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Challenges and Opportunities in the Smart Machine Industry

A benchmark of the digital maturity of products and processes in machine manufacturing in Belgium

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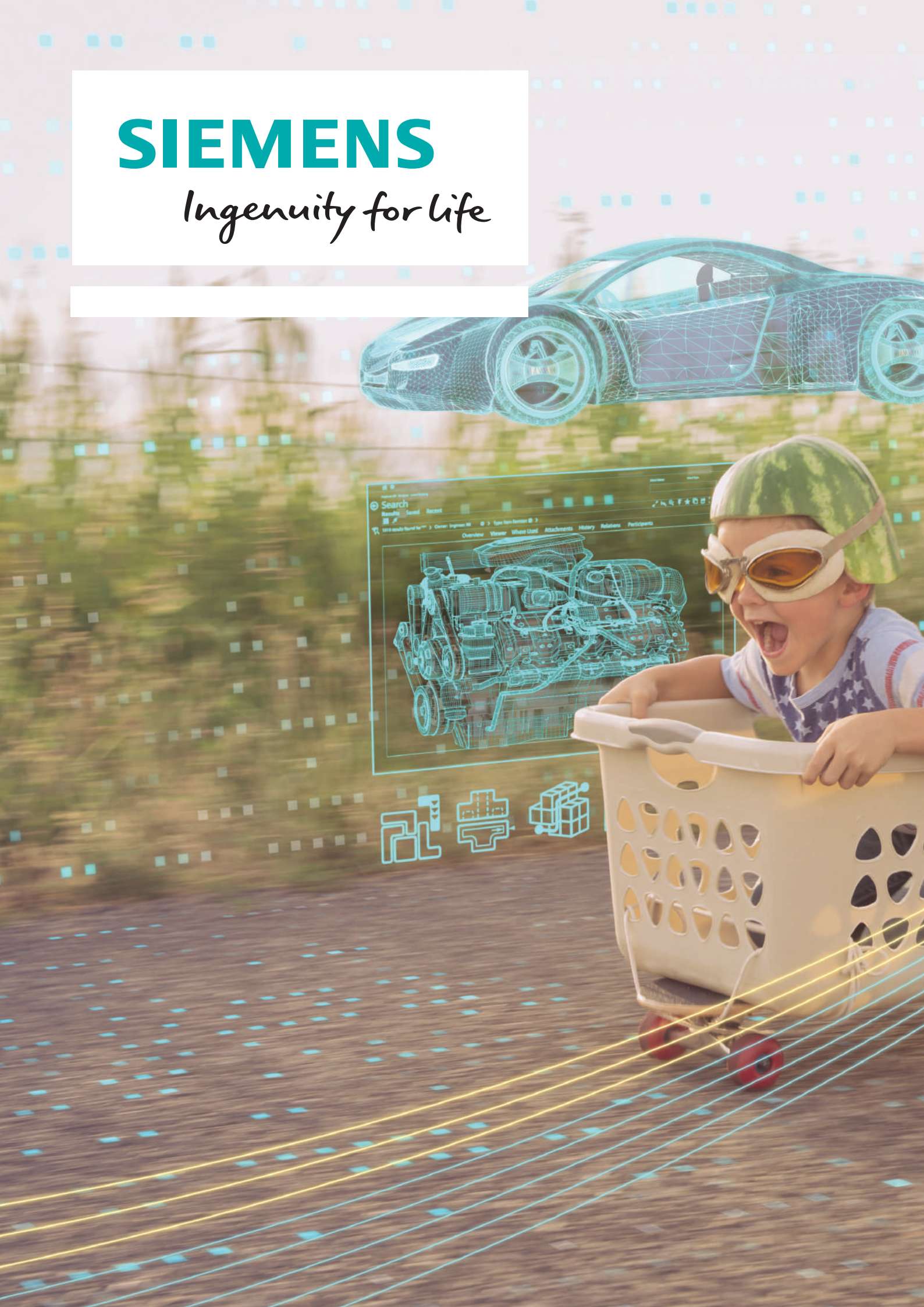

A benchmark of the digital maturity of products and processes in machine manufacturing

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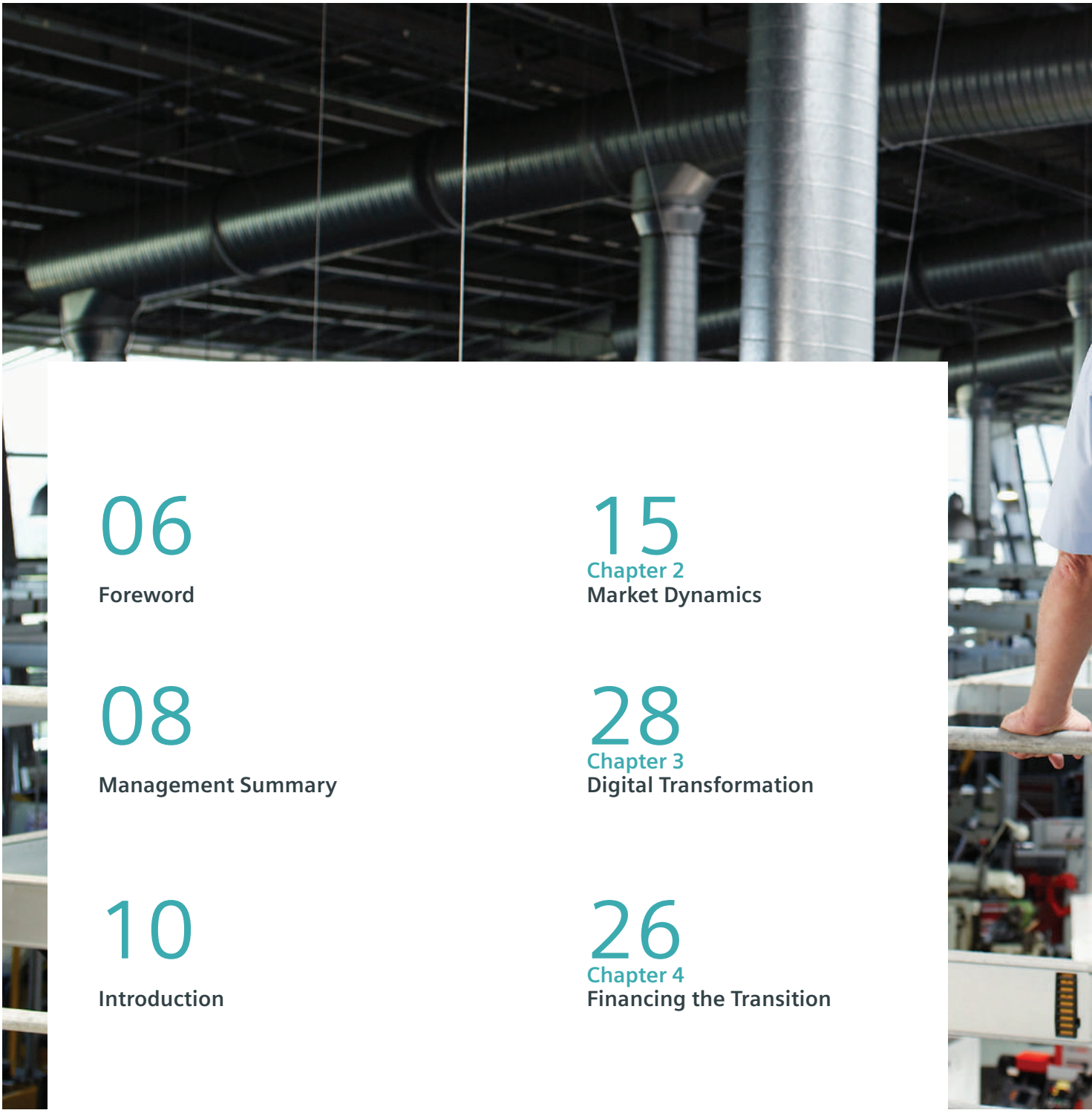

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Foreword

Machine manufacturing is in the middle of an industrial revolution. In what is now being called the Smart Industry, there is a digital transition taking place in both product and process that is upending the way companies compete in the market.

Technological advancements are creating machines that are 'smarter' than ever before. Enhanced with sensors and software and connected to the internet, machines can now be controlled remotely. This Internet of Things (IoT) is presenting machine manufacturers with an opportunity to develop new products and services based on data collection.

Production processes are also becoming smarter, using advanced software for virtual prototyping in the design phase, for instance, or running simulations in parallel with the physical construction (Digital Twin). These processes allow the design of a machine to be tested and readied for production at a much earlier stage of development (Virtual Commissioning). Such smart processes are important for meeting the demands of ever-shorter time to market and product life cycles.

The impact these developments have on the industry is growing fast. Machine manufacturers who embrace the concept of the Smart Industry will be better equipped to react to new customer demands such as offering product options in the form of modules. This modularization makes production capacity more flexible and lowers costs. Innovative manufacturers are also better at creating new business models. They can deliver innovative remote services, for example, and offer machines on the basis of performance or pay-per-use and not just for sale as has traditionally been the case.

How advanced are machine manufacturers in their digital transformation? Is there a sense of urgency? What are their priorities? How quickly are they adopting new technologies? Do their employees have the right skills? Are they in a position to change the entire process from design to manufacture and service all at once? What kinds of collaborations are they participating in? And are they agile enough to react effectively to changing trends?

These are the questions we are looking to answer with our benchmark survey of a large number of machine manufacturers based in Belgium. The results provide clear insights into the challenges and opportunities in the transition to a Smart Industry company. We also identified organizations that are leading the way and doing things differently. We hope you find plenty of wisdom and inspiration from the information in this report to help strengthen your own business. And finally, we would like to thank each of the companies that participated in our survey for their time and effort in helping us with this research.

