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THE OLIVER WYMAN

PERSPECTIVES ON MANUFACTURING INDUSTRIES

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INTRODUCTION

Dear Reader,

Change in manufacturing is unrelenting, and it is about to get much faster. Megatrends – ranging from new technology to the environment – are starting to generate large new markets, and firms will need to rethink the way they operate in order to seize the opportunities. Thriving in this world of flux could mean a shift in corporate culture that puts perfectionism aside and instead promotes agile, test-driven development.

This edition provides some hints at where to find the opportunities as the industrial world develops new businesses and ecosystems at an unprecedented pace.

One focus is on innovations in sectors such as industrial plants and construction. New machines will enable major advances in building and management: Low-cost drones will, for example, enable inspection of remote facilities. The best way for incumbents to take advantage of these technologies might be to invest in or form alliances with the startups that are pioneering them.

Manufacturing technology often sounds like it should mainly concern physical machines, but some of the most useful advances will come from bots. These will take over some of the tasks currently performed by people in areas such as purchasing, accounts, and human resources – replacing human workers or making them more effective. In addition, new ways of thinking about pricing and product design will help to maximize revenues and uncover new ways to cut costs.

The forces behind the changes are combinations of megatrends, as our cover story explains. These range from global phenomena such as climate change, to the technology advances creating the Internet of Things. They will lead to an era of faster product cycles, new ecosystems, and a wide-ranging transformation of manufacturing industry. The coming wave is full of opportunities – that much is certain. The challenge is to seize the opportunity!

Yours sincerely,

THOMAS KAUTZSCH

Head of Oliver Wyman's
Global Automotive and Manufacturing Industries practice

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COVER STORY

MEGATRENDS AND THE FUTURE OF INDUSTRY

A NEW ERA IN MANUFACTURING PRESENTS LONG-TERM OPPORTUNITIES

Thomas Kautzsch, Daniel Kronenwett, and Guillaume Thibault

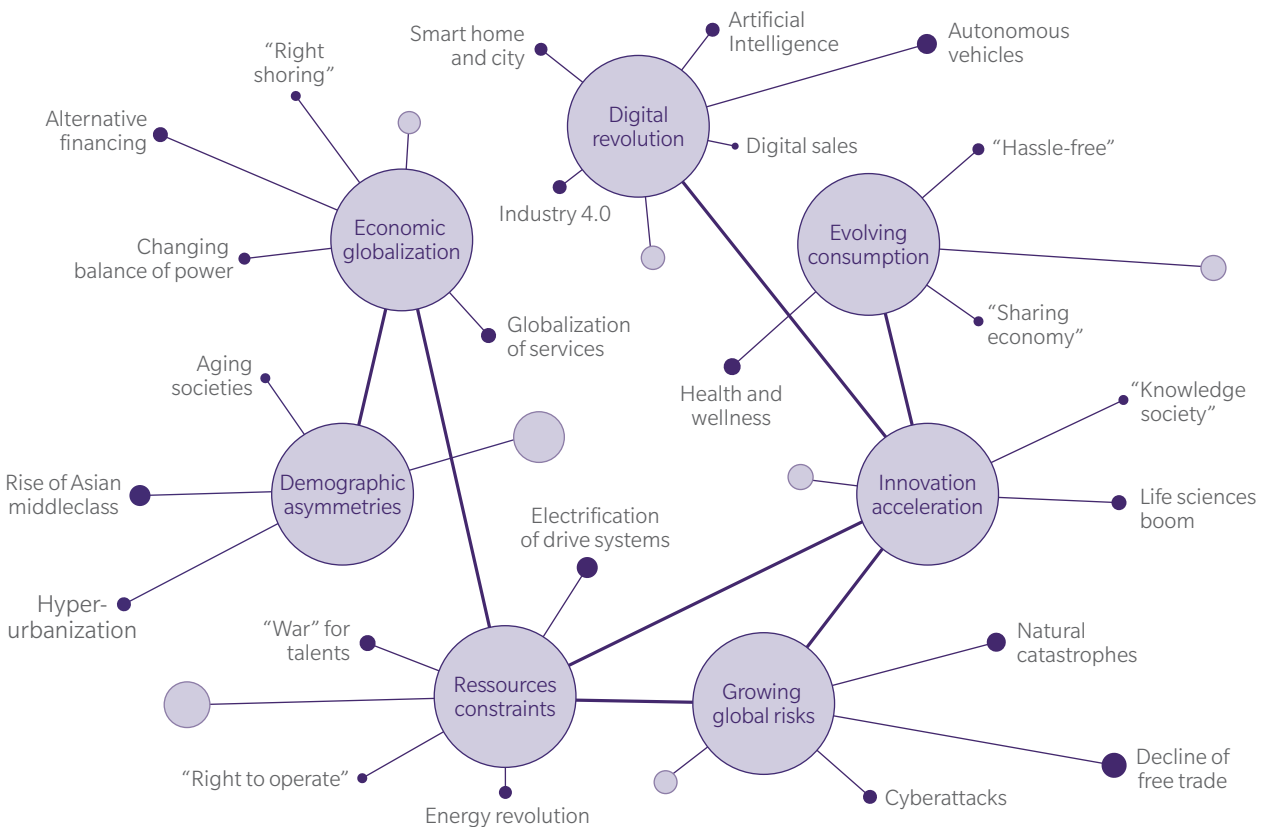
The manufacturing industry has enjoyed a decade of healthy growth since the financial crisis by optimizing existing products for established markets in a favorable business environment. From this point forward, however, the big growth opportunities will come in new markets, as a wave of megatrends generates new prospects for manufacturers. We expect these new markets to be worth US$1 trillion over the course of a decade, as large parts of industry are revolutionized, resulting in a new generation of corporate winners.

These megatrends are a combination of technological leaps and upheavals in global society and the environment that will reshape economies, businesses, and lifestyles. Environmental and population pressures require cleaner energy and better-functioning cities, for example. These forces are driving the demand for renewable power and smart transport systems to ease congestion. Technological answers include an increase in energy storage capacity, which will improve the range of electric vehicles and smooth out the supply of renewable power amid weather changes. More generally, smart products will bring digital intelligