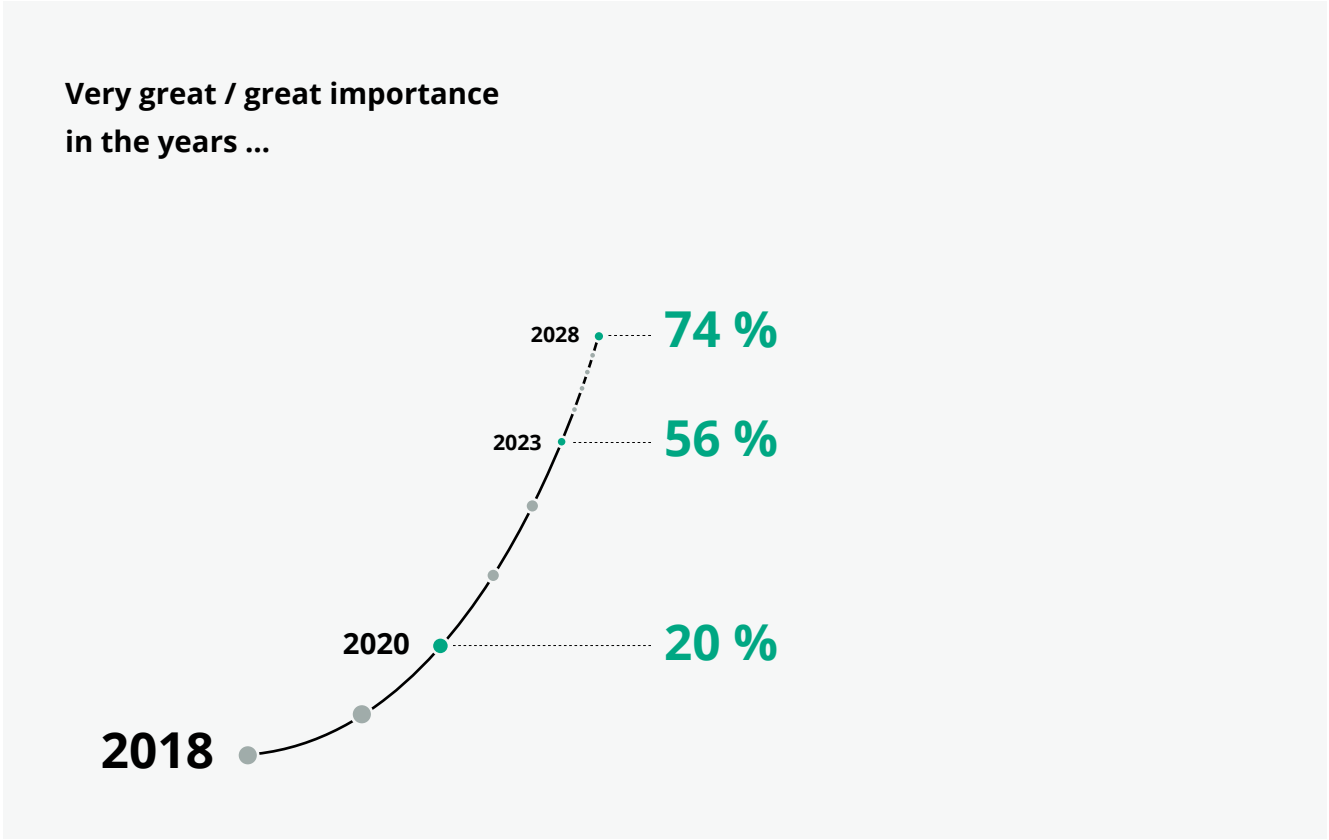
(e.g. in purchasing) or to leverage new revenue potential (e.g. as a new sales channel)?

Comparison according to **year of survey**



What significance will such industrial Internet platforms have for your industry in the future?

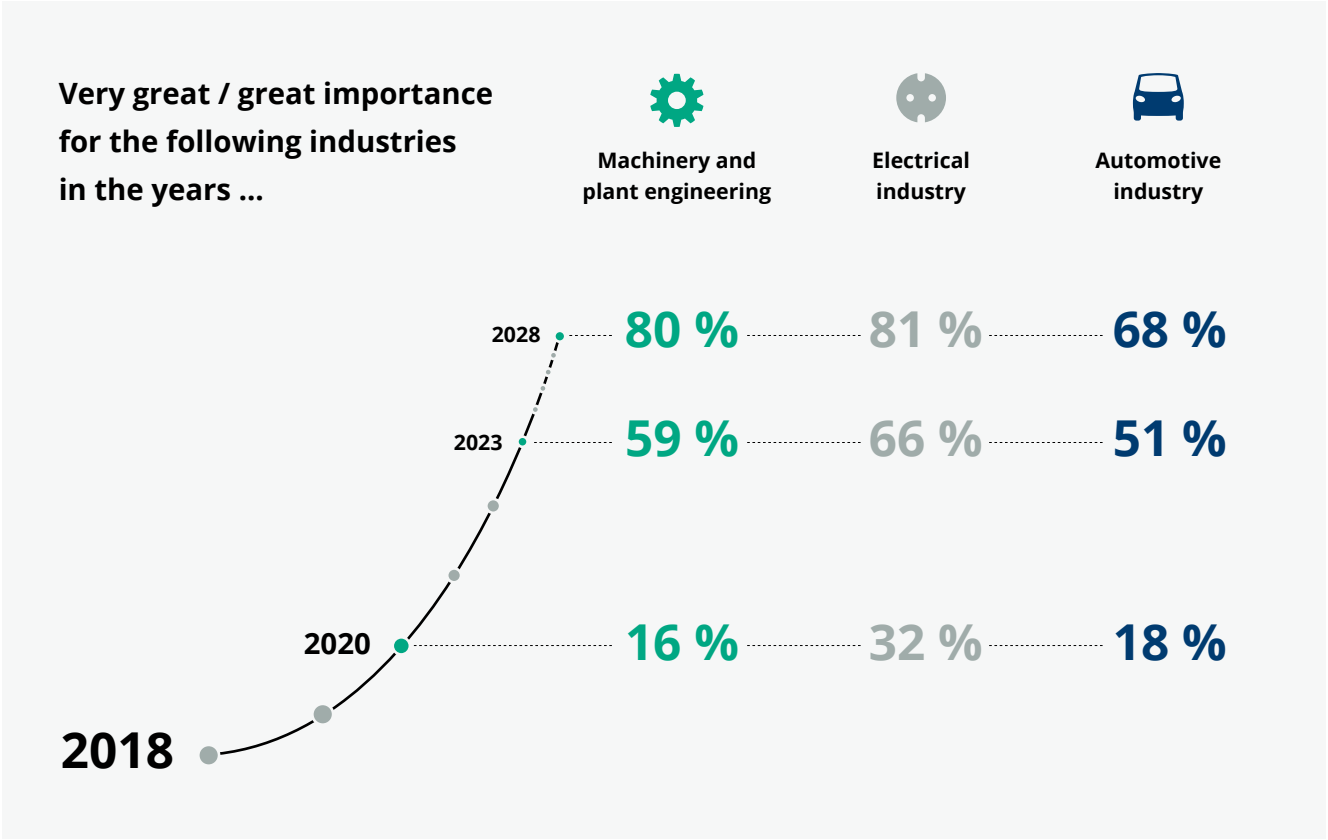
Surveyed on a 6-point scale from "very great" to "none at all"



As far as the future is concerned, however, platform economy occupies an important position. Whereas 20 percent believe that 2020 will be a decisive year for their own industry, this figure increases to 56 percent three years later. As many as 74 percent of respondents forecast this for 2028.

What significance will such industrial Internet platforms have for your industry in the future?

Comparison according to industries. Surveyed on a 6-point scale from "very great" to "none at all"



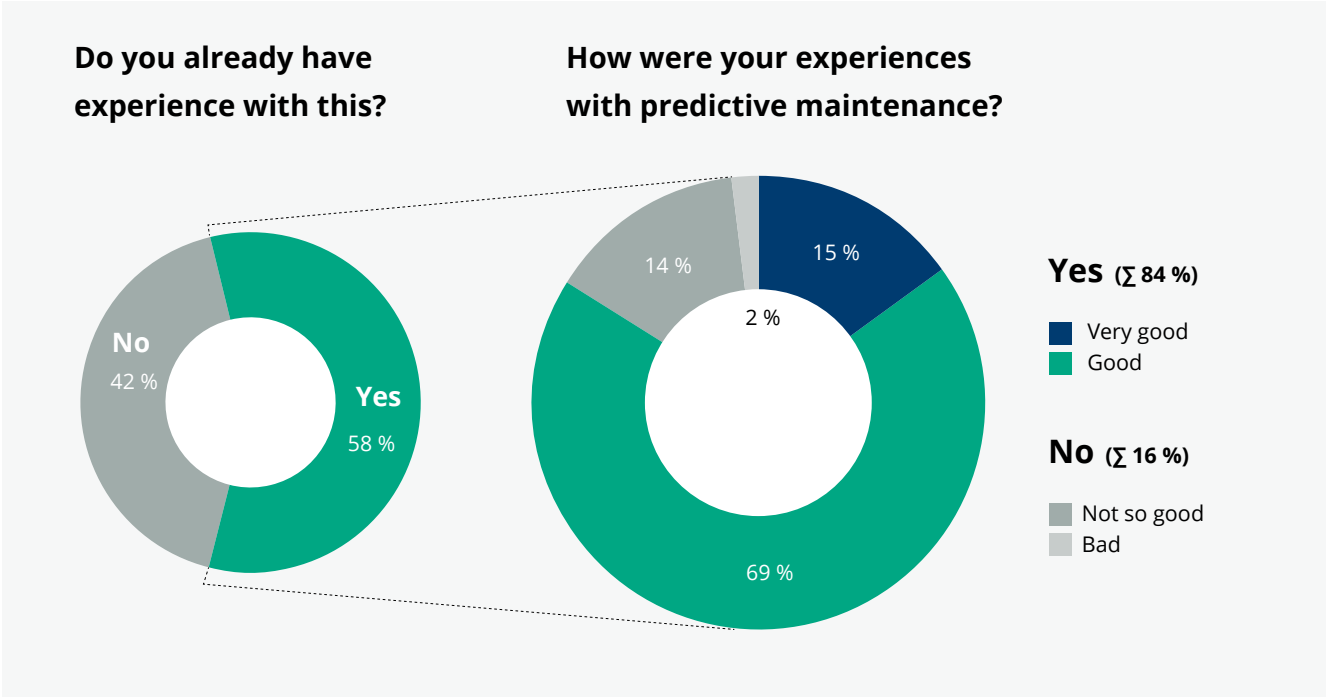
Above all, mechanical and plant engineering and the electrical industry expect platforms to become increasingly relevant. For them, the opportunities there are many: In addition to sales and purchasing, data-driven business models for optimizing their products should play a major role in the future. The automotive industry, on the other hand, is far more skeptical. Monitoring and real-time optimization of the vehicles produced is likely to be considerably more difficult in the end customer segment, especially considering serious consumer data protection concerns. It is possible that the automotive industry has also become particularly cautious with forecasts due to current discussions, in particular regarding engine control.

4.8
Predictive maintenance falls short of its possibilities

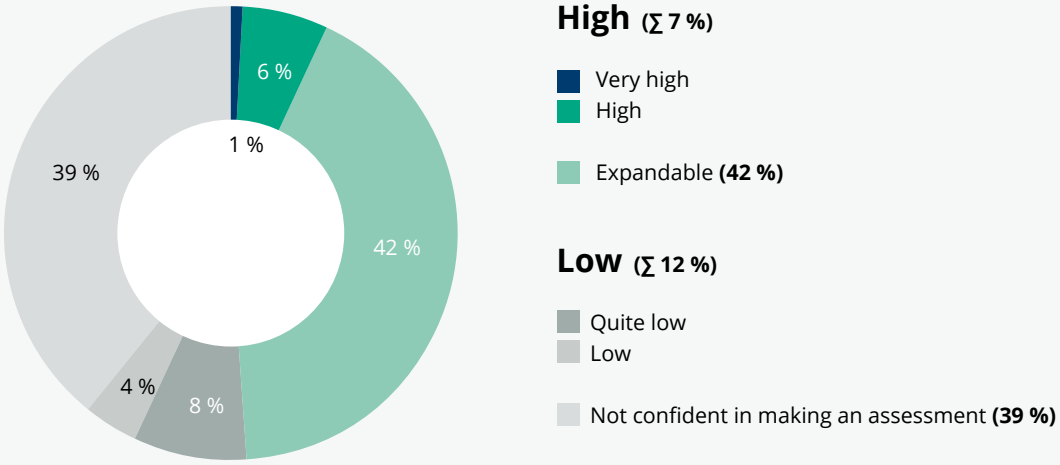
Predictive maintenance is always one of the first applications to be mentioned when it comes to specific Industry 4.0 applications. However, not all companies have yet had actual experience with it under real conditions: 42 percent of respondents have had no contact with predictive maintenance. Among those using it through, there is a overwhelmingly positive impression. 84 percent of these companies are satisfied with predictive maintenance; only 16 percent have found a reason for complaint. The quite high level of satisfaction regarding predictive maintenance, however, is based on a still rather low performance capability. At present, only 7 percent rate this as high. 40 percent, however, still see development needs.

Accordingly, it appears that predictive maintenance often offers what it promises, but that still does not seem to be enough.

A frequently mentioned application of Industry 4.0 is predictive maintenance.



How do you generally assess the performance of predictive maintenance offers currently available on the market?



There are several explanations for this. On the one hand, many production downtimes are still often due to operating errors that cannot be ruled out by maintenance systems. And many companies already have extensive experience with wearing of their machines as well as appropriate on-site maintenance intervals, so that the current added value of predictive maintenance is likely to be far lower than is often claimed. Such systems must therefore offer more. It would, for example, be conceivable to combine assistance programs for operators, which can also reduce application errors, or develop solutions for simultaneous optimization based on machine data. In general, however, the development remains relevant for companies: 74 percent rate predictive maintenance as an important topic for their own machinery especially when looking at the next three years.

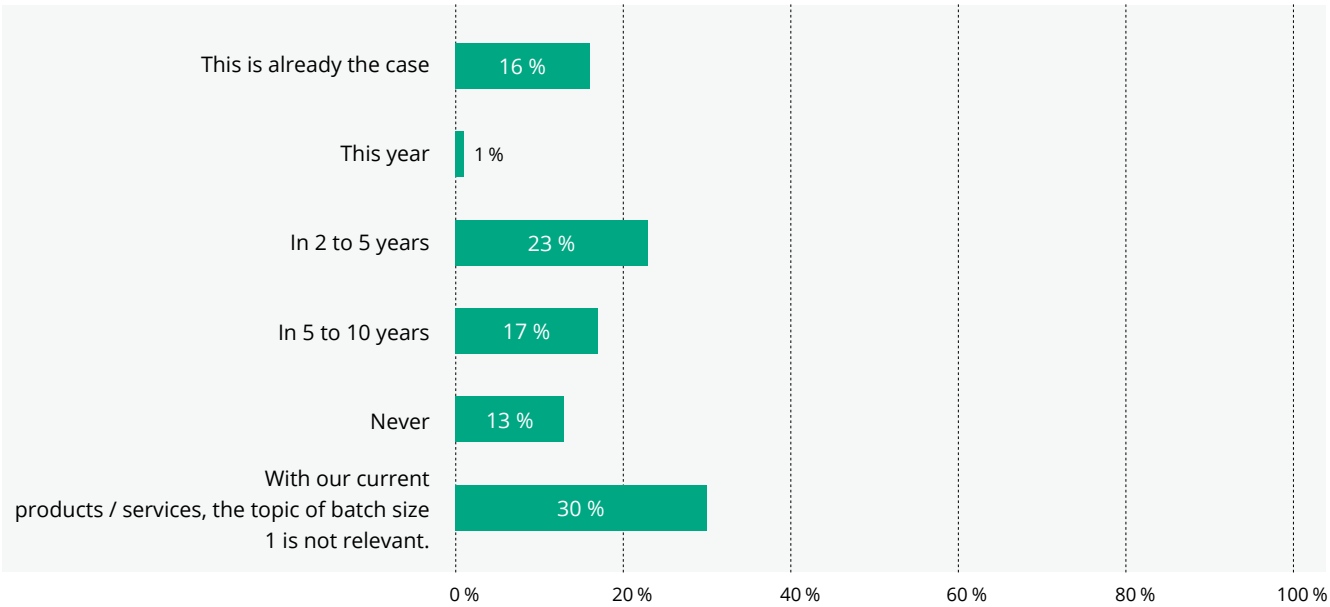
What significance will predictive maintenance probably have for your company in three years?

Responses "**very high**" + "**high**" + "**rather high**", surveyed on a 6-point scale from "very high" to "none at all"

4.9
Batch size 1 is already a reality

Individualized manufacturing can benefit from Industry 4.0 if processes from purchasing, sales, logistics and production are closely integrated and autonomous. At the same time, additive manufacturing offers unprecedented flexibility without lengthy set-up times. The situation is looking promising for batch size 1. Already, 16 percent of the companies are in a position to produce batch size 1 at the cost of series production. In the coming years, numerous companies plan to catch up: about one in four in the next two to five years, another 17 percent in a period of five to ten years. Only 13 percent believe they will never be able to achieve this goal.

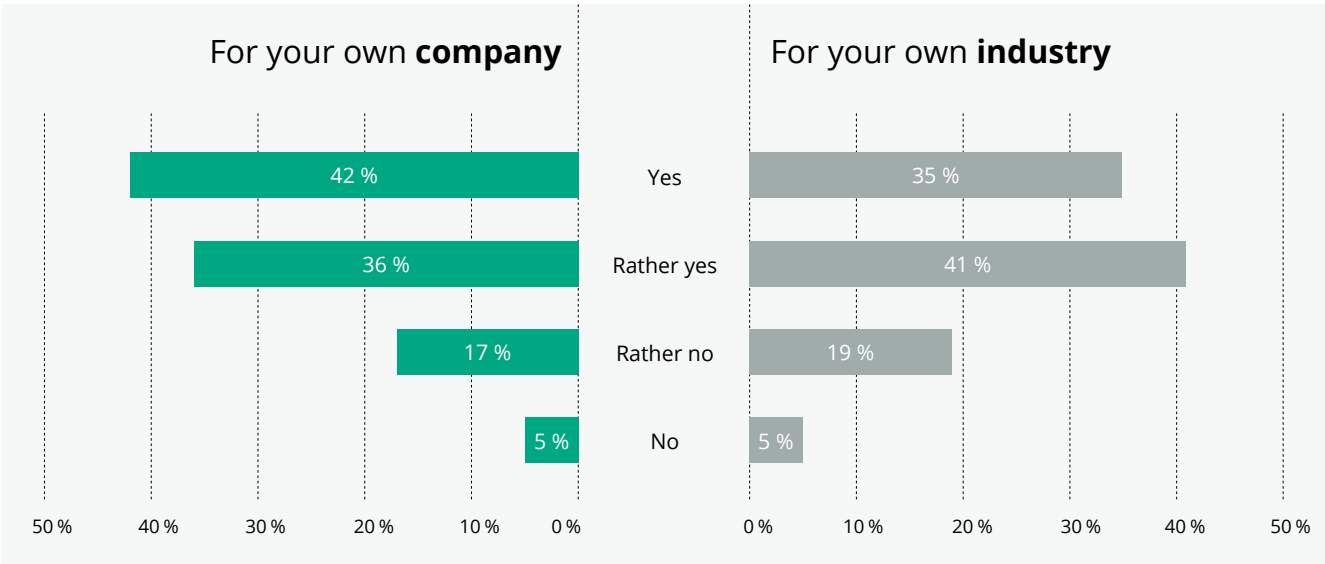
The first companies have already succeeded in manufacturing products with batch size 1 at the cost of series production. When will your company be able to do this?



For 30 percent of the respondents, batch size 1 is not important. In many cases, these are likely to be suppliers of simpler parts and components. In this area, mass production in static production lines will certainly remain the core business for a long time to come. But such companies should not neglect the topic either, at least with regard to the distant future. The more sophisticated and more autonomous Industrial 4.0-driven process control in purchasing and logistics becomes, the higher and more specific the requirements on the supply chain will become. In any case, a clear majority of respondents consider batch size 1 a strategic topic.

Is the topic of individualized manufacturing already an important strategic topic for your company or in your industry?

Comparison according to **companies / industries**

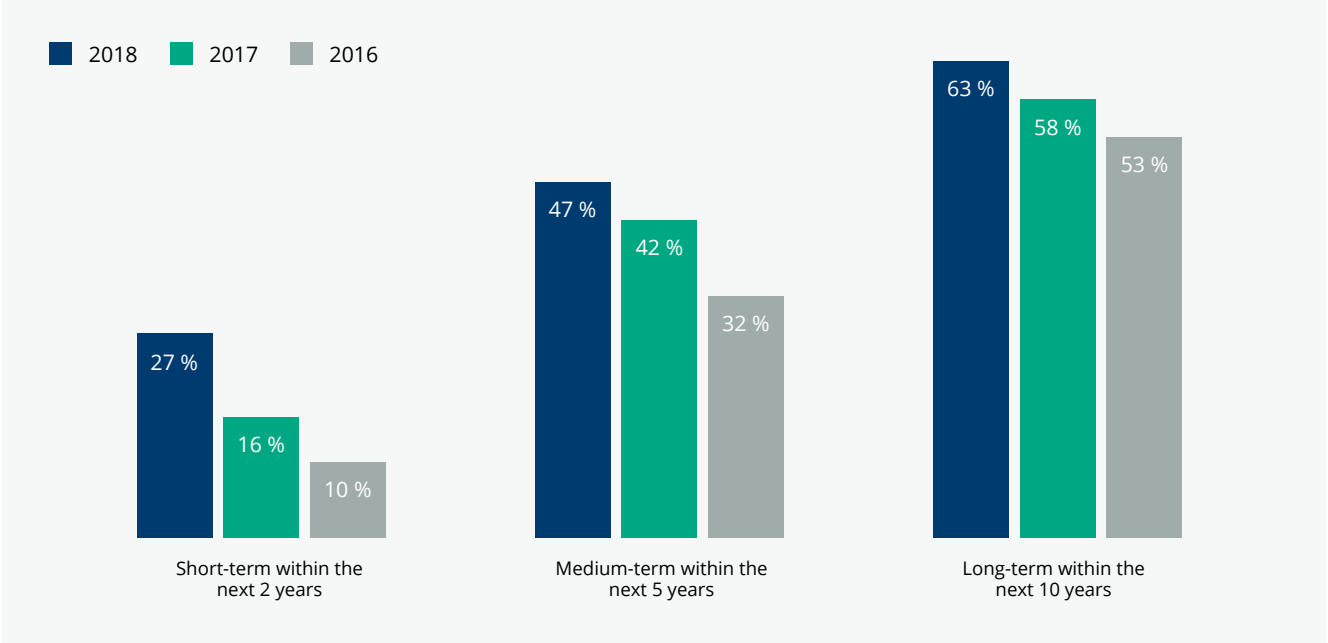


4.10 Companies' own industry fuels fears of disruption

Industry 4.0 not only offers an opportunity for companies, but it can also undoubtedly become a threat. All technological upheavals bring about losers – it is not uncommon for established companies in their industry to cling to successful concepts of the past for too long. And especially with regards to digital transformation, the right idea at the right time is far more decisive for the future of an industry than available resources. The fear of disruption therefore motivates many companies – and more every year. In 2016, only one in ten industrial companies believed that disruptive invaders would enter the competition within the next two years. In the meantime, this figure has risen to 27 percent.

Keyword Disruption: How great do you think the probability is that new competitors with Industry 4.0 / Digitization innovations will attack your business?

Comparison according to **survey year**; responses "great" + "rather great"*



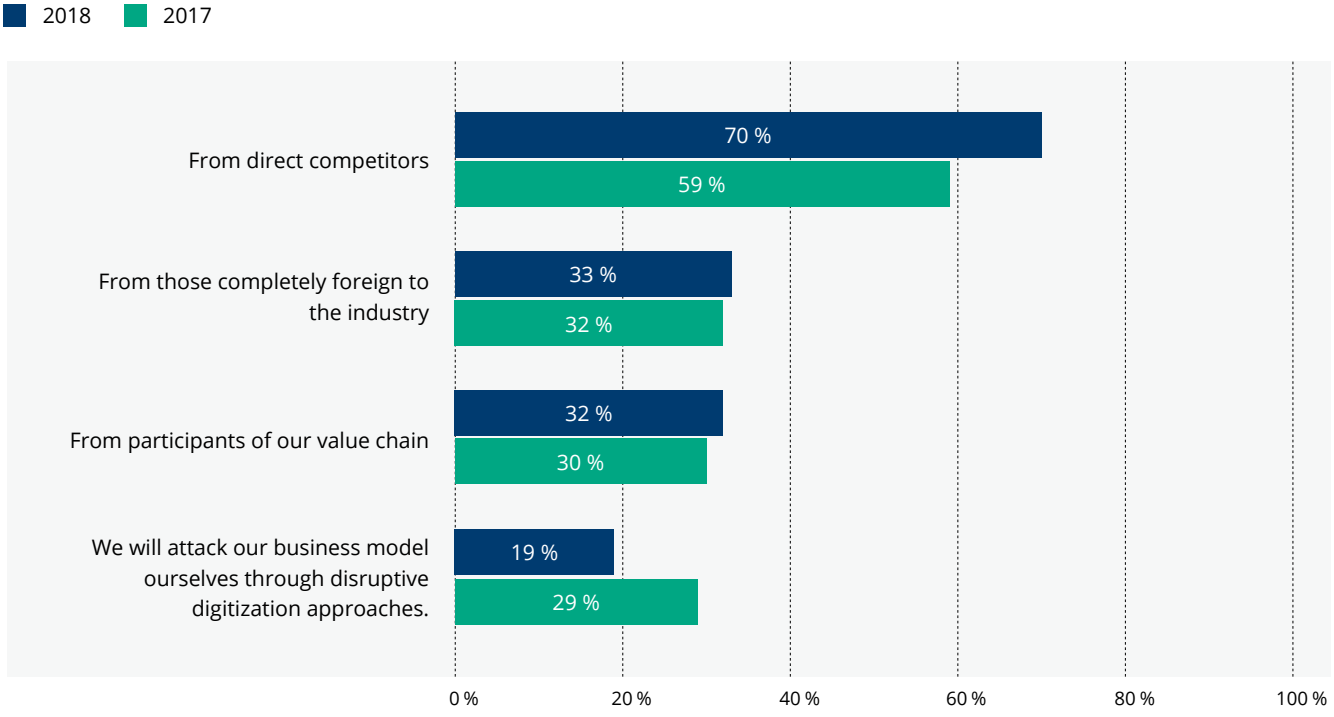
* surveyed on a 4-point scale from "great" to "low"

"Digitization is happening. It is not the question of when a company should use digitization, but if and how long a company can survive economically without using digitization."

Manfred Sieger, Siemens AG

Who do you expect to launch disruptive attacks on your business model?

Comparison according to **survey year**; only participants who answered "great" or "rather great" in the preliminary question



The surveyed periods of five and ten years also show increasing uncertainty. This certainly has to do with the fact that the theoretical threat is increasingly being substantiated by practical experience. And predominantly from their own industry: 70 percent see the threat for 2018 from their own ranks, 11 percentage points more than in the previous year. The technological upheaval is therefore becoming noticeable. Individual pioneers in various industries are pushing ahead with disruptive models and putting pressure on their competitors. In mechanical engineering in particular, an attack is expected to come from direct market competitors, with 80 percent of respondents agreeing with this assessment.

4.11
Innovation is driven by people

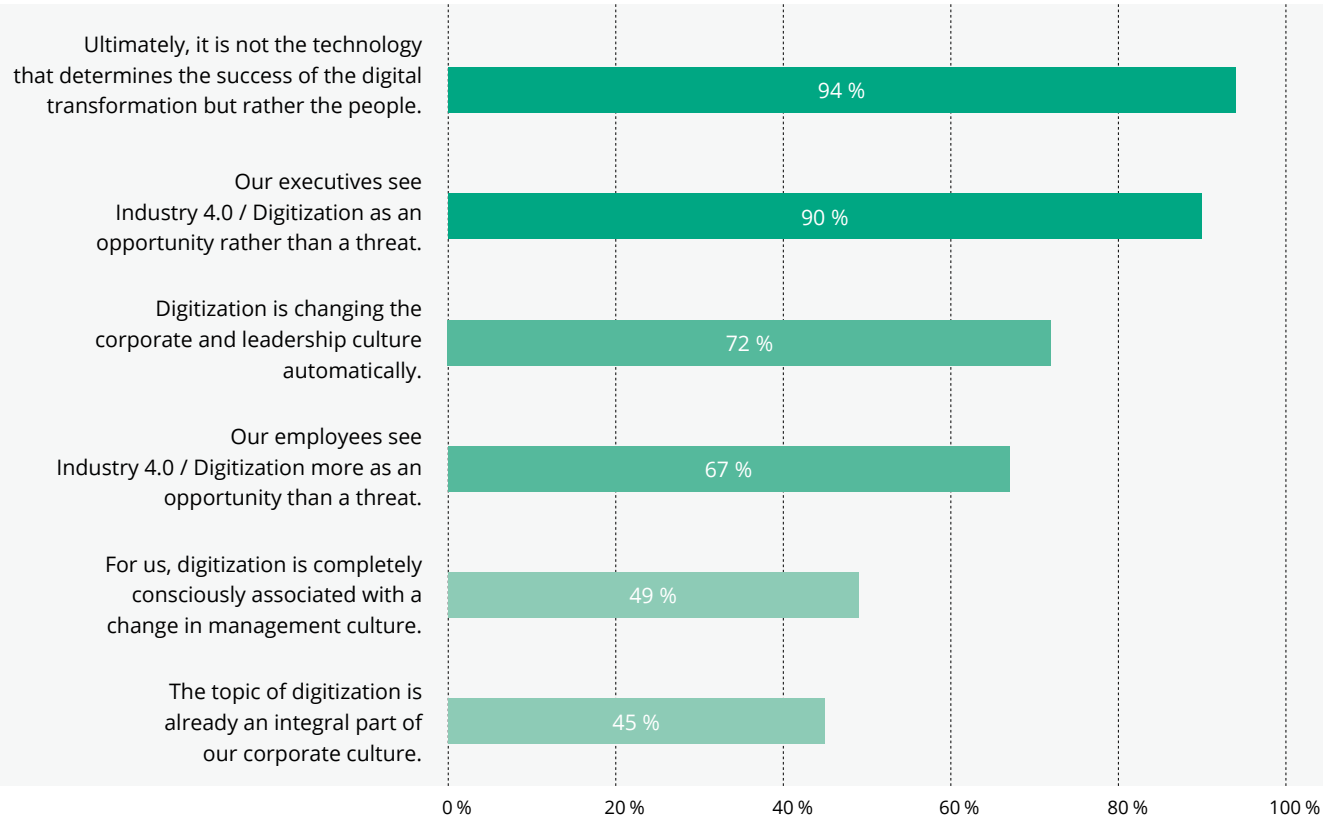
With all of the new technical possibilities, the credo in industry in is: Humans are driving digital transformation, not technology. 94 percent of respondents share this opinion. Above all, it is the executives who are inspired by Industry 4.0. Nine out of ten see change as an opportunity. Employees, on the other hand, are more skeptical. One third of the respondents are rather suspicious of the technological revolution. Above all, the fear for one's own job is likely to play a significant role. It is therefore the task of executives to confront these fears and inspire employees with enthusiasm for future innovations. Those who do not succeed in leading and motivating their staff into the new age will have a very difficult time in the competition of ideas.

Most companies have already internalized the fact that executives must generally rethink and embrace a new corporate culture. 72 percent believe that this will go hand in hand with digitization - virtually automatically. Surely new requirements will cause many executives to rethink their everyday business, but to rely completely on the companies' own dynamics in this area could be too short-sighted.

Deep learning processes are not least triggered by failures and only a few companies will want to afford such painful experiences. It is better to turn executives into mentors and multipliers. Almost half of companies are already consciously striving for this targeted change.

How do your employees and executives assess Industry 4.0 / Digitization? How is your company positioned overall in this area?

Only answers "correct" + "rather correct"*



Surveyed on a 4-point scale from "correct" to "not correct"

However executives determine their new role, one thing is certain: They still have a lot to do. So far, only 45 percent of companies have understood digitization to be an integral part of their corporate culture - and this clearly contradicts the almost general realization that people are at the center of the Industry 4.0 movement.

4 Conclusion

"Digitization is a great challenge for a company and for the people who work in the corresponding processes and procedures. However, it is not a threat if it is used correctly and reasonably. We should all face this new technology with sound judgement and use its advantages for our own good."

Reinhard Jenne, Director Customer Service, HF Mixing Group

Industry 4.0 has undoubtedly begun to make its mark on German companies. Well over half of them have already gained practical experience, and many more will follow in the foreseeable future.
Digital transformation in the area of customer business is developing at a slightly slower pace. In 2018, too, companies will focus on their own processes and procedures. Efficiency is to be increased with new technological approaches and transparency improved. But gradually the awareness of the real possibilities of Industry 4.0 is rising. More and more products are being offered with additional digital benefits and software solutions are being added to the portfolio alongside physical goods.

But the main goal is far from being reached. Only a few companies are genuine smart enterprises. There is still much to be done in the search for new business models based on digital transformation - this is exactly where the great value creation potential lies. Time is of the essence, as certain pioneers are already beginning to develop these attractive business fields. Not only new competitors from the IT sector are making the leap, but also representatives from their own field.
It is primarily up to executives to prepare their companies for this technological race. They must get their employees excited about digital transformation and take away their fears, because one thing is clear: Ultimately, it is people who will drive change, not machines. The majority of companies have already internalized this.

5

Glossary Industry 4.0

A

Actuators

Small devices in the >> *Internet of Things* that are addressed via the return channel of a network connection. They trigger certain actions, such as closing or opening circuits or changing control values. They are usually networked via a >> *gateway*.

Additive manufacturing

Also called 3D printing. This is an automatic process in which a component is made based on digital 3D design data by molding material in layers. The material required for this is various types of plastics, but also metals and composites. Thanks to additive manufacturing >> *rapid prototyping* is also possible, but also the production of single pieces in >> *batch size 1*.

Additive methods can be used to form components with internal structures that cannot be achieved with conventional subtractive methods such as milling or drilling. For example, the aircraft industry uses additive manufacturing for the production of innovative lightweight components that combine material savings and increased dimensional stability.

Artificial intelligence

Artificial Intelligence (AI) is a branch of computer science that focuses on >> *automation* of intelligent behavior and >> *autonomization* of systems. The sub-areas of AI include knowledge-based systems, pattern recognition, speech recognition and generation, predictive algorithms, robotics, >> *machine learning*, >> *deep learning* and much more.

AI is regarded as one of the most important future topics for the economy, as it offers numerous new possibilities for value creation in addition to the advanced automation of business processes. For example, autonomous vehicles, intelligent assistants as software, medical diagnostic software and household robots will be some of the future markets of the coming decades.

Augmented reality

Essentially computer-aided expansion of environmental perception. This is generally understood as the insertion of additional information in the form of texts or images onto an image of the environment. >>>

Augmented Reality (AR) on the smartphone, for example, consists of apps that display tourist information about buildings when pointed at with the camera. AR glasses are used in Industry 4.0 to support service technicians in their work, for example. The machine or system is recorded via a camera integrated into the glasses and instructions for action or explanations are displayed in the field of vision via software.

Automation

Term for the transfer of an action or process to a independently running system, such as a machine or software. In early forms of automation, only monotonous, repetitive actions were transferred to machines. Current forms of automation also transfer more complex actions from organizational and commercial calculations to software (process automation) or robots.

Autonomization

Generally a term used to describe the development of a system of control loops that can operate without operator intervention. Specifically, the term for complete >> *automation* of actions or processes using methods of >> *artificial intelligence*. Ideally, autonomously running systems (software agents, robots) are created that perform tasks with high flexibility and integrated intelligence. One example is an autonomous vehicle that drives automatically in traffic and can make its way from a starting point to a destination without driver intervention.

B

Batch size 1

Batch size usually refers to the quantity of products that are manufactured within a production order. Batch size 1 is therefore a single piece that is not produced by hand but rather using mass production processes. Here, either specially equipped production lines or >> *additive manufacturing* processes are used.

Big data

The term for large amounts of heterogeneous data that are analyzed by companies. In industrial manufacturing, this includes large quantities of sensor data supplied by networked, smart products. Marketing understands big data as the unstructured conglomerates of social media posts, emails, recordings in CRM systems and other customer-relevant data.

These collections of heterogeneous data are difficult to evaluate with conventional methods. Companies therefore use various statistical analysis methods, >> *machine learning* and similar methods to transform big data into >> *smart data*.

Blockchain

A new database format in which user data is stored in blocks and each new block is linked to the previous one by signatures. This means that the individual blocks in the database can no longer be changed without affecting the chained signatures.
In order to further guarantee the integrity of the data, blockchain databases are distributed across several servers. This means that each data block must be confirmed by a majority of the servers involved. This makes subsequent changes to a data block impossible, since all other instances of the blockchain database still contain the original data block.
Blockchain technology has a wide range of applications, also in industry. It is, for example, possible to monitor the transport of goods in the >> *supply chain* via a blockchain database. Security against counterfeiting makes it easy to monitor the integrity of goods or the conformity of delivery routes with contractual agreements.

D

Deep learning

A special form of >> *machine learning*. It is based on the use of neural networks whose structure is modeled on that of the human brain. A neural net consists of surface layers for the input and output of data from several deeper layers - hence the name "deep."
Neural networks are adaptive, because input data change the internal structure of the networks and after some time lead to adapted output data. For this purpose, neural networks are trained using historical or predefined data.
An example: Neural networks are successfully used for describing image content. Training takes place with marked sample pictures. The content that was trained can then be recognized on new images.

Digital transformation

Digital transformation is an ongoing process of change based on digital technologies that change the way companies work and the market environment in which they operate. Automatable digital processes are replacing conventional processes, which are often based on manual work. Since digital technologies are also used by customers, their expectations change ("everything, immediately"). This results in an enormous market dynamic, which also requires new, more efficient and more agile forms of company organization.

Digital twin

In general, the term refers to the digital representation of an object from the real world. In >> *Industry 4.0* a machine or plant is simulated through virtual software with a digital twin. It is used to optimize processes before commissioning or to implement additional optimizations during ongoing operation. For this purpose, all system states of the digital twin are adapted to real-world processes in real time.

Digitization

This term is often used synonymously with >> *digital transformation*. It signifies, however, more of a process that takes place throughout economy and society, in which digital technologies become more important. Digitization has an impact not only on individual companies but also on people's private lives, the education system, the media and other areas.

Disruption

Meaning either a disturbance or break. This term is typically used for radical innovations that change entire markets and industries as technological upheavals. For example: The car was a disruption for the carriage manufacturing industry. Car companies were predominantly founded by technicians, because only they had the necessary know-how. As a result, almost all carriage manufacturers disappeared from the market.

Disruptive business models

A disruptive business model enforces a radical innovation (>> *disruption*) with regards to business models. For example, Uber developed a disruptive business model in the taxi industry with its digitally based platform model.

E

Edge computing

In the >>*Internet of Things* an "edge" is the transition between an internal network, such as a >> *smart factory*, and the public Internet. Edge computing is a term for the possibility to equip >> *gateways* with a company's own computing capacities and perform certain tasks on site. This can be used, for example, to filter data to relieve the load put on the network connection or data center. In addition, edge computing also enables fast reactions to critical states in networked machines and systems.

G

Gateway

In many >> *Internet of Things* installations, especially in the context of >> *Industry 4.0*, a "gateway" is the interface to the Internet. It bundles data from several >> *sensors* and opens return channels to several >> *actuators* so that not every device has to be networked but rather only the gateway. It ensures secure transmission of data and protects machines and systems against cyber attacks. If a gateway is equipped with its own computing capacity, this is referred to as edge device or >> e*dge computing*.

I

Industrial Internet platforms

A collective term for different Internet-based platform models in industry. These include, for example, trading platforms, sharing platforms, IoT platforms and others. They provide users with opportunities of value creation. Via sharing platforms, companies can, for example, rent out machines and systems that are not needed at the moment or offer them to other users, for example to reduce downtimes.

Industry 4.0

The term for a future project involving the comprehensive >> *digitization* of industrial production. It also indicates that a fourth industrial revolution is imminent. The first revolution was steam-powered mechanization, the second mass production on assembly lines and the third automation with electronics.
The fourth industrial revolution (Industry 4.0) involves intelligent networking of machines and processes in industry with the help of information and communication technology. One of the goals is achieving flexible production in a convertible factory that produces customer-focused solutions using data and delivers them with optimized logistics as part of a resource-conserving recycling economy.

Internet of Things

In general, the Internet of things is an infrastructure for networking devices and is based on the Internet protocol. With regards to >> *Industry 4.0,* it forms a network of smart devices that are equipped with >> *sensors* and >> *actuators*. They collect data and send it via a >> *gateway* to an >> *industrial Internet platform.*

M

Machine learning

A collective term for procedures and algorithms with which knowledge can be generated from experience (in the form of data). Machine learning belongs to the large field of >> *artificial intelligence* and utilizes mathematical-statistical methods and neural networks (>> *deep learning*). A typical application of machine learning in >> *Industry 4.0* is >> *predictive maintenance.*

P

Platform economy

The term platform economy refers to digital two-way markets in which an intermediary (the platform) initiates business transactions between different players - usually suppliers and consumers of products and services. For this purpose, an Internet platform is used that facilitates transactions or even just makes them possible using digital technologies.
Such platforms are available in different industries and for different purposes. An example of a platform in the retail industry is the Amazon Marketplace. Amazon makes its online shop infrastructure, which was initially only set up for its own purposes, available to merchants who can offer their own goods. >>>

Here, customers can be found more easily and in greater numbers than with their own online shop, as they can access the enormous number of Amazon customers. Other well-known and successful platform business models are for booking rooms (Airbnb, Booking), taxi rides (Uber) or carpooling (BlablaCar).

Predictive analytics

A method for making predictions based on data analysis. Historical data from a specific domain to be observed (customer behavior, market movements, customer flows in an online shop, etc.) is typically collected and analyzed in order to make predictions. Statistical methods and >> *machine learning* are used for the analysis. The result is a predictive model that enables prediction of future events based on current data from the same domain. This allows companies, for example, to calculate purchase probabilities based on current customer behavior.

Predictive maintenance

The regular maintenance of machines and systems at regular intervals is replaced by wear-dependent maintenance, in which maintenance times are determined by data analysis. Here, >> *machine learning* is usually utilized.
The data required for predictive maintenance are, for example, temperature curves, vibrations, current fluctuations and similar data determined via >> *sensors* on the machines. The machine learning software must first collect data over a longer period of time in order to establish a usage profile of the machine. This profile can be used to distinguish between normal and abnormal states. Once this training process is complete, the software can detect and report early warning signs of errors, wear and tear and failures.

R

Rapid prototyping

A generic term for the rapid production of prototypes based on construction data. For this purpose, >> *additive manufacturing* processes are used. Rapid prototyping can be used to produce both models and functional prototypes.

S

Sensors

Small devices in the >> *Internet of Things* that collect data and environmental conditions such as temperature, pressure, brightness, humidity, vibration, current, voltage, sound signals, and more. They are usually networked via a >> *gateway*.

Smart business

General term for all data-based business models in the field of >> *Industry 4.0* and the >> *Internet of Things*. A smart business emerges when a company has integrated innovative, smart products and services into its product portfolio and its business model is based on the assessment of >> *smart data*.

Smart data

Data sets extracted with analysis software from large amounts of raw data (>> *big data*) containing meaningful information. They are characterized by high-value information and also by high data quality, meaning they contain no duplicates or errors, for example. The benefits of smart data lie, for example, in the development of new business models through targeted analysis.

Smart enterprise

The term for a company that possess the following three characteristics: 1. It uses data to optimize its business processes; 2. it implements knowledge management that spans across all departments; 3. it enables all employees to work together across departments.

Smart factory

A factory that enables extensive self-organization in production and all related business processes. A requirement for this is >> *automation* and >> *digitization* with the aim of developing efficient and adaptable production that achieves optimum value creation at all times.

Smart product

A product that, unlike traditional products, is equipped with built-in intelligence and the ability to network. Because of this, it has additional digital functions that increase its direct benefit or automate certain services, such as reordering raw materials.

Software services

Collective term for processing company functions using software. A distinction must be made between internal software services such as controlling dashboards or >> *predictive analytics* and customer-oriented software services such as interfaces to >> *industrial platforms* or >> *predictive maintenance*.

Supply chain

The supply chain of a company in its simplest form creates a triad of "supplier - producer - customer." For most companies, however, the supply chain is a complex and dynamic network of suppliers and customers. Companies can be situated at different stages of this supply chain, for example as manufacturers of raw materials or intermediate products, but also as processors or system integrators.

V

Virtual reality

Virtual reality (VR) is the representation of an entirely computer-generated, interactive virtual environment. So-called VR glasses are often used for this purpose. These combine closed glasses, closed headphones and a microphone. The wearer is optically and acoustically shielded from his or her environment and ideally only perceives the virtual reality. In addition, data gloves are occasionally used that also enable users to grasp objects in virtual reality.