This report was created in collaboration with our trusted solution partners cards PLM Solutions, Adopt id PLM and PLM-S.

January 2019

Dr. Jan Leuridan

Senior Vice President
Simulation & Test Solutions
Siemens Industry Software


SIEMENS
Ingenuity for life
Driving the Digital Enterprise

Management summary

Business Strategy

Executives of machine manufacturers are chiefly concerned with product innovation (49%) and customer satisfaction (47%). In addition to this external focus, their internal priorities are improving productivity (41%) and lowering costs (32%). Digital transformation and business innovation receive relatively low scores (19% and 15%, respectively). Thus, there is little focus on the resources that will help them reach their internal and external goals. The biggest operational challenge for management is reducing time to market (47%). This requires faster sourcing of parts, but improving multidisciplinary collaboration also plays a significant role. This is a challenge for 31% of respondents. Connecting machines to the internet (IoT) was mentioned by 28% of the participants in the survey.

Market Dynamics

When we look at the challenges and opportunities that influence a machine manufacturer's position in the market, the top three correspond closely with management's priorities. At the top of the list is customization and differentiation (55%), with reducing time to market in second place (41%) and delivering the most innovative products in third (37%). Innovation that relies heavily on technology forms the foundation for new business models. This is something that disrupts a lot of markets. Currently, the majority of machine manufacturers are seeing this happen in their markets, yet a remarkable 48% is unable to say whether their customers' markets were also being disrupted by innovations. However, nearly half would describe themselves as innovators and early adopters in the use of new technology.

Digital Transformation

The use of smart sensors has had the greatest influence on business operations (43%). The rise of the Internet of Things, which often includes connectivity of sensors, was ranked third. Also expected to significantly influence business models are Artificial Intelligence and Machine Learning, certainly according to the companies that are most advanced in their digital transformation. The tools that machine manufacturers tend to focus on are mostly aimed at the design process (CAD/CAM) and less at more advanced innovations like mechatronic system simulation. The biggest advantages in the manufacturing process are expected to be found in production engineering and product design (41%). For the digital leaders, it is the IoT that is expected to have the largest impact on business processes.

Financing the Transition

More than half of the companies surveyed are seeing a (partial) shift in either their own markets, or those of their customers, from ownership to usage. An example of this is offering machines as a service on a pay-per-use basis. Still, most continue to offer the traditional sale option (86%), some in combination with maintenance contracts. It is important to note here that machines can often be a one-off, which makes it difficult to offer standard as-a-service contracts. Also, the application of smart devices and IoT is still in its infancy, so remote management is often not possible.

Business Agility

Agile companies have horizontal organizations and work with multidisciplinary teams. They make use of an integrated IT architecture that gives everyone real-time access to all relevant information. In addition, these companies tend to focus more on assembly than on manufacturing, and on specialization and backward integration in the supply chain. Most machine manufacturers still have work to do in these areas and have made little progress in their digital transformation to a Smart Industry. They do, however, realize that an innovative work environment is the key to finding and keeping talented employees. And improvements are underway, as nearly three quarters of the companies surveyed have already mapped out a strategy for modernizing their process applications.

Smart Industry Companies

An analysis of the research results reveals a distinct group of companies that are leading the way in digital transformation. These companies are able to standardize their processes to reduce costs, while achieving a high level of customization that guarantees customer loyalty as well. They give a higher priority to digital transformation and business innovation than the rest. They are far ahead in adopting new technology and often use this to develop new business models. They are also more likely to have implemented an integrated IT system, work in multidisciplinary teams in a horizontal organization and take on a leadership role in the value chain. This group is clearly already a part of the Smart Industry.

Introduction

This report contains the principle results of our benchmark survey of machine manufacturers in Belgium. The survey consisted of an online questionnaire that also included several hypothetical statements which resulted in very interesting and insightful responses. Research took place from September 28 through November 29, 2018.

Target audience and response

The target industry for the research was machine manufacturers in Belgium. Persons responsible for automating the manufacturing process at each of the companies contacted were invited to participate in the survey. Nearly 90 people took the time to fill out the questionnaire. The high level of response is a good indicator of just how important the Smart Industry is in machine manufacturing.

Respondent's positions within the company

A majority of the respondents (60%) fills a management role within the key operational areas of machine manufacturing (e.g., operations, engineering, process and production management). Another quarter of the respondents is C-level executives (i.e., general/managing, technical or financial officers). Nearly 15% of respondents is CEO.

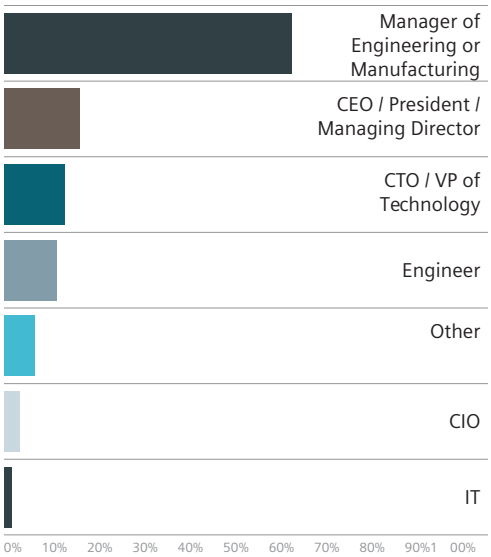
Relationship between company size and position

Respondents in the survey represent a balanced mix of company sizes from small enterprises to medium and large organizations. Half of the respondents in C-level positions work for smaller companies (less than 100 employees). Of the mid-sized and larger companies that participated, the number of C-level respondents is between 20% and 25%. Participants from mid-sized companies are mostly managers of engineering, production, processes, and operations.

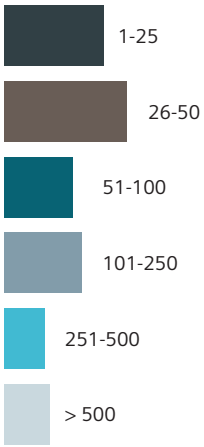
The contents of this research report

In the first chapter, we review the business strategies of machine manufacturers and the impact these have on their operational focus. The second chapter highlights the market dynamics, including the adoption of new technologies. In the third chapter, we take a closer look at the methods and techniques that make digital transformation possible. The fourth chapter discusses financing the transformation in relation to the development of new business models. In the final chapter, we look at the organizational and technological aspects that dictate a company's level of agility.

What is your role within the company?



How large is your company (in FTE)?



Chapter 1
Business Strategy

Machine manufacturers know exactly what they want to achieve, but how to make that happen is less clear.

"Digital transformation and business innovation score low on management's priorities, with 19% and 15%, respectively."

A focus on innovation, customer retention and productivity

Machine manufacturing executives are concerned most often with product innovation (49%). This is not surprising given the fact that the range of technological possibilities is growing fast, especially in the areas of IT and mechatronics. Management is also focused on customer satisfaction and retention (47%). Their customers want to take advantage of new possibilities, especially when the market is highly competitive. Even machine manufacturers that operate in niche markets with relatively limited competition are compelled to innovate continuously to keep up with the demands of their largest clients. Machine manufacturers also understand that their competition is not sitting still. In addition to this external focus, they are most likely to concentrate on improving productivity (41%) and reducing costs (32%) to stay profitable and have enough funds available for innovation. We will see later in this report that many of the companies have room for improvement when it comes to efficiency across departments and processes.

Digital transformation and business innovation are underappreciated

Digital transformation and business innovation both score relatively low at 19% and 15%, respectively. This is somewhat puzzling, since it is exactly the use of new technologies that brings more opportunities for pulling ahead of the competition and developing new business models. From conversations with machine manufacturers, it is clear there are significant external factors that determine to a large extent how much progress a company can make in its digital transformation. Innovations can sometimes be implemented too quickly for customers. Sometimes it is a lack of clarity on the market potential that limits new products. Also, many machines are custom-made for individual customers who dictate the exact specifications. Moreover, not all customers understand the value of sharing data with a machine's manufacturer, in improvements or offering new services, for example, and security concerns can often be an issue as well.

Which of the following priorities are currently on the agenda of the management in your company?

Priorities management agenda	
Product innovation	49%
Customer satisfaction and retention	47%
Increasing working productivity	41%
Reducing business expenses	32%
Creating a more agile organization	25%
Digital transformation (digitizing current proposition, operations, customer service)	19%
(International) expansion	17%
Employee satisfaction and retention	16%
Business innovation (new sales or service propositions, new sales channels)	15%
National and/or international revenue growth	5%

Challenge: shorter time to market and more collaboration

Advancements in machine manufacturing happen quickly and the competition is fierce. This explains why 47% of the companies see decreasing the time to market as their most important challenge. For a company to be able to move quickly, improving their ability to collaborate between departments and disciplines is essential. This is an important challenge for 31% of the companies. Survey respondents believe, for example, that service engineers should be more closely involved in the design process to bring in experiences from the field. Ranking third on the list of priorities (28%) is connecting machines with the internet (IoT). Assembling machines from modular components ranks further down, in fifth place. Less than a quarter of respondents named modularization as a priority, even though it can significantly reduce both costs and time to market.

Which challenges in the machine manufacturing industry play an important part in setting those priorities?

Challenges machine manufacturing	
Shorter time-to-market translating to faster production processes	47%
Facilitating cooperation between departments and disciplines	31%
Connecting machines to the internet (Internet of Things)	28%
Attracting and retaining new talent (human capital)	26%
Simplifying delivery on customer specifications by developing modular machines	25%
Application of more software across the machine manufacturing process	20%
Succesful application of data (Big Data)	19%
Coordination and cooperation in the supply chain	18%
Privacy/security of connected or intelligent machines	10%
Integrating physical and virtual production areas	5%
Moving from traditional to service-based pricing models (Pay-per-Use)	3%

"We see that machine manufacturers focus more on the 'what' (the goals) than on the 'how' (the means) of making the digital transformation."

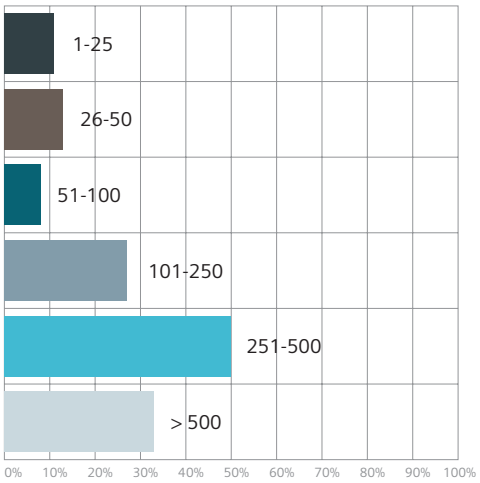
The goals are clear, but the means are still to be determined

We saw earlier that machine manufacturers give priority to innovation and cost reduction. However, they are much less focused on the things that can help them achieve those goals: digital transformation, business innovation and modularization. The maturity level in the Smart Industry is still quite low, and not enough advantage is being taken of the opportunities it offers. In the following chapter, we will see that there is a distinct lack of an integral digital strategy for achieving strategic goals. In addition, many suppliers do not even have an adequate supply of intelligent components on offer. Coordinating and integrating new standards and protocols also takes too much time, making it difficult to keep up with advancements in innovation.

Business size dictates prioritization of digital transformation

Larger companies tend to give higher priority to digital transformation. For these companies, the use of Big Data and Artificial Intelligence have the greatest impact on their business operations. They also make use of more tools than other companies. Smaller companies lead the way in the adoption of new methods and technologies. The higher the position of the respondent within the company hierarchy, the more positively they tend to rate their company on progress toward digital transformation.

Business size in relation to prioritizing digital transformation



Chapter 2
Market Dynamics

Machine manufacturers are quick to adopt new technology but often have little grasp of whether their market is being disrupted.

Focus on customization and speed of delivery

Customers continue to make more business-specific demands on what machines can do, but this should not be allowed to undermine profitability. The solution to this is 'mass customization,' or standardization based on component parts. We see this in the responses to the question of which industry trends have the greatest influence on the competitive position in the market.

Number one in the ranking is customization and differentiation (55%). The trend of buyers being able to choose their own product components is already visible in other markets (design your own athletic shoe, configure your own notebook). The second development in the ranking is the faster delivery speeds and shorter time to market (41%). In short, the industry wants to deliver both standardization (cost focus) and customization (customer focus), but it is difficult to say whether this will still be possible as more and more technology is used in machines and processes. Ranking third, then, is the ability to deliver innovative products (37%).

Which market opportunities and developments have the greatest influence for strengthening your competitive position?

Market opportunities	
Customization and differentiation of customer specifications	49%
Speed of delivery, achieving a shorter time-to-market	41%
Delivering the most innovative products	32%
Further diversification (new markets with new or existing products)	25%
Cost leadership and standardization	19%
Faster implementation of software and making machines intelligent	17%
Successful international expansion	16%
Using data to improve continuity and usage	15%
Financing models aligned with pay-per-use	5%

"If I had asked people what they wanted, they would have said faster horses."
Henry Ford

Many machine manufacturers do not know if their market is being disrupted

Global online and mobile developments are disrupting a lot of markets. Innovation that relies heavily on technology is bringing buyers and sellers together in faster and more transparent ways, creating new business models along the way. Companies such as Uber, Spotify, Netflix and AirBnB are perfect examples. Products are rapidly transforming into services and both companies and consumers are making a shift from ownership to usership. Everything needs to be available anytime and anywhere.

Interestingly, 48% of respondents couldn't say if their market, or their customers' markets, were being disrupted. This group is made up mainly of engineers who probably, because of their profession, have limited insight into the opportunities and threats in the market. Of the remaining companies, 35% see no disruptive developments in their market, while 52% are somewhat affected by disruption and 13% see clear evidence of disruptive developments. Those companies seeing the most disruption, are also the furthest in their digital transition and in supply chain integration.

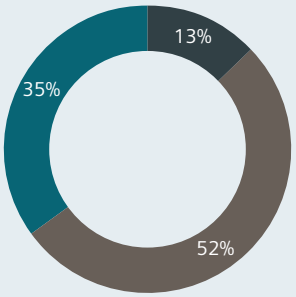
Many machine manufacturers operate internationally and in specific niches, so a new competitor suddenly entering the market with an entirely different business model tends to be less likely. That can also be said for their customers in various production and processing industries. We see more disruption taking place in consumer markets and service industries, such as retail, wholesale or financial services.

And yet, the shorter time to market and higher speed of delivery for customer-specific machines is pushing companies to keep innovating. Developments in their customers' markets create the indirect impression that competition is increasing. Digitalization, globalization and changing consumer behaviors are driving this trend.

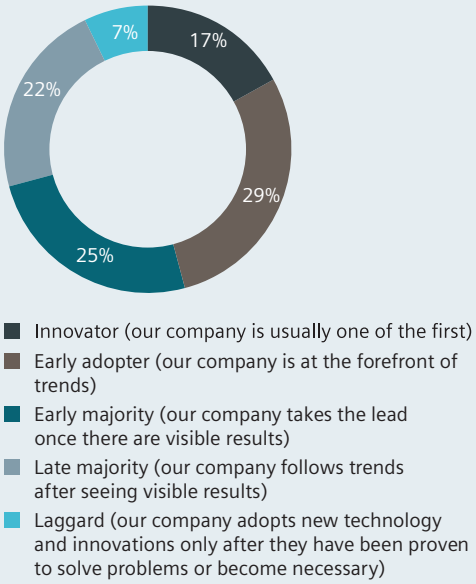
Are machine manufacturers operating at the forefront of technology?

More than 46% of the companies consider themselves in the lead when it comes to the adoption of new technology and innovative opportunities. These companies see themselves as either the 'innovators'

Are your (potential) customers currently affected by developments that signify a disruptive market?



How would you describe your company when it comes to the adoption of new technologies or innovations?



(17%) or 'early adopters' (29%). Nearly 30% would categorize themselves as members of the 'early majority': once a new technology has proven its value, they are among the first group of users. In total, this means that 71% of the companies see themselves at the forefront of adopting new technologies.

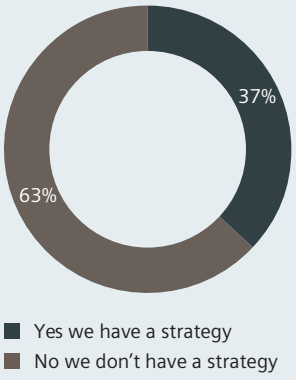
Previously, we saw that 49% of management considers product innovation to be a top priority. The companies that are leading in digital transformation tend to have product innovation in their top three priorities more often than organizations that place themselves in the 'late majority' or 'laggard' categories. For the laggards, operational priorities such as cost reduction tend to rank highest. Judging by these results, it would be fair to say that the leaders have a more external focus while the followers tend to be more concerned with internal goals. Interestingly, there is also a notable difference between how a company rates itself on adopting new technologies and the priority its management gives to digital transformation.

There is seldom a strategy for backward value chain integration

Because of the shorter time to market, there is a need for more speed when sourcing parts and components in the supply chain. There is also a greater need for integration in the value chain to help optimize mechanical and technological coordination. However, a full 37% of the companies have no strategy in place for backward chain integration. In some cases, there is no operational advantage available, but many other organizations have simply not spent enough time considering the possibilities.

Of those companies that do have a strategy in place, 31% operates independently and 16% choose to collaborate through partnerships and joint ventures. Relatively few companies organize a backward integration by producing the components themselves (2%) or acquiring a supplier's business (13%). The business has apparently become too complex for companies to supply everything themselves. Building strong partnerships and paying attention to the ecosystem are crucial.

Does your company have a strategy for more control and gaining direct influence over your supply chain (backward integration)?



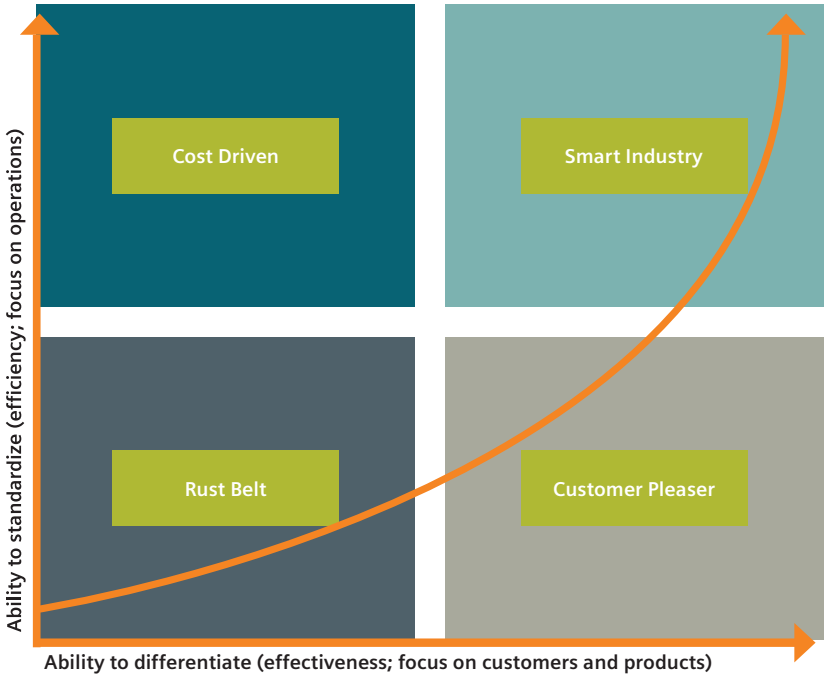
Chapter 3
Digital Transformation

The market demands new forms of connectivity, but machine manufacturers prefer investing in design tools.

The path to maturity in the digital transformation

Some machine manufacturers have been making the same equipment for years and often operate in niche markets where competition is limited. They see little reason to change the way they operate their business. But that could be about to change, if history tells us anything. We need only to look to the example of suppliers of professional dark room equipment for photo studios that saw their market dry up completely within a couple of years once digital photography was introduced, or the more recent development of 3D-printing sending existing production machinery to the scrap heap.

Digital maturity matrix of the machine industry



Businesses that have begun taking steps toward change generally have two choices: standardization or differentiation. When they must compete heavily on price, they often choose standardization, keeping the number of product variations to a minimum so that they can concentrate on process rationalization and efficiency. When their customers are more likely to have specific individual needs for machine configuration, they will choose differentiation.

The problem is that the technological advancements happen quickly, and this makes product life cycles and the available time to market shorter and shorter. Customers want to be able to use the latest technology, but not at any price. The challenge, then, is how to cleverly combine standardization with differentiation to deliver 'mass customization.' This is the basis of the Smart Industry, where digital simulation runs parallel to the physical machine manufacture to speed up and improve the design and delivery processes. It also allows customers to build their own machines by selecting the modules they need. This path to maturity in the digital transformation is explained below.

Leaders versus the rest

Defined in the maturity matrix are four distinct maturity levels. Companies in the Rust Belt quadrant have done little to no digitalization. The Customer Pleasers are focused on opportunities for differentiation so that they can better satisfy their customers. Cost Drivers are concerned only with standardization and increased efficiency to keep costs low and time to market short. Companies in the Smart Industry category have developed the ability to keep costs in check while at the same time preserving customer loyalty. It is this group of companies that are the leaders in digital transformation. In this chapter, we will compare their scores to the rest of the companies in the other maturity quadrants.

Smart sensors and IoT will dictate the business model

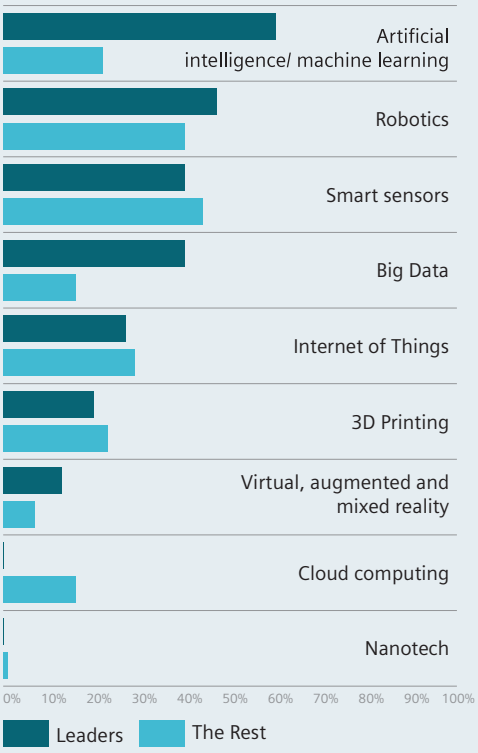
The rise of smart sensors will have the greatest influence on the future business model, according to 43% of respondents. At third place (28%) is the IoT (Internet of Things) whereby sensors are often connected. In second place is the increase in robotics in machine manufacturing (41%). The use of Artificial Intelligence and Machine Learning are also expected to influence the business model, according to 28% of all the companies surveyed. But when we differentiate between levels of digital maturity, we see that a full 60% of the leaders believe these will have a significant impact on their future business model, and 40% also believe these intelligent machines will generate new information streams (Big Data).

Should machine manufacturers dare to lead the charge?

The generally accepted view is that there may be a digital transition happening, but it won't be happening quickly in many of the markets where machine manufacturers are active. Most tend to simply keep up with market demand. "Taking the lead has no use if the customer is not ready for it, but falling behind is also not an option", says one of the respondents. Making use of new technological developments appears to depend on the question of whether customers value it – and if they are willing to pay for it. This can be a dangerous strategy when a technological trend is fast and spreads quickly because it leaves the organization precious little time to adapt. The way to avoid being left permanently behind is to get on board with technological modernization now rather than later.

Only 13% of the companies feel that technological advancements will have no influence on their future operations. This group also expects no changes in the types of expertise needed in their organization. It is machine manufacturers operating in niche markets that expect to have little need for knowledge in new disciplines. Their hardware is the dominant factor and they do not believe that more digital intelligence in machines will bring more value. They base this opinion on the specifications that their customers are asking for.

Which technological developments will have the greatest impact on your company's future business model?



"Preparing for technological advancements now is necessary if you don't want to miss the boat later."

Automation is taking over the design process

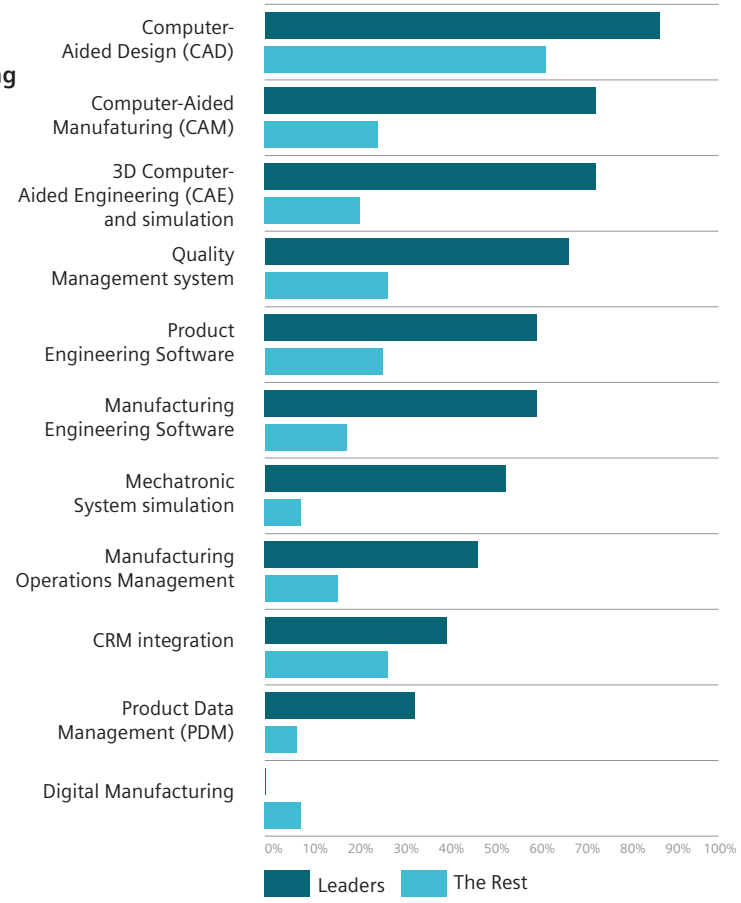
Currently, 66% of the companies have invested in CAD software and 33% in CAM software, and 34% have implemented Quality Management tools. We also see a nearly even divide between engineering, simulation and manufacturing, with a quarter of the companies having already implemented tools in each of these areas. The graph clearly shows that the leaders at the highest levels of maturity in the digital transformation have made much more progress than the rest of the companies. They have implemented, on average, three times as many software tools, including tools for 3D Computer-Aided Engineering.

Integral management of product data will be increasingly important

A company's ability to produce quickly and on a modular basis depends on how well departments can collaborate and whether processes can be integrated. Central to that ability is the use of data. Nearly a quarter of the companies have taken steps in that direction by investing in Product Data Management (PDM) software. A good investment, certainly, as designers, engineers and builders must all have the same timely product data available. This is especially true now that machine components continue to become more integrated with each new wave of innovations. Changes to the design and engineering and feedback from the simulation process all need to be shared across the entire business. The same is true for changes to module specifications. This is because such changes affect every part of the process, from design to purchasing and inventory, and from production planning to service and maintenance.

The conclusion is that the most progress has been made in traditional areas of automation such as CAD/CAM, and less in the more advanced types of innovation that can speed processes, like mechatronic system simulation, model testing and digital manufacturing, for example. The digitally mature companies in the lead are the exception to this conclusion.

Which software tools you have you implemented regarding the technological developments?



Mechatronic System Simulation

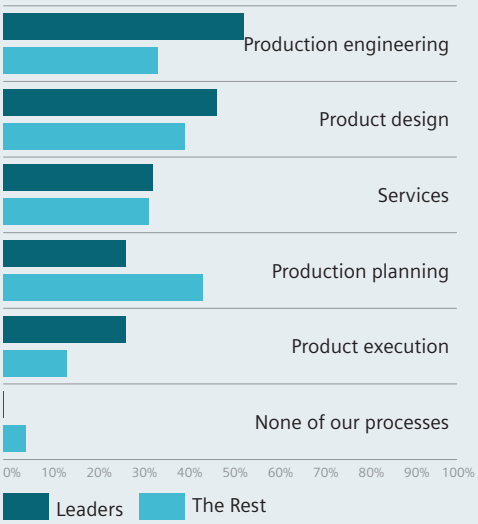
This type of Computer-Aided Engineering is a multidisciplinary approach to modeling and analyzing systems. Using simulation, the electric, hydraulic, pneumatic and mechanical system components can be linked to form an extended schematic model, which speeds up the design process and significantly reduces the risk of errors because everything can be tested simultaneously. Moreover, it also lays the groundwork for better collaboration between all the different disciplines involved in the innovation process.

