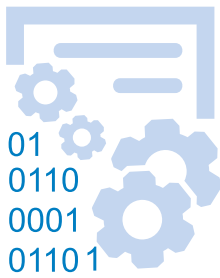# Digital Transformation in the Manufacturing Industry

Industry 4.0: From Vision to Reality

IDC White Paper, sponsored by Dassault Systèmes

Mark Alexander Schulte

ARE YOU READY FOR DIGITAL TRANSFORMATION?

Digital transformation or Industry 4.0 in the manufacturing industry leads to extensive changes in all areas of value creation, resulting in more efficient production processes, stronger customer-centricity and new marketing and business models. Or, in other words, in efficiency, agility, and innovation.

Digitization unlocks outstanding opportunities for German industrial enterprises keen to safeguard their competitiveness in a global context by means of innovative business processes and models. However, IDC's Industry 4.0 surveys of recent years have shown that Germany's manufacturing sector is lagging behind in its implementation of the digital transformation.

Yet some pioneering enterprises are exploring developments that are already giving them an edge over competitors: Kaeser, for instance, offers a compressor network-based "Compressed air-as-a-Service," morphing from product manufacturer to service provider. As part of a pilot project, Henkel is deploying smart, self-learning robots that perform co-packing activities with employees. And Infineon is setting up seamless tracking of its products along the global value chain, because integrated value chains speed up response times in the event of faults, permit faster learning, and thus improve quality.

The above examples show that the digital age has long since dawned. Organizations must make the most of the opportunities for their enterprises. IDC forecasts that by 2019, 75% of industrial enterprises worldwide will transform their value chain through digitally networked processes and objects, thus increasing response speed and productivity by 15%. One thing is plain, though, miss the Industry 4.0 boat now and your competitors will leave you behind.

Against this background, in August 2016 IDC surveyed 200 enterprises in the manufacturing industry to find out their views on digital transformation, planned and implemented Industry 4.0 projects, and which aspects industrial enterprises should heed when realizing their projects. This White Paper distills the main views of the interviewed professionals and managers and makes recommendations on how enterprises can successfully master digital transformation.

WIND OF CHANGE IN GERMAN INDUSTRY: VISION BECOMES REALITY

Many industrial enterprises are under pressure to take action, reduce costs, improve internal processes and increase profitability. These major operative challenges often leave little time for working on innovations. However, this situation makes doing so all the more worthwhile, as digital transformation addresses many of these challenges. Consequently, compared to 2014 the number of professionals and managers engaged in Industry 4.0 has almost doubled.

FIGURE 1

Compared to 2014 engagement with Industry 4.0 has practically doubled

Attention to Industry 4.0 among professionals and managers
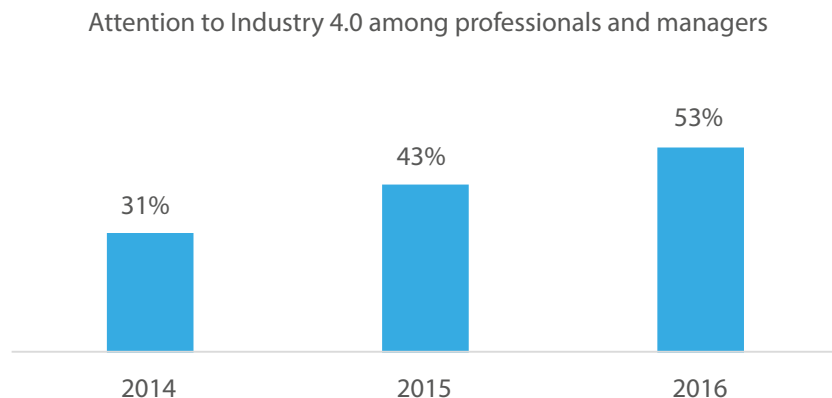
Q: Have you already addressed the subject of Industry 4.0?
N = 314 (2014), N = 417 (2015), N = 363 (2016)   Source: IDC, 2016

Yet Industry 4.0 still fails to enjoy broad awareness at a department level. While eight out of ten IT managers address the subject, in engineering, production and logistics, only 45% do so. Far too often they are unaware of or fail to appreciate the challenges ahead. Even if the subject is addressed to a greater extent across all departments, digital transformation is still spearheaded by IT departments. And though this does not mean that other departments are idle when it comes to business development, they still do not accord digitization its due status.

Yet technology will continue to penetrate and drive the value creation process. Corporate IT will therefore play a key role in planning, piloting and implementing Industry 4.0 initiatives. However, new competencies, state-of-the-art know-how, and qualified personnel must first be built up and IT departments still need to develop further. Frequently, teams are not up to tackling the challenges of Industry 4.0. If they do, digital transformation offers a unique opportunity to spearhead corporate development.

Despite openness to change, enterprises must speed up their implementation of Industry 4.0 projects

In recent years, attention to Industry 4.0 has increased substantially. But are projects really taken up and implemented across the board?

Today, most industrial companies are still in their starting blocks: 52% are planning or piloting Industry 4.0 projects and thus currently laying the foundation of future activities. The number of these enterprises has increased dramatically in the past year, however, by almost a third. German industry is undoubtedly ready for change, with enterprises keen to optimize their business activities by increasing shop floor networking, achieving digital continuity in the value chain and through innovative products.

Nevertheless, going live with pilot projects is a big obstacle for many enterprises. The number of enterprises with Industry 4.0 projects in progress has remained steady. Migration concepts are urgently needed if Industry 4.0 is to really take off. Often established structures and little desire for change stand in the way of a broad-based rollout. Enterprises should be able to draw on external know-how so they can go live as soon as possible with their pilot projects and scale them accordingly.

FIGURE 2

Enterprises find it very difficult to get pilot projects up and running in live operation

Status quo regarding the implementation of Industry 4.0 initiatives

Industry 4.0 maturity level
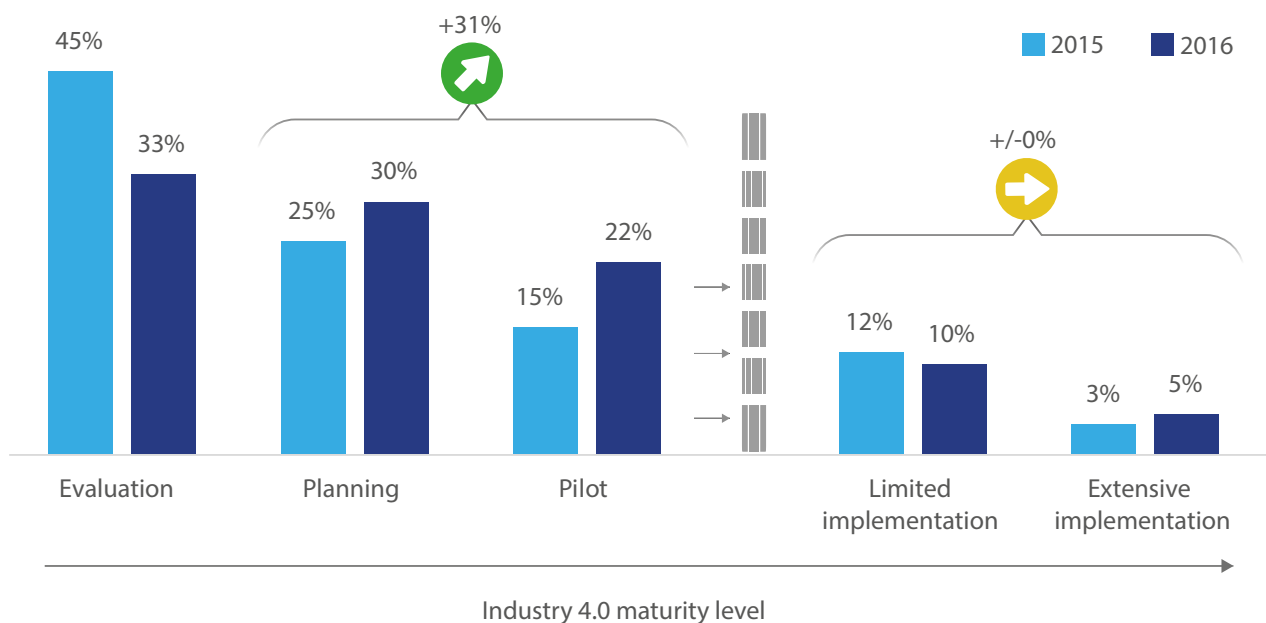
Q: At what stage is your organization in terms of implementing Industry 4.0 initiatives?
N = 201 (2015), N = 200 (2016)

Source: IDC, 2016

One thing is clear, though: not every pilot project will satisfy the high expectations among organizations. Ultimately, new technologies and concepts must be viable and help achieve corporate targets. They must not be pursued as an end in themselves. At Henkel, for instance, emphasis is placed on a "trial and error" method. Successful pilots should be quickly scaled and stopped just as swiftly if they prove to lead nowhere. In general, it applies for industrial enterprises that only the bold, those prepared to take a risk and explore new avenues, will benefit from digital transformation.

Industrial enterprises must make the next move: From networking and control to optimization

Only through its application can the vision of Industry 4.0 be fleshed out. Planned and implemented use cases show that recording, monitoring and controlling processes, machinery and products are currently the primary aims of increased networking and digitization. So avoiding errors when designing new production methods and products is clearly a priority.

This approach makes complete sense and corresponds to a typical maturing process: enterprises initially drive shop floor networking through sensors, actuators and cyber physical systems. In the second step, they aim to achieve greater transparency and control over their production processes. And finally the potential for optimizing and making money out of data is addressed.

At the same time, the number of planned, piloted, and implemented uses cases has risen perceptibly over the past year. The results thus support the identified maturing process and spirit of change in enterprises. Nevertheless, industrial enterprises must focus more strongly on optimizing processes, developing more customized products and advancing their business model via Industry 4.0. This is where the potential lies to outstrip the competition in an innovative bold approach.

Semiconductor manufacturer Infineon is a successful example of optimizing the value creation process. The microelectronic enterprise's components are produced at several sites, starting for instance in Dresden, with up to 1,200 individual steps before assembly in Malaysia and onto Singapore for testing, packaging, and shipping to customers.
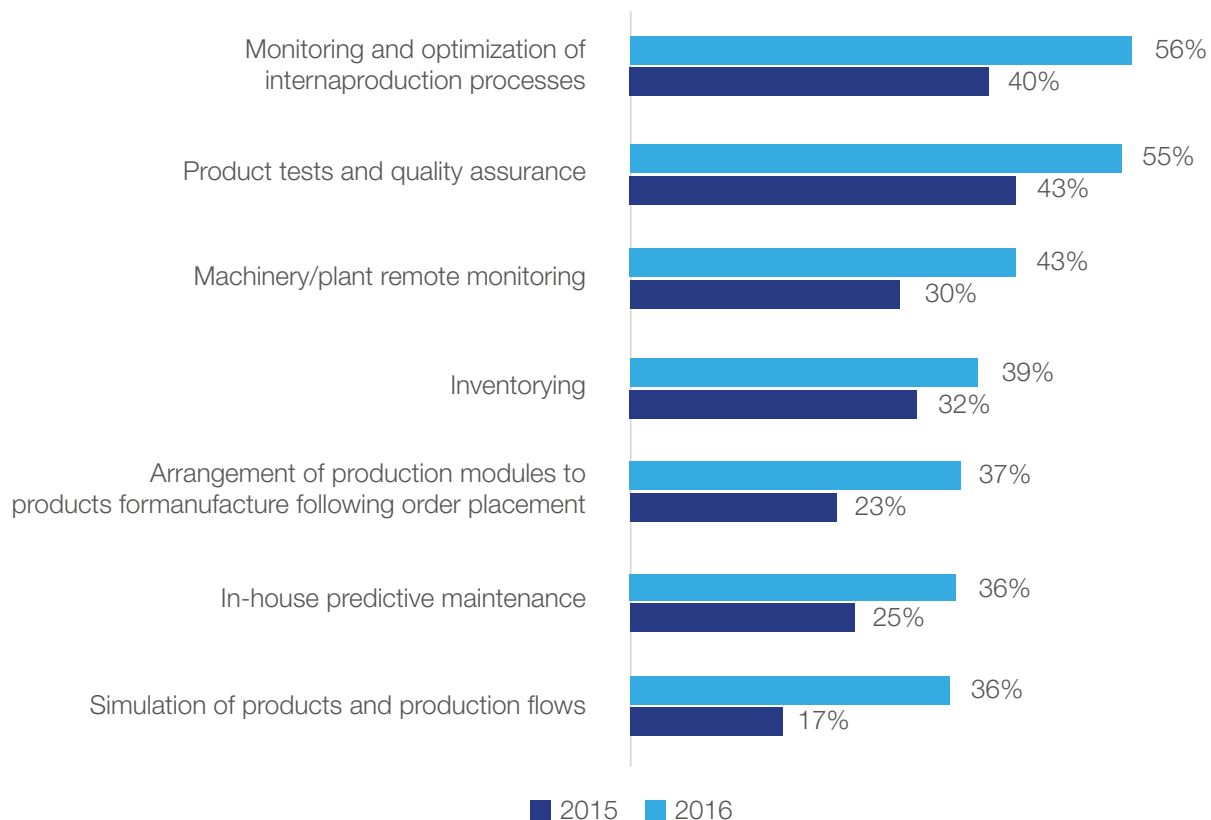
Seamless product traceability is implemented to ensure that each product can be clearly identified at any time at those sites, while real-time information exchanges about production stages and beyond reduces the manufacturer's learning cycles across the entire production setup. Improvements in productivity and yield therefore take hold faster.

FIGURE 3

Perceptible increase in use cases:

The priority is still on shop floor mapping and monitoring

Most commonly planned and implemented Industry 4.0 use cases

Use case	2016	2015
Monitoring and optimization of internaproduction processes	56%	40%
Product tests and quality assurance	55%	43%
Machinery/plant remote monitoring	43%	30%
Inventorying	39%	32%
Arrangement of production modules to products formanufacture following order placement	37%	23%
In-house predictive maintenance	36%	25%
Simulation of products and production flows	36%	17%

■ 2015 ■ 2016

Q: Which of the following applications describes the Industry 4.0 initiatives implemented or planned in your enterprise?
N = 167; only enterprises that use or plan networked objects; abbreviated figure   Source: IDC, 2016

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Plant suppliers like Kaeser or Schaeffler are also pushing ahead with Industry 4.0 use cases. The compressor manufacturer not only offers "Compressed air-as-a-Service," but also develops predictive maintenance application scenarios for its stationary and mobile compressors. In recent years, Schaeffler has invested significantly in research and development, equipping its components with sensors, actuators and control devices, enabling them to record and process valuable data, for instance on machine status, and pass it onto value-adding services.

These use cases illustrate the potential of Industry 4.0. All competitors seek ways of increasing their market share, so it is vital to act swiftly, for speed is of the essence. In the coming months, greater effort must therefore be put into driving the development, piloting, and scaling of use cases, for it is also obvious that technological progress marches on.

THE INCREASING BLURRING OF VALUE CREATION PROCESSES CALLS FOR DIGITAL CONTINUITY

Industry 4.0 not only enhances shopfloor networking, but also impacts on the digitization of the entire in-company value chain process. Great opportunities are presented for intensifying coordination along the value chain, making the most of experiences faster, and ultimately responding more quickly to faults or new customer requirements.

However, digitization in product development also brings challenges. The major task for engineering is to develop a standard database across all departments, thus forming the basis for digital continuity and consistency along the value chain. Particularly in view of the fact that various systems and formats are often deployed within single development lines, or media interruptions are a frequent occurrence. Digital availability of all relevant information, drawings and plans is essential for engineering to master increasing product complexity, respond faster to new requirements and shorten time-to-market.
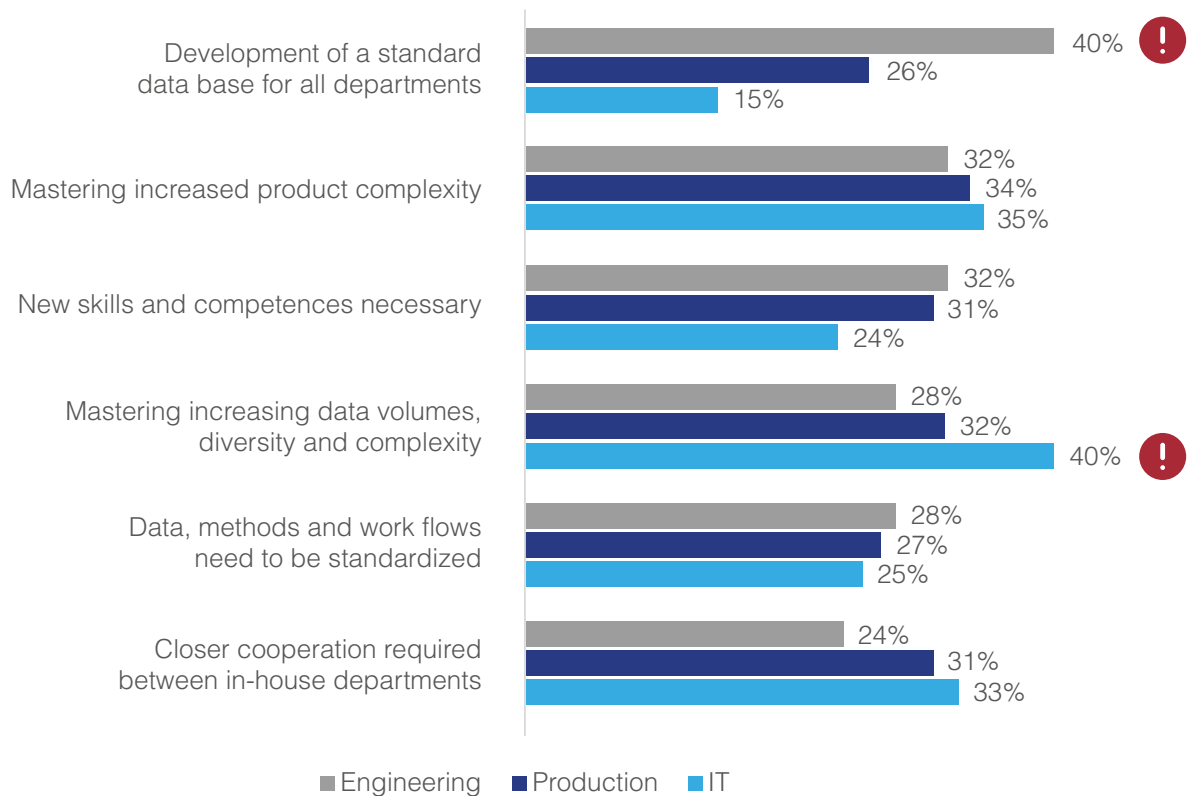
Interestingly, IT colleagues in particular show no appreciation for this. Building a standard database is the biggest problem for engineering, for IT it is the smallest. But do our IT colleagues think things through?

They regard growing data diversity and volumes as by far the greatest challenge brought by Industry 4.0. This shows that while IT is still focusing on the cause of the problem, engineering is already thinking about a solution.

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FIGURE 4

Rapidly growing data volumes: IT identifies the problem, engineering solves it

Major challenges for Engineering due to Industry 4.0

	Engineering	Production	IT
Development of a standard data base for all departments	40%	26%	15%
Mastering increased product complexity	32%	34%	35%
New skills and competences necessary	32%	31%	24%
Mastering increasing data volumes, diversity and complexity	28%	32%	40%
Data, methods and work flows need to be standardized	28%	27%	25%
Closer cooperation required between in-house departments	24%	31%	33%

■ Engineering ■ Production ■ IT

Q: In your opinion, what are the three main challenges posed by Industry 4.0 for engineering?
N = 184; Select of three main criteria; Abbreviated figure

Source: IDC, 2016

Huge potential: Information, time and revenue are lost through a lack of coordination

The following figures show how urgently action is required along the value chain:

- In **55% of enterprises** too much time is lost on coordination between departments' process steps

- **44% of enterprises** lose **revenue** on account of poor interdepartmental cooperation

- In **42% of enterprises**, information **is lost** along the value chain

There are various reasons for these alarming findings. However, a crucial factor is that the value chain is spread over several sites and plants, often involving different technological levels and systems. They hinder the seamless exchange of digital information and thus efficient interdepartmental cooperation. The greatest challenges along the value chain facing consumer goods manufacturer Henkel are the various systems, some of which have evolved over time and need to be converged.

Getting rid of silos: 70% of enterprises aim to accelerate the exchange of information along the value chain

It is high time that enterprises took action. The following illustration also clearly shows how rarely departments have access to a consistent database. Merely 5% of the industrial enterprises interviewed currently possess a central data platform that can be used by all departments in the value creation process. So digital continuity still has a long way to go.
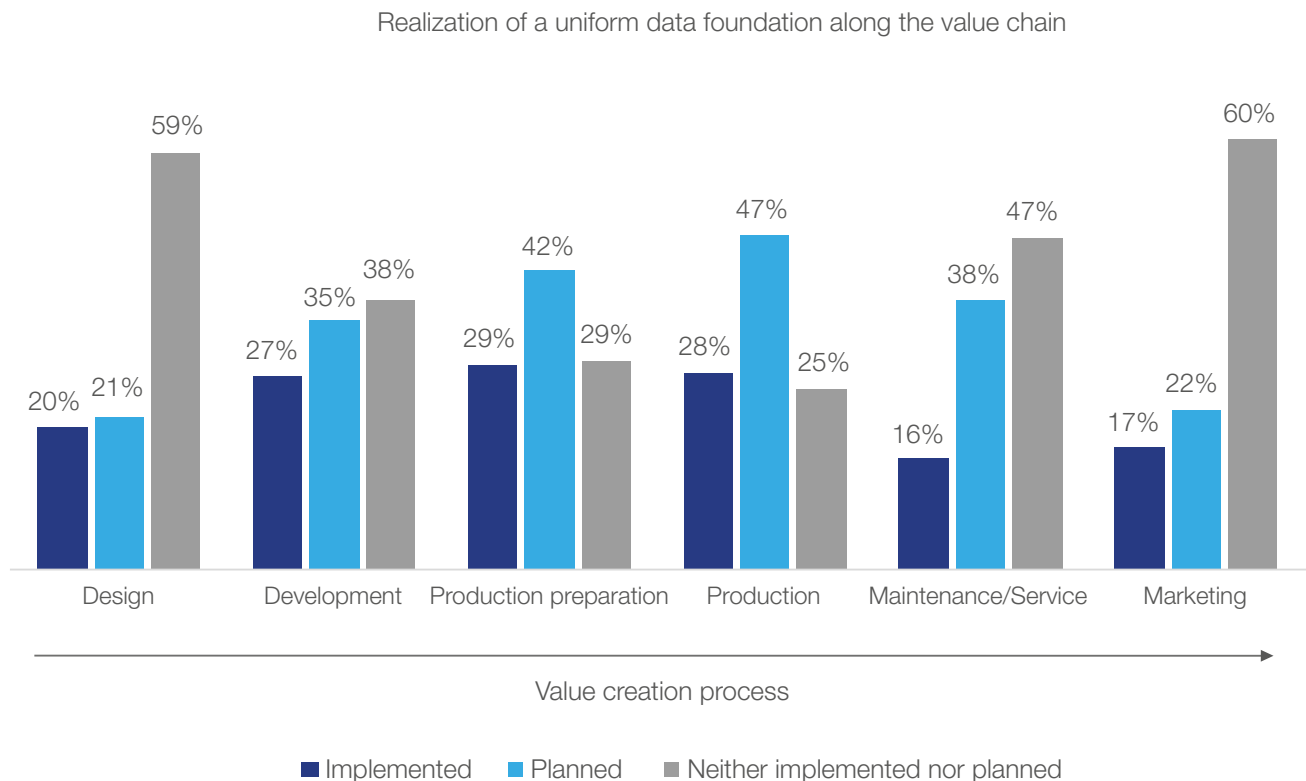
Nevertheless, most enterprises are keen to act and get rid of the existing departmental data silos. Departments closely related to production especially should have access to a consistent database to permit faster feedback between development, production and operation or maintenance.

Only 5% of industrial enterprises maintain a central data platform that networks all departments in the value creation process.

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FIGURE 5

Enterprises aim to promote information exchange between departments involved in production

Realization of a uniform data foundation along the value chain

Value creation process

■ Implemented   ■ Planned   ■ Neither implemented nor planned

Q: In which areas is data base convergence implemented or planned?
N = 174

Source: IDC, 2016

> *"Focusing on system standardization alone isn't the answer; it's not cost-effective. So aside from standardization, introduction, migration through to a central platform are helpful. The benefits of a central platform are lower infrastructure and operating costs."*

Dr. Thomas Kaufmann, VP Automotive Division, Supply Chain & Production Management, Infineon Technologies AG

Many enterprises therefore begin by improving digital continuity in processes closely related to production and then, in a second step, extend their activities to include related areas such as design or marketing. This procedure makes sense since the greatest potential lies especially in closer, more efficient collaboration between engineering and production. For instance, information on wear and tear or rejects can be fed back faster to development and taken into account in future products. The third and final step goes beyond the bounds of the enterprise: realizing digital continuity with the entire economic system of partners, customers, and suppliers.

The challenge is a frequently heterogeneous system landscape, which stands in the way of standardization and data exchange. Building a standard data platform addresses precisely this challenge. However, a major solution is not always the right choice in every situation. This is particularly true in cases where time is scarce and too short to allow for migration. Focusing on the interoperability of core systems may then be a sensible course. At the same time, an increasing number of industrial companies are opting for cloud provisioning models as part of their Industry 4.0 initiatives, especially when the focus is on implementing projects quickly and flexibly.
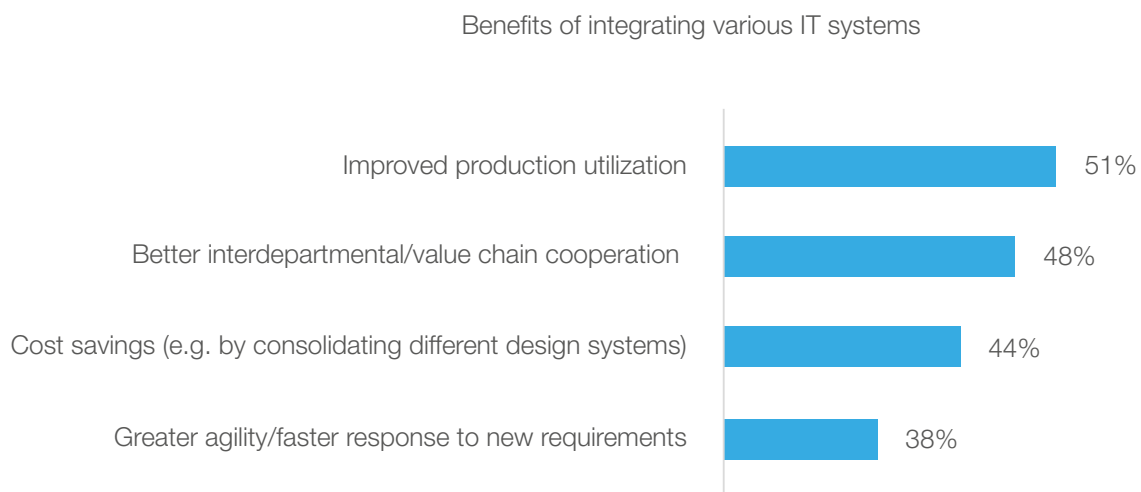
Digital continuity for enhanced efficiency and agility

Exchanging information between systems and the digital availability of documents are crucial factors of success for digital transformation. The compressor manufacturer Kaeser, for instance, decided to realize the paperless factory. In future, assembly plans will be available digitally in the form of 3D visualizations on stationary or mobile devices. A standard machine interface — i.e., machines and measuring instruments connected to a standard system — is part of the package.

The benefits of digital continuity are legion. One in two interviewees expects improved production utilization and enhanced efficiency in the manufacturing process. At the same time, 48% of interviewees are confident that interdepartmental cooperation will improve through the avoidance of media breakdowns and information loss. Finally, closer coordination along the value creation process enables enterprises to respond more agilely to new requirements and thus serve customers faster. So it is plain that pushing ahead with digital continuity is worthwhile for enterprises, and becomes all the more vital for the realization of a smart factory.

FIGURE 6

One in two interviewees expects improved production utilization thanks to a more intensive exchange of information

Benefits of integrating various IT systems

Improved production utilization	51%
Better interdepartmental/value chain cooperation	48%
Cost savings (e.g. by consolidating different design systems)	44%
Greater agility/faster response to new requirements	38%

Q: Which benefits would you expect in your enterprise from integration of various IT systems?
N = 200; Multiple answers, figure abbreviated

Source: IDC, 2016

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The next stage: Tapping digital use cases with wearables and augmented and virtual reality

The availability of digital drawings, plans, and real time information opens up new possibilities for employees in the various departments. Wearable devices and augmented and virtual reality play a key role in this aspect. Smart glasses and augmented reality for service engineers, smart watches prompting production line mechanics about the next part for processing or the use of virtual reality in design are no longer a vision, but reality today.

Interviewees also recognize the potential of these technologies:

- **55%** expect that superimposing information onto a machine via **augmented reality** will greatly simplify the work of **service engineers**

- **55%** expect that superimposing information onto a machine via augmented reality will greatly simplify the work of service engineers

These innovative use cases may come to represent a milestone in process optimization, setting enterprises apart from competitors. So it is logical that one in three industrial enterprises aims to deploy wearable devices and AR/VR in the production and engineering environment in the coming three years. It is the next logical step in digital continuity.

DIGITAL TRANFORMATION: SUCCESS FACTORS AND BEST PRACTICES

Some obstacles need to be tackled on the way to Industry 4.0. The IT, engineering, and production interviewees have different views of the challenges. IT regards harmonization of the various systems and data sources as the main stumbling block. They need to get down to integrating IT and operations technology (OT) so that networked machines and systems can swap data. The main obstacle from a production point of view is departing from established structures and processes that often defy flexibility and agility. Development decision-makers regard implementing innovative projects especially difficult without compromising operations.

TABLE 1

Security, complexity and finance are the key success factors in digital transformation projects

The three main challenges involved in turning Industry 4.0 into reality

IT	Production	Engineering
Integration of various data sources	Ensuring data security and protection	Managing emerging complexity
Ensuring data security and protection	Breaking down established structures and procedures	Financing implementation
Managing arising complexity	Financing implementation	Implementing projects without compromising operations

Q: What are the three major challenges to turning Industry 4.0 into reality?
N = 184

Source: IDC, 2016

The major challenges to turning Industry 4.0 into reality:

27 % Integration of various data sources

24 % Financing implementation

24 % Technologies not mature enough yet

23 % Managing arising complexity

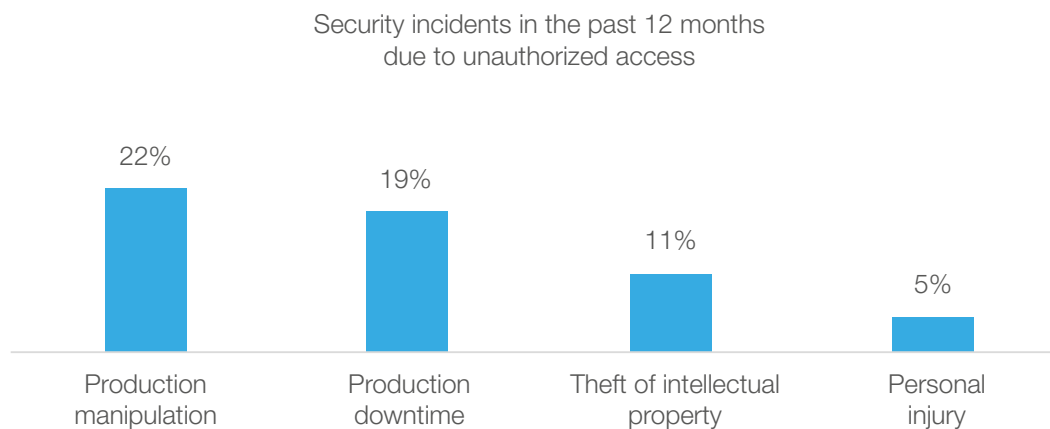**22 %** Ensuring data security and protection

However, there are three aspects that all departments regard as major challenges. They are maintaining data protection and security, managing the existing complexity and financing implementation. Successful digital transformation mainly depends on whether industrial enterprises manage to develop solutions for these challenges. These aspects must therefore be regarded as strategic success factors and addressed at an early planning stage.

Inadequately secured production systems are potential show-stoppers for Industry 4.0 projects. Besides financial damage, the risk looms of legal consequences or a tarnished image. Developing a concept to protect their corporate data is therefore more vital than ever for industrial enterprises.

Production companies are already grappling with security incidents caused by unauthorized access, which occurs with alarming frequency. Results show that qualms about security in relation to Industry 4.0 are not just a figment of "German Angst." Cyber criminals are increasingly targeting vulnerable industrial enterprises in the throes of digitization. Enterprises must therefore urgently address security aspects and include them in their plans from the outset. The implementation of Industry 4.0 projects makes comprehensive security measures all the more imperative.

FIGURE 7

There are already a number of alarming security incidents due to unauthorized access

Security incidents in the past 12 months
due to unauthorized access

Production manipulation	Production downtime	Theft of intellectual property	Personal injury
22%	19%	11%	5%

Q: Have there been any security incidents in your enterprise due to external culprits in the last year?
N = 99; only factory operators

Source: IDC, 2016

"*Digitization know-how is called for more than ever and teams must develop a feel for the potential of software and data.*"

Dr.-Ing. Walter Koch, Head of R&D Processes, Schaeffler AG

Besides ensuring data protection and security, the availability of qualified staff is an important success factor for Industry 4.0. No matter whether IT, engineering or production, digitization know-how is required in all areas. Industry 4.0 demands new skills from employees that must be fostered through courses and further training. At the same time, young employees with a completely different professional background and high IT affinity are coming forward. Schaeffler, the automotive and industrial supplier, therefore attaches importance to the smooth interaction of employees with many years of practical experience in production and an increasing number of younger, digital-native colleagues joining Schaeffler.

The skills of young professionals are in demand: around one-third of the interviewed enterprises has created a new post related to Industry 4.0. So currently there can be no talk of job killing. Quite the contrary, new job roles such as data scientist are created. One thing is plain, though, digitization will fuel the "war of talents."

High time: Enterprises fix organizational and financial lines

Besides suitable technology, enterprises must also adopt the right organizational measures to successfully set their course for Industry 4.0. This primarily includes defining responsibilities and assigning tasks.

At Schaeffler, for instance, the post of chief digital officer (CDO) was created in 2015 with responsibility for the company's digitization strategy. The enterprise's fields of action for digital development are defined in a digital agenda. Henkel also set up a digital task force to foster and develop digitization.

More than 50% of industrial enterprises have now appointed dedicated Industry 4.0 managers or teams who devise the road map, coordinate projects, and act as point of contact for departments. Their number is clearly growing — up 16% compared to last year. So, increasingly, enterprises are recognizing the need for an over-arching approach. Project success rates increase significantly when representatives from all value-adding departments are involved.
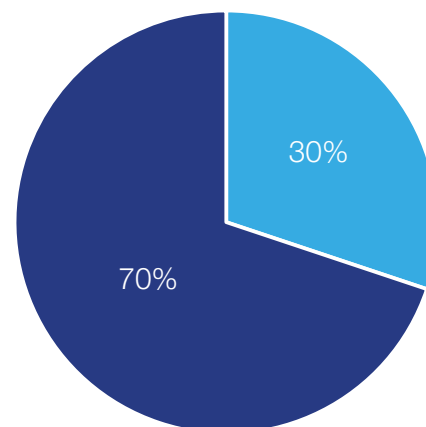
FIGURE 8

Around a third of the industrial enterprises created an Industry 4.0 job last year

Do you have dedicated Industry 4.0 managers or teams?
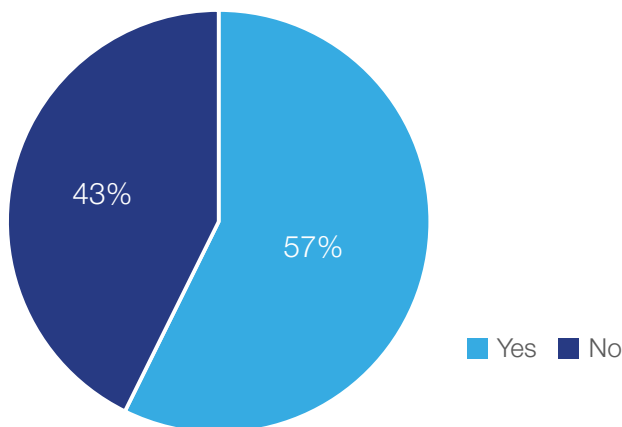
Has a new post for an Industry 4.0 manager been created in your enterprise over the past 12 months?

43%
57%
■ Yes ■ No

30%
70%

N = 200

Source: IDC, 2016

At the same time, budgets must also be defined for Industry 4.0 managers or teams to forge ahead with digital transformation projects. The number of enterprises with Industry 4.0 budgets is rising steeply. While only 23% made provisions two years ago, more than two-thirds of plant operators are doing so this year. A significant increase can also be identified for factory suppliers.

So, it is clear that enterprises are not only adopting a technological approach to Industry 4.0, but are also staking out the organizational and financial parameters. The air of change is more noticeable than ever.

FIGURE 9

Planned Industry 4.0 budgets by factory operators has trebled compared to 2014

Planned Industry 4.0 budgets by German industrial enterprises

■ Factory operators   ■ Factory suppliers
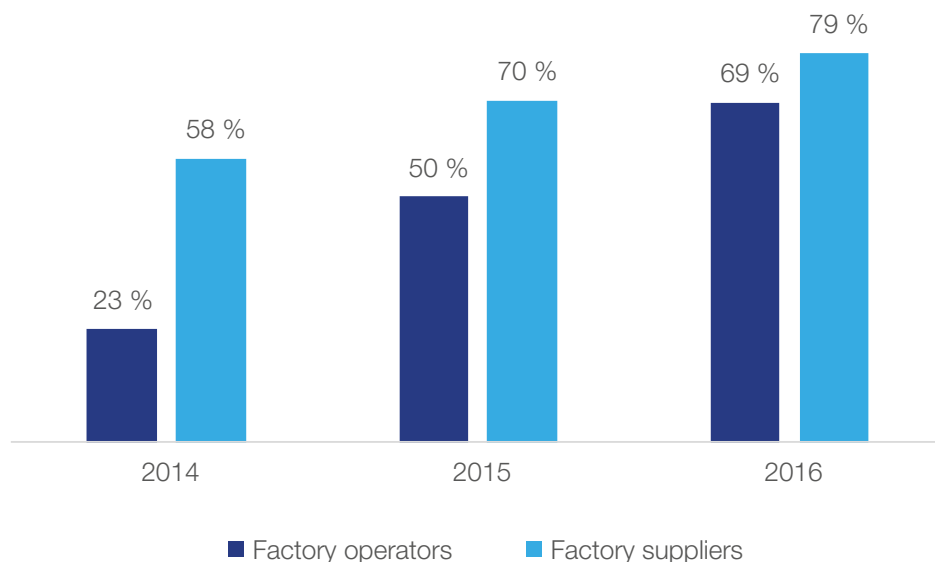
Q: Will there be a budget for Industry 4.0 initiatives in the upcoming year?
N = 211 (2014), N = 201 (2015), N = 200 (2016), weighted according to 2014

Source: IDC, 2016

Departments and IT: Transformation only works in tandem

Industry 4.0 calls for much closer coordination and cooperation along the value creation process. There will be very few enterprises that do not need to do anything in this area. Three experts describe how the following best practices helped improve interdepartmental coordination.

> *"Employees from the departments are directly involved in pilot projects from the first so that they understand it right away and can later act as experts during the rollout."*
>
> **Wolfgang Weber, Corporate Director Supply Chain, Henkel Global Supply Chain B.V.**

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"Employees can develop ideas in so-called 'Innovation Communities' and once matured to a certain degree may result in projects. A process that also strengthens employees' personal initiatives."

Dr. Thomas Kaufmann, VP Automotive Division,

Supply Chain & Production Management, Infineon Technologies AG

"Implementing new use cases with regard to increasing networking is not so much a problem of technology, but the internal corporate culture. Intensive interdepartmental cooperation comes to many as a culture shock. An internal change process has to take place."

Falko Lameter, Head of IT Organization, Kaeser Kompressoren SE

Best practices supply good ideas on how to strengthen cooperation between IT and departments. Activities should center around an intensive regular exchange of ideas that is actively cultivated and firmly established in the organization. And it is not just about defining processes and work flows. Enterprises should promote the involvement of interested parties in Industry 4.0 competence centers to take digitization subjects to the next level, by allowing IT, production or engineering employees to discuss subjects on an equal footing and develop pilot projects. A open error culture is a very important aspect. One thing is sure, all departments must make a greater effort if they are to stay on top of future tasks. It is the only way to make a success of transformation.

CONCLUSION

Digital transformation affects every industry in Germany. The manufacturing sector has held itself aloof from this change process for too long. However, there is a wind of change in the industry, reviving it from its lethargy. And it is high time to catch up lost ground. It is plain that enterprises must act now if they want to be successful in the future and not be outstripped by competitors.

Last year a growing number of pioneer enterprises showed what Industry 4.0 can do. However, the transformation process is not finished, even for them. Lower production costs, better customer centricity and a higher level of automation drive their digitization efforts. The innovation dynamic is fast-paced and if you don't go with the flow, you will be left behind.

Industry 4.0 does not just result in a smart networked shop floor, however, but also fundamentally changes cooperation all along the value creation process. There is huge potential for optimization: information is lost along the value chain in around 50% of enterprises. The realization of digital continuity will therefore impact significantly on time-to-market and revenue targets.

Despite the perceptible mood of change, the potential risks must not be neglected. This applies in particular to the subject of data protection and security. Digitization must be paired with state-of-the-art security concepts. IT is called upon to give shop floor IT the benefit of its experience and team up with them to ensure the ruggedness of solutions.

The upcoming months and years will bring exciting changes and chances for industrial enterprises. However, amid all the new technologies, processes, and business models, a key factor must not be neglected: the human factor. Yet Industry 4.0 is not currently the job killer many expected — quite the contrary. Nevertheless, involving employees in this change process will be at least as much of a challenge as the technological implementation of Industry 4.0.

RECOMMENDATIONS

1. **Set your organizational course for Industry 4.0.** Define responsibilities and form interdisciplinary Industry 4.0 competence teams. Interdepartmental exchange not only makes sense from a creative point of view, but also promotes departmental acceptance of the final project implementation.

2. **Do not pursue digitization as an end in itself.** Define fields of action for your enterprise in which Industry 4.0 can generate added value. It is about better achieving corporate goals through innovative technologies and processes. Foster and encourage projects in these areas: start small, think big and scale fast.

3. **Do away with the data silos in departments.** Data volumes and diversity are set to rise rapidly as a result of Industry 4.0. Seamless cooperation based on digital information and documents will thus be even more crucial. Achieving digital continuity is therefore essential to take value creation process coordination to the next level.

4. **Show your employees the way.** Courses and further training are urgently needed for employees to keep the German manufacturing community in a competitive position. So encourage digital know-how in the workforce with targeted development measures. Also encourage an exchange process between younger and older colleagues to capitalize on different experiences.

5. **Create a balance between innovation and security.** And enjoy the rewards of risks. Incorporate measures to ensure data security in your Industry 4.0 projects from the first. Consider concepts like Security by Design, whitelisting or Trusted Computing and raise user awareness of potential risks.
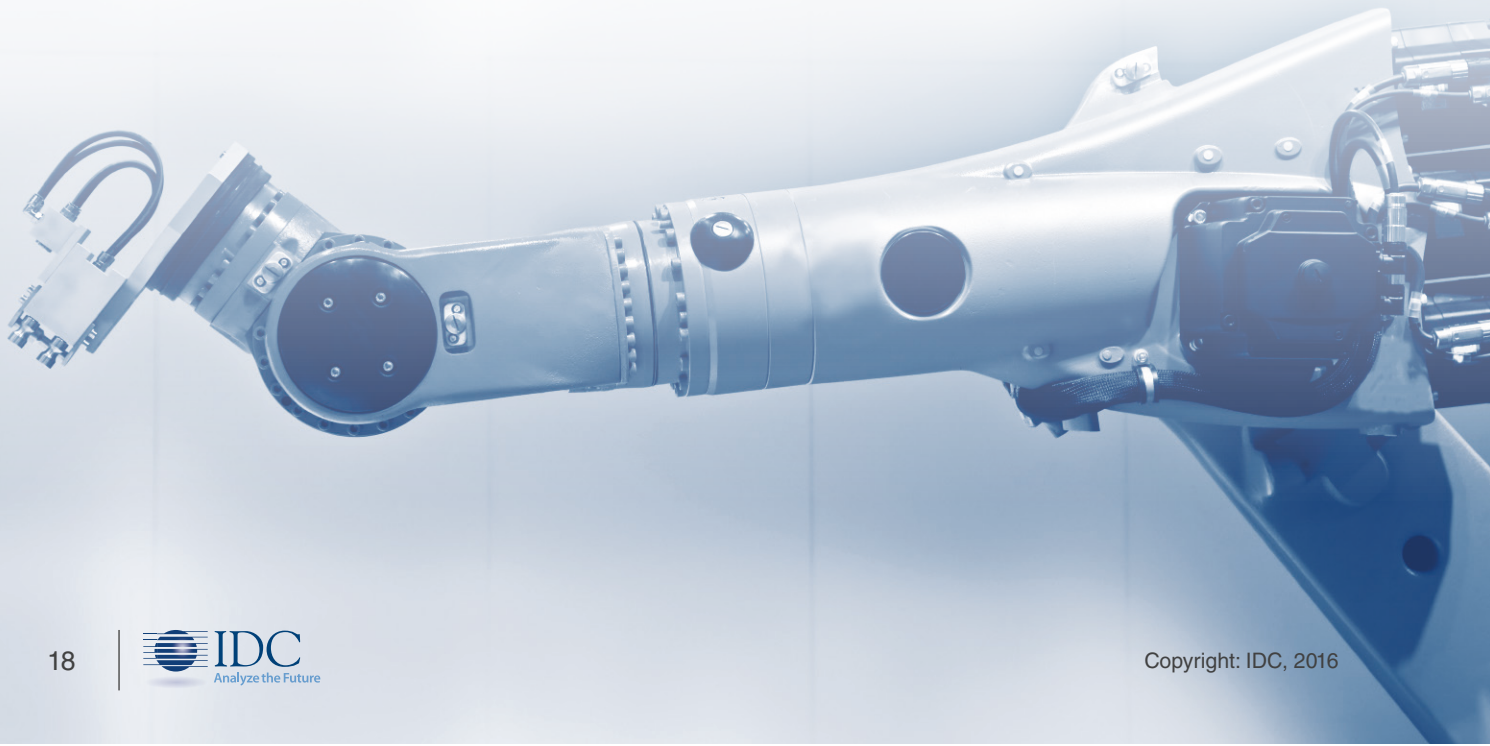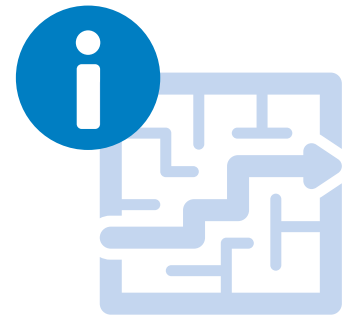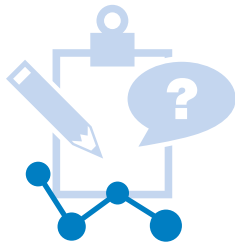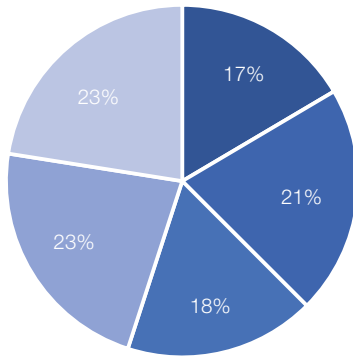
METHODS

This White Paper is based on a survey of 200 enterprises in Germany's manufacturing sector in August 2016. Meetings with experts from industrial enterprises were also conducted. The survey random sample is spread as follows:
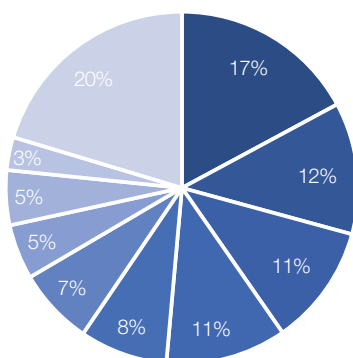
Employees

17%
21%
18%
23%
23%

- 100–249 employees
- 250-499 employees
- 500-999 employees
- 1,000-4,999 employees
- 5,000 employees and over

Focus of activity

50%
50%
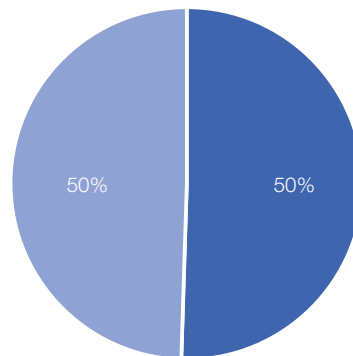
- Factory suppliers
- Factory operators

Industry

17%
12%
11%
11%
8%
7%
5%
5%
3%
20%

- Automotive
- Chemical products
- Metal production and processing
- Electronic and optical equipment
- Rubber and plastic goods
- Paper, cardboard and products thereof
- Pharmaceutical products
- Furniture
- Food and animal feedstuffs, drinks
- Miscellaneous

Department

11%
24%
24%
23%
19%
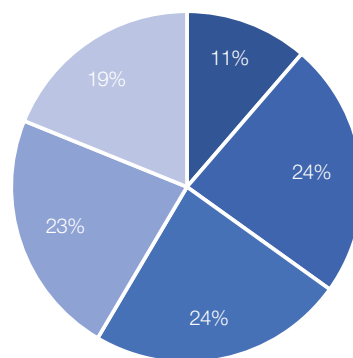
- Production
- IT
- Engineering
- Production control/Quality assurance/Maintenance
- Logistics/Warehouse

Abweichung von 100% durch Rundung

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