Industrial applications are still rare, but initial attempts have been made with flight simulators, virtual training for workflows and the construction of virtual prototypes in a VR environment. So-called mixed-reality glasses, which depict virtual elements on a display of the environment and are intended, for example, to support service technicians, are somewhat more widespread. However, the transitions to AR (>> *augmented reality*) here are fluid.

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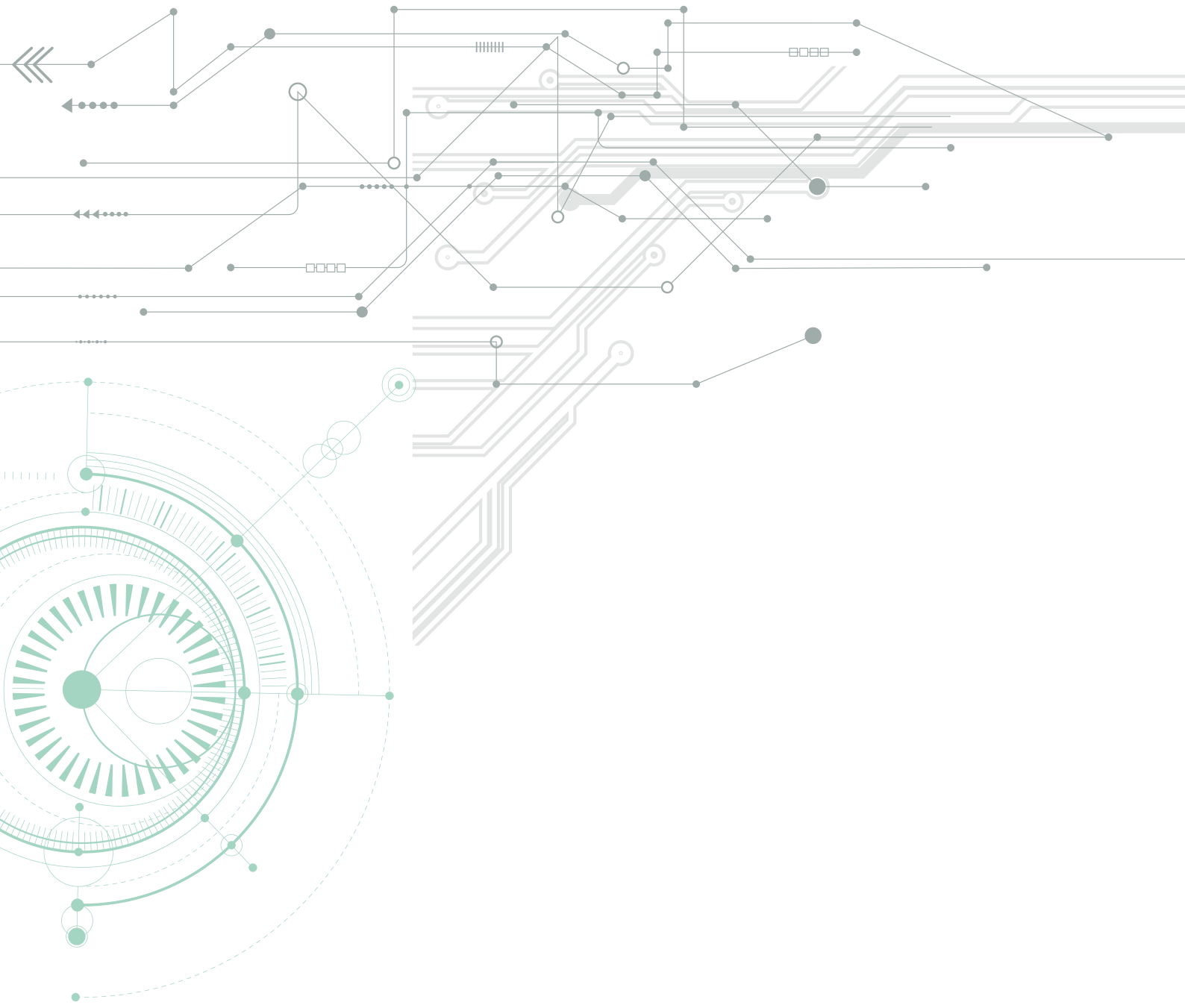

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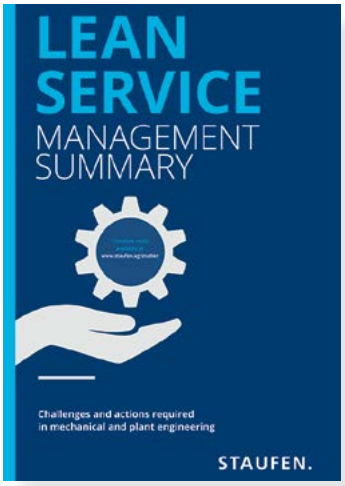

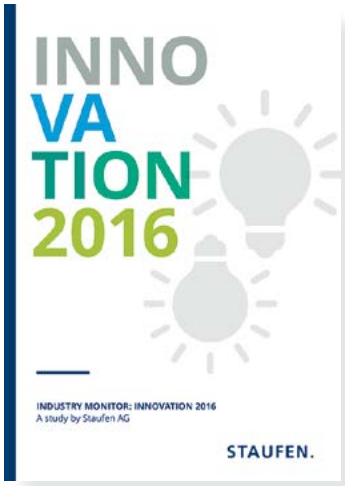

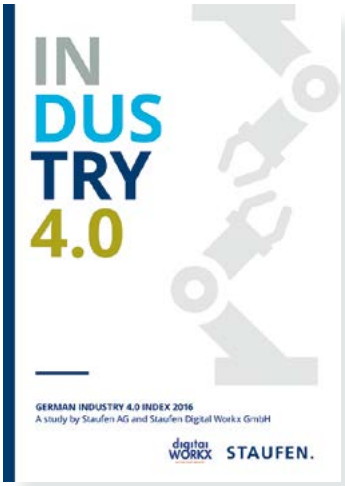

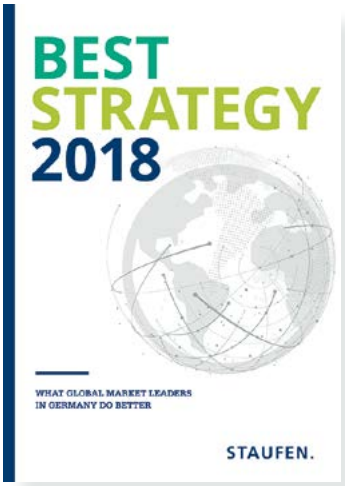

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