Room for improvement on nearly every front

According to the respondents, the biggest gains to be had in the machine manufacturing process are in the areas of product design and production planning (both indicated by 41% of respondents). This coincides with the results mentioned earlier, since companies appear to have invested mainly in design software. Planning is also an issue, given the focus of most managers on shortening the time to market and increasing efficiency. It is an operational imperative to coordinate the processes of different departments to help them work better together.

Production engineering is also mentioned frequently. The percentage for the entire group is 38%; for the leaders, that percentage is much higher at 53%. The leaders have also done more to address the challenge of delivering customer specifications through modularization. That requires a broader support of the engineering process, which is where there appears to be much room for improvement.

In which part of the machine manufacturing process does your company expect to (still) realize the most improvement?



"The project hours for software are an increasingly larger part. The total number of hours is also increasing, partly because our machines offer more possibilities."

IoT and smart devices have a mostly external impact

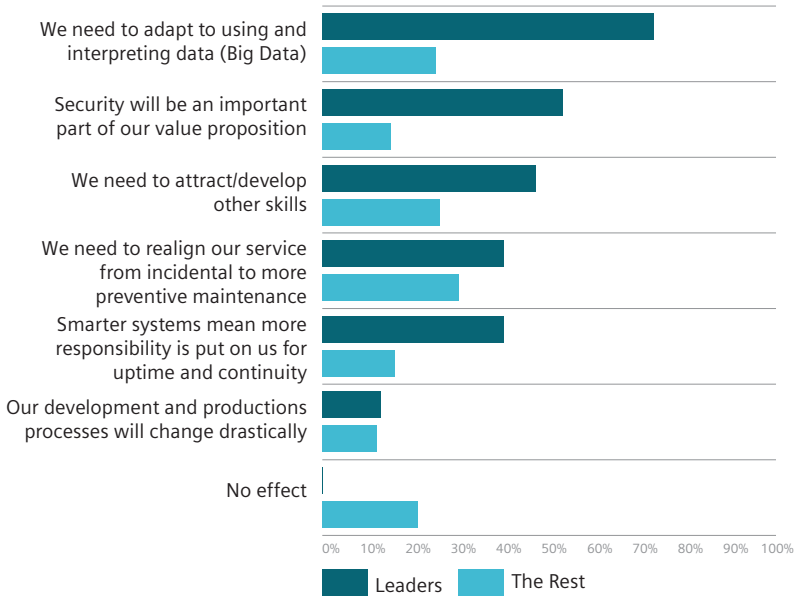
The rise of the Internet of Things and smart devices has an obvious impact on business operations. The top three are: the use and interpretation of Big Data (33%), the shift from incidental to preventative services (32%) and attracting and/or developing new skills (30%). All these activities have an external focus. The effect on internal processes is seen as much smaller (12%).

Thus, IoT and smart devices appear to have the most influence on the front end of the organization. The accent tends to be on services: how can operational data about a customer's machines be used to improve continuity and performance? In the answer to this question lies the foundation for future (additional) business models. Data also forms the input for innovating the offering.

According to the survey responses, customers sometimes put up barriers to sharing data due to security concerns. It is, then, the job of the machine manufacturer to help them understand the value of data-sharing for preventative management and maintenance to avoid shutdowns and for optimizing functionality.

The respondents who believe that the rise of IoT and smart devices has no effect on their business are the same group mentioned earlier that believes technological advancements will have no impact on future business operations.

What effect do the Internet of Things and Smart Devices have on your own business processes?



Hypothesis

"By 2021, our company will have made the transformation from a product-oriented organization to a process-oriented organization."

Total

46% Agree

Leaders

53% Agree

Rest

45% Agree

Response

The opinions in response to this hypothetical statement are strongly divided. Those who agree indicate a necessity for producing with a greater focus on the customer and for expanding the service after the sale. Those who disagree say that producing customized machines is and always will be their core business. They appear to disagree mainly with the possibility of expanding the service processes, such as managing machines remotely. Here are a few of the reactions from both sides.

Agree with the hypothesis:

"Factory and process automation will take up a big part of future investments."

"Our product is a commodity; we should further develop smart/flexible processes to do late customization within a solely price-driven market."

"It is our goal to bring the right information at the right moment to employees, customers and suppliers. A process-oriented organization is an absolute must to achieve this goal."

"We see more and more service-oriented activities emerging, especially in the service and support for our products."

"We have highly experienced people to define, develop and implement a process-oriented methodology within our organization by the end of 2020."

Disagree with the hypothesis:

"We build different types of machines and never make the same thing twice, so our processes will always require a lot of product development."

"It will take more time to change. Mentalities are difficult to change. Our organization is still firmly tied to production."

"Since we produce products in small series, our organization can't benefit from a process-oriented approach."

"The market will not shift easily from product orientation to a fully service-oriented way of working."

"We are selling very specific products requiring a lot of engineering work. Configuration to order is part of our new development strategy, but it will not be possible to drive completely on standard options by 2021."

Chapter 4
Financing the Transition

New opportunities emerge in a connected machine environment.

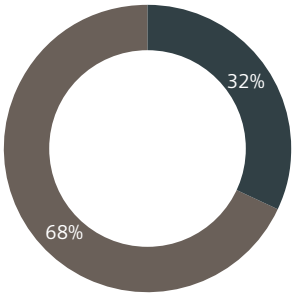
Introduction of new business models still limited

In many markets we see a trend that both consumers and companies are buying fewer products and services. They prefer to pay for usage rather than ownership to remain flexible in response to changes in cost. The trend for businesses is to avoid investing in capital goods (Capex) and opt for monthly contracts as operational costs (Opex). This trend is not clearly visible in the machine manufacturing industry. Only 32% of the companies see their own market, or the markets of their customers, shifting from ownership to usership. Also, we see that 'as-a-service' models (6%) and leasing (3%) are seldom used. A large majority of the business is made up of traditional sales (86%), with or without a maintenance contract.

Pay-per-use is the future, but it requires an investment

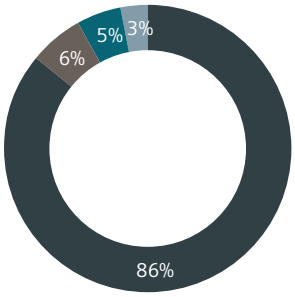
New pay-per-use pricing models create a greater demand for cash flow as well as external financing. Where previously all revenues were generated at the point of sale, now companies must invest first as revenues are instead realized over a period of years (based on actual usage). How do companies deal with this dilemma, when costs go up and revenues go down in the medium term? Right now, 34% of respondents say this trend is not affecting their company and is not expected to do so in the foreseeable future. For 11%, the change as a result of these new pricing models is already happening. Some 26% expect a change in cash flows, and another 19% see this effect on specific sales projects. That is a total of 56%!

Do you see your market, or your customers' markets, shifting from ownership towards usage?

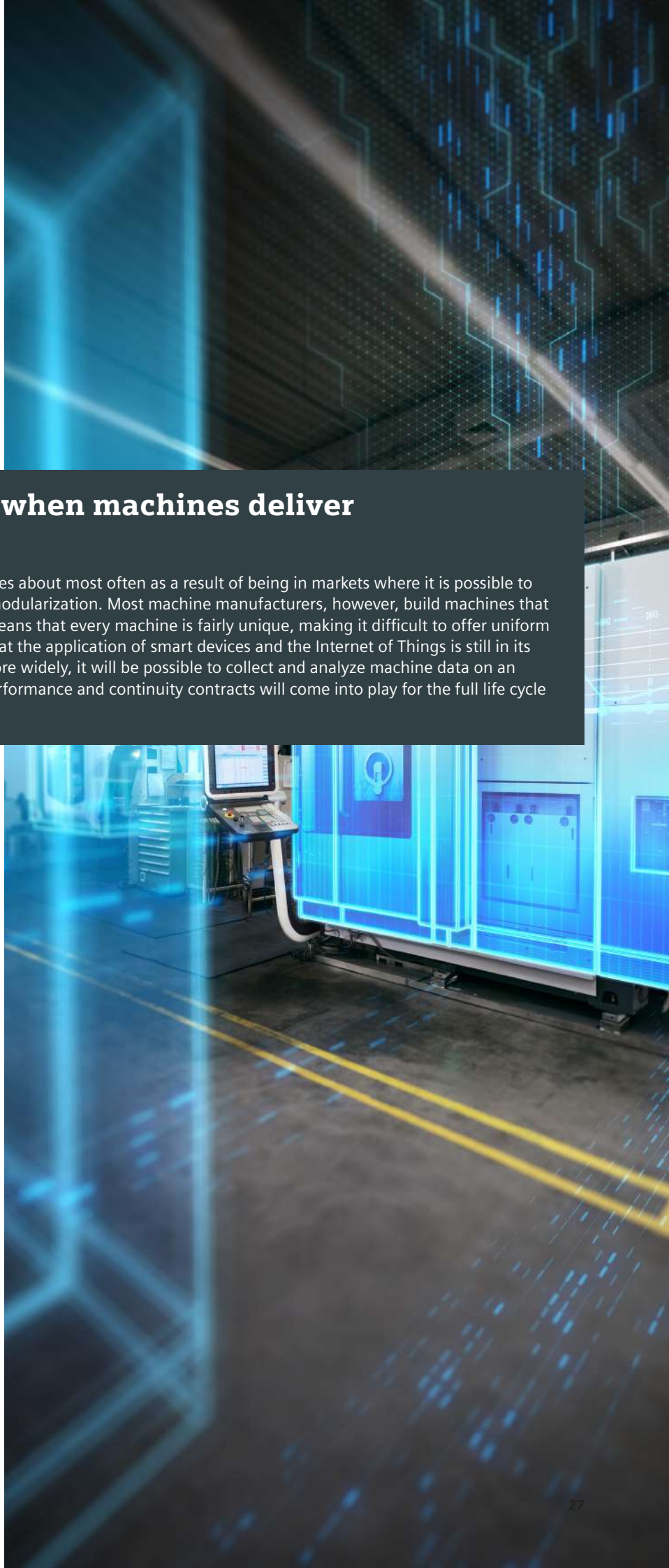


- Yes, see shift towards usage
- No, don't see shift towards usage

Which pricing models does your company offer to customers?



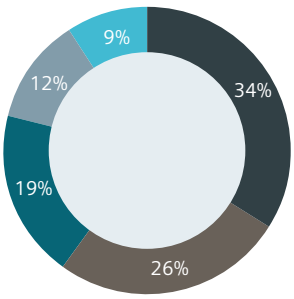
- Traditional sales, with or without maintenance contracts
- Pricing determined by usage, as under a subscription-as-a-service model
- Other
- Financial and/or operational lease options



As-a-service emerges when machines deliver real-time data

The transition to an as-a-service offering comes about most often as a result of being in markets where it is possible to provide extensive standardization based on modularization. Most machine manufacturers, however, build machines that are made to order for their customers. This means that every machine is fairly unique, making it difficult to offer uniform made-to-order contracts. It is worth noting that the application of smart devices and the Internet of Things is still in its infancy. When these applications are used more widely, it will be possible to collect and analyze machine data on an enormous scale. That is when as-a-service performance and continuity contracts will come into play for the full life cycle of a machine.

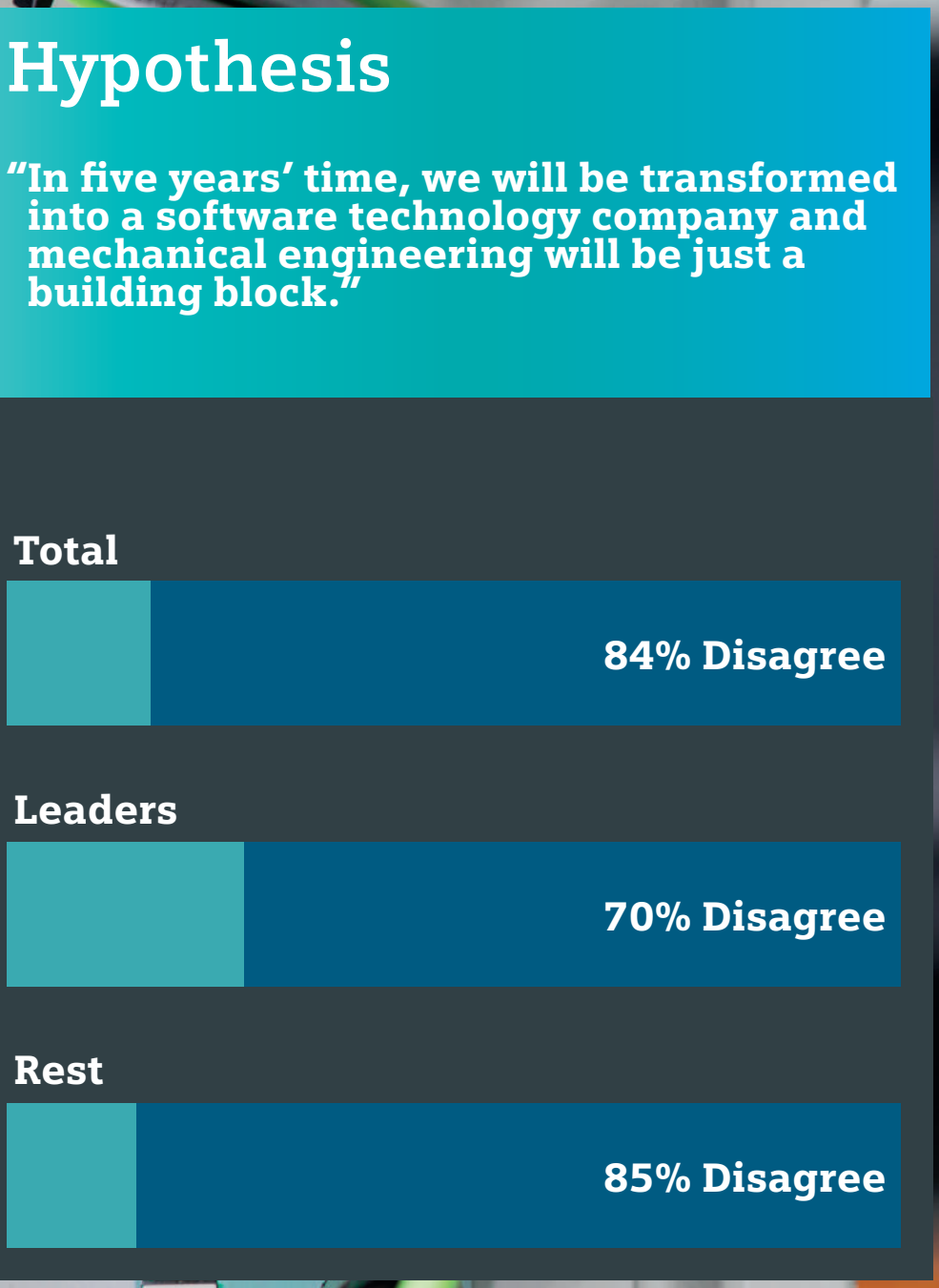
Has your company experienced a change in cashflow and financing needs due to the new pricing models?



- No, we don't experience it, and don't expect to in the future
- No, we don't experience yet, but expect to in the future
- Partially, with specific or incidental sales projects
- Yes, we experience this on a regular basis
- Other

Hypothesis

“In five years’ time, we will be transformed into a software technology company and mechanical engineering will be just a building block.”



Mechanics is still the foundation, but software is increasingly important

Nearly all the companies disagree with the hypothetical statement that mechanical engineering will be just a building block five years from now. The problem, however, appears to be with the idea of 'just five years.' Judging by the responses, most do clearly expect an increasing importance of software. This is especially true for the leaders, but even respondents who say they have little use for new digital expertise and see no real market opportunities from technological advancements or intelligent machines are expecting software to become more important. It seems likely that machine manufacturers expect to eventually invest more in software when more buyers and end users start to demand it. With it, they will be in a better position to react to trends like consumerization (standard, yet flexible), short product life cycles and outsourcing expertise (machine maintenance, for example) that is not part of the customer's core business.

A few nuanced reactions to the hypothetical statement:

"All our decisions about production, marketing and sales are based on the interpretation of collected data."

"We should transform, but the required CAPEX will not allow us to achieve this in 5 years' time."

"Customers are not yet ready to open their network. They prefer to stay independent with simple but robust equipment."

"Mechanical and software design will be equally important and strongly intertwined. Making machines smart will help detect and prevent problems, but the mechanical design will still determine the lifespan and the maintenance costs, as well as the versatility and performance potential."

"Mechanical engineering is still important for our machines, but there will be a growing intelligent combination with software components."

"Our innovation is a mix of process technology and software functionality."

"Today, our product is strictly mechanical. In the near future, IoT will certainly play a role and software development is a part of this. I don't think it will be our main business, though."

Chapter 5
Business Agility

To increase agility, companies must take both organizational and technological steps.

Solving the dilemma of standardization versus differentiation

In a dynamic, digitally-driven market, companies have a greater need for agility. On the one hand, there is a need for the business to be focused on efficiency and standardization to keep costs under control. On the other is the need for speed and flexibility in response to market changes and to be able to differentiate sufficiently based on customer needs. To solve the dilemma of standardization versus differentiation, a lot of innovation in technology and organization is required. Let's examine some of the paradigm shifts.

From vertical to horizontal organization

The traditional organizational structure is a pyramid with a hierarchy of responsibility in organograms that resemble a rake, with a manager at the top and rigid lines going down to show the people and departments he or she oversees. Companies that want to be flexible enough to move with the market understand that it is better to work with an organization that looks less like a rake and more like a swarm, where teams are created more sporadically and can shift rapidly to respond to challenges and opportunities.

From IT islands to integral automation

When business departments each work within their own system, a number of problems arise. The departments can have difficulty working together because sharing information is difficult. Sometimes that information must be shared manually. Also, they can tend to work from 'different versions of the truth' when trying to make decisions together. The solution is a company-wide system that integrates all the data.

From departments to multidisciplinary teams

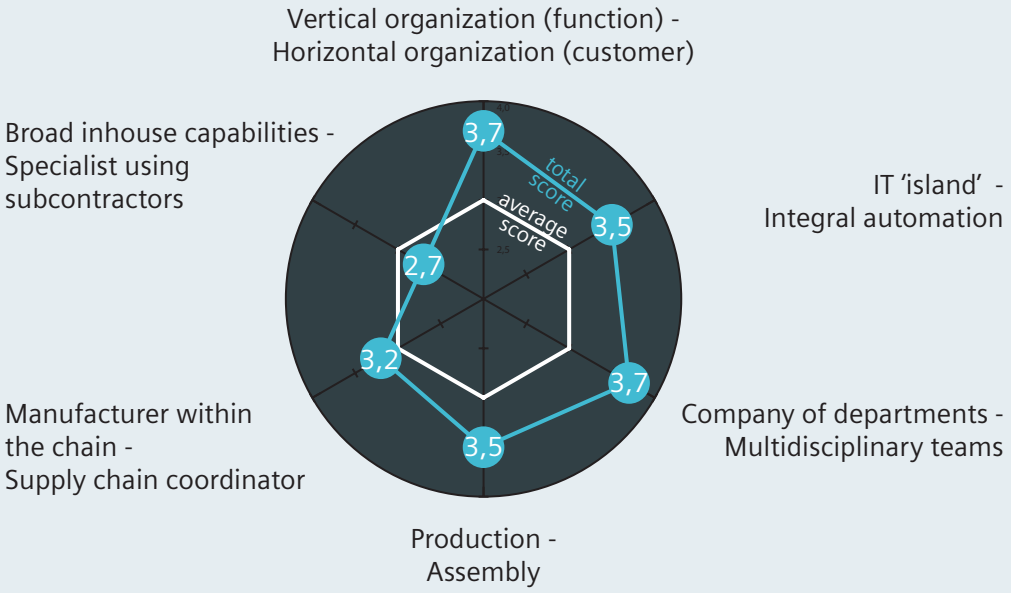
There are often multiple departments involved in achieving various business goals or working on a certain project. To manage this effectively, it can be a good idea to work with multidisciplinary teams in which all necessary expertise is readily available. This reduces the sub-optimization of processes and allows people from different departments to move and change directions faster.

From production to assembly

Machine manufacturers want to be more focused on customers, but at the same time keep costs to a minimum. There are different ways of achieving this. The first is modularization, whereby the customer can choose between different machine components. A step further is outsourcing production, so that the machine manufacturer merely assembles all the components. One example of this is Boeing, where they work with 5.000 suppliers and do only the design and assembly work themselves.

From chain operation to chain coordination

It is mainly those companies that have shifted their core business from production to assembly that are most concerned with backward integration in the chain. They do this by setting up partnerships or joint ventures that work together more extensively, or through acquisition and reshoring. By outsourcing more elements of the production process, they evolve into the coordinator of the supply chain.



Where would you place your company on the transition of your organization, processes and technology?

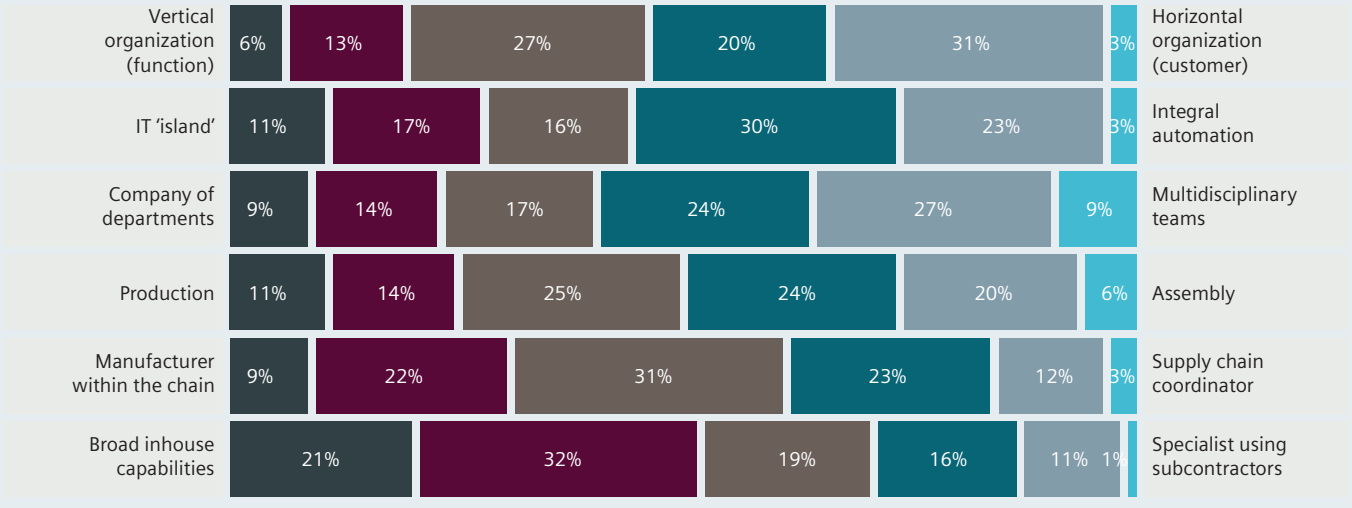
From generalist to specialist with contractors

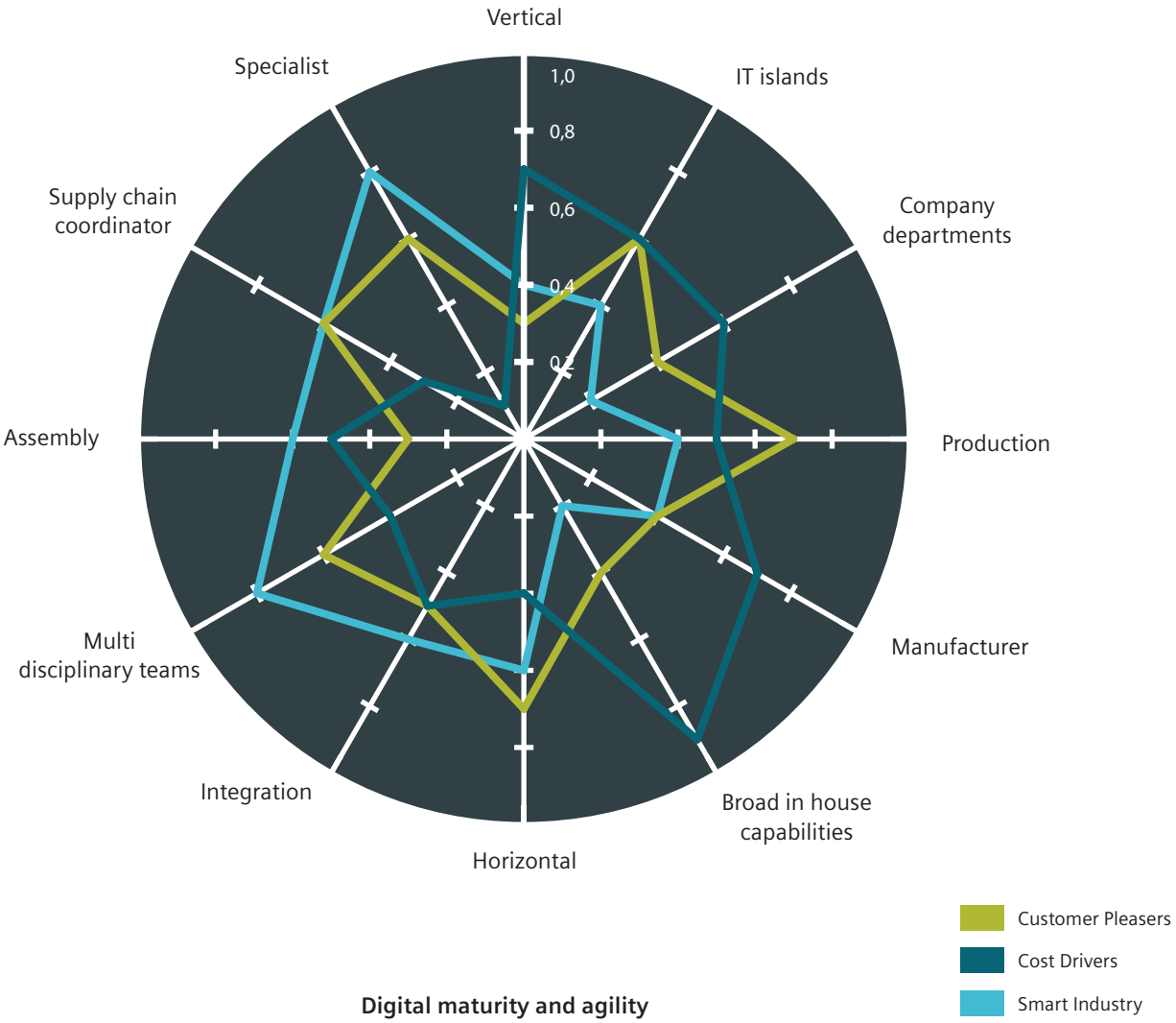
Since machines are becoming more complex because of the use of new technologies, more companies are choosing to do less in-house. They are positioning themselves as specialists and delegating the production process to subcontractors.

The agility of machine manufacturers is not yet ideal

In the figure below, we see that machine manufacturers score only slightly above the average on a 6-point scale in nearly every aspect that determines business agility. The highest score is for transitioning from departments to multidisciplinary teams. The score for the shift from broad in-house capabilities to the position of specialist working with subcontractors is even below the average. The next figure shows the spread and the average in the transitions for each aspect.

Spread per aspect that determines agility (from a scale from 1 to 6)





Digital maturity and agility

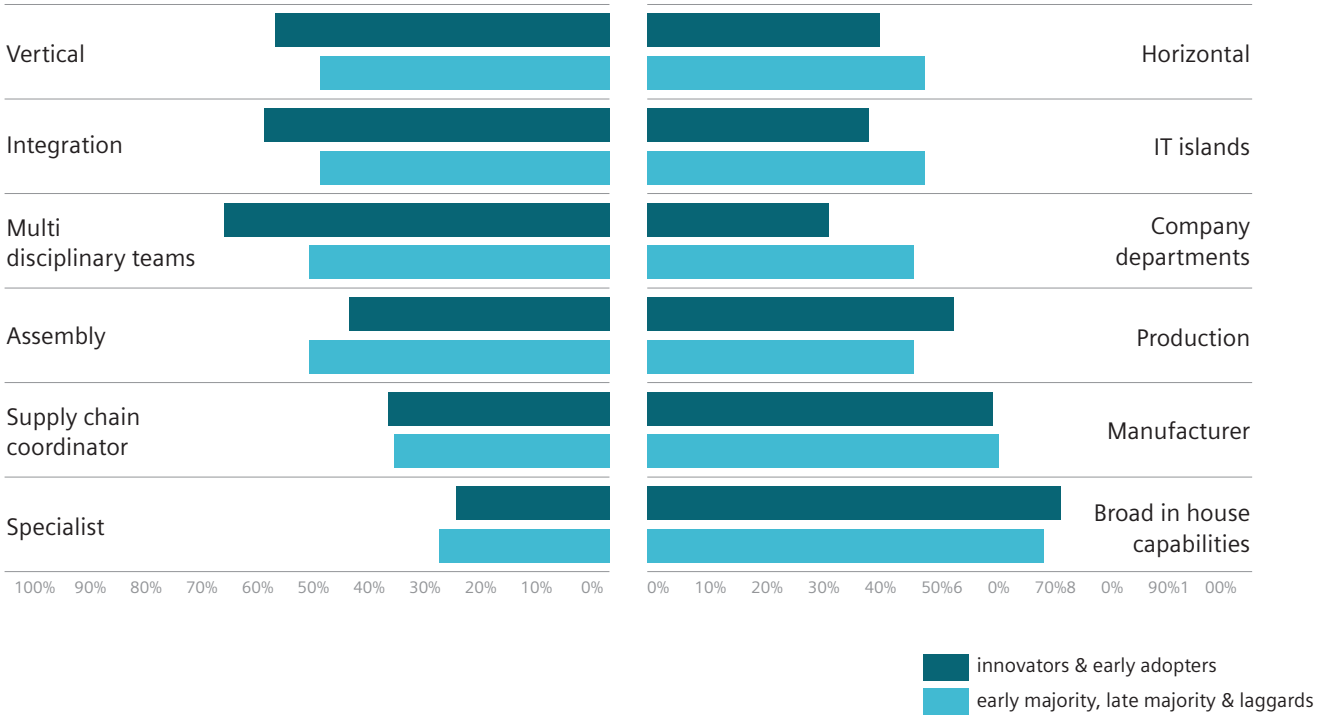
"A complete focus on being cost-driven often limits innovation and the entrepreneurial spirit that is needed for digital transformation."

Digital maturity is also an indicator of agility

In chapter 3, we differentiated between the various levels of maturity in digital transformation. The graph above shows the relationship between those maturity levels and the different elements that determine business agility. The Customer Pleasers – indicated by the green line – place the focus on delivering customization for customer retention. The Cost Drivers - the dark blue line – are interested in standardization to keep costs low. Companies with the highest levels of maturity understand how to do both. These companies fall in the category Smart Industry, indicated by the light blue line.

We see that the Smart Industry group scores highest in the left portion of the chart. These companies have taken the most steps toward maximizing their agility. Cost Drivers have made no visible transition on any single aspect. They prefer to do everything in house, for example, and retain a strictly hierarchical organization. The Customer Pleasers also lag in the transition, but the steps that they have made are comparable to those of the Customer Pleasers. They are more likely to position themselves as specialists and coordinators in the value chain.

Business agility & diffusion of innovations



Innovators & adopters versus the rest

Adoption of new technologies determines agility

Companies that consider themselves to be innovators or early adopters are further than the rest in nearly every aspect of the transition to an agile organization. They generally work more often with multidisciplinary teams and integrated systems. An average of approximately 30% of the companies in the category of early majority, late majority or laggards have achieved a transition on these aspects.

"The degree to which an organizational structure helps or hinders depends on the vision defined by management, and on the pressure coming from customers and the market."

Innovative environments and modern leadership engage (new) talent

Only 28% of the machine manufacturers say excellent employee benefits are an advantage for finding and keeping technical talent. The ability to differentiate in the market for talent is considered mostly a result of offering an innovative work environment where employees have an opportunity to grow (47%).

Nearly 40% see modern leadership and an organizational structure that fits a new generation as a means of finding and keeping talent. That is quite a challenge, given that we saw earlier that many companies still have a traditional culture: 49% has a

vertical organization and 47% operates with departments that are clearly divided. This culture has often been formed over many years, and that makes it difficult to implement changes. It is hardly surprising then, that working in multidisciplinary teams is seen as a factor in the talent market by only 28% of the companies, and the diversity of positions that employees can fill by only 30%.

B2B machine manufacturers often tend to have company names and brands that are less attractive than the bigger B2C multinationals. And those companies are searching the same talent pool of employees with technical skills. This problem makes an innovative business culture that much more important for machine manufacturers.

Modernizing the data and application landscape

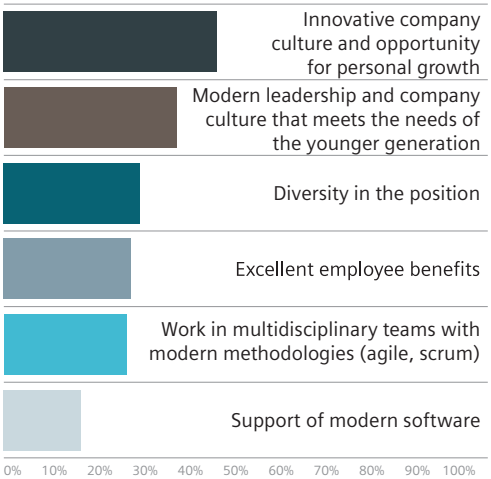
A large majority of the companies (73%) have charted a strategy for modernizing their process applications. For 52%, however, this strategy is limited to the essential elements of the application landscape. Only 2% have completed the modernization process and are already making use of software that is state of the art. By contrast, 24% of the companies have not developed any strategy at all.

On further investigation, it appears that the problem is mostly the degree of integration. Individual applications are often acquired for managing the complex processes that make up machine manufacturing. This often makes it difficult to integrate data from the various applications and create a single end-to-end system that can control the entire process.

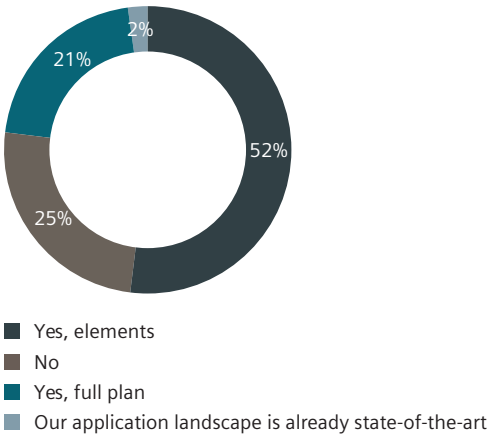
Additionally, integration is needed for teams and departments to have all relevant information about innovation projects readily available. Only then can they coordinate their activities properly and learn from each other. When applications make it easier to exchange information, it also becomes easier to build the business case to support further investment in innovation.

Implementing an integrated suite that is also cost-effective for complex processes makes all the difference in maintaining a competitive edge. When this type of suite is built on modules, it also allows companies to implement the solutions in manageable increments, to not only expand functionality, but also to better manage product data.

Which aspects are important to your company for finding and keeping technical talent?



Does your company have a strategy or plan for modernizing the existing application landscape for the entire machine manufacturing process?



Hypothesis, facts & numbers...

"Our company's growth is restrained by our current organizational structure made up of departments operating mostly autonomously."

A few nuanced reactions to the hypothetical statement:

"Departments work against each other instead of with each other (own umbrella effect)."

"In a small company, the organizational structure is always cross-functional."

"Currently too little interdepartmental cooperation is facilitated."

"The manufacturing department feeds our software and R&D department and vice versa."

"This is our strength in the industry."

"Most of our people have the capacity and the competency to be useful in most of the internal departments."

"Our company is small and lean, so every employee has multiple functions and the number of organizational layers is limited."

"We work in a niche market, so growth will be mostly dependent on attracting people with new skills that enable us to offer a more diverse package."

Opinions on this hypothetical statement are deeply divided. Approximately half agree that their company's growth is limited by an organizational structure with walls between its departments. Some respondents are currently working toward modernization by creating a horizontal structure and transitioning to multidisciplinary teams. Companies that have been successful in this, find that their organizational structure is more of an enabler for taking advantage of technological possibilities and market opportunities.

How a company is organized is a strong determinant for its success in transitioning to the smart machine industry. This certainly applies in the machine manufacturing industry where companies have been organized for decades around separate departments and yet, paradoxically, technology has always been a driving force. The degree to which an organizational structure helps or hinders depends on the vision defined by management, and on the pressure coming from customers and the market.

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Cards PLM Solutions
C-mine 12
B-3600 Genk
+32 89 201 738
info@cardsplmsolutions.com
www.cardsplmsolutions.nl

Adopt id PLM
Joe Englishstraat 72
B-8800 Roeselare
+32 51 200 028
inf@adopt-id.com
http://www.adopt-id.com

PLM-S
Damstraat 70
B-9220 Hamme
+32 472 02 68 60
info@plm-s.com
http://plm-s.com

Siemens Industry Software B.V.
Digital Factory Division
Het Zuiderkruis 63
5215 MV 's-Hertogenbosch, Netherlands

+31 (0)73 680 2500

Info.benelux.plm@siemens.com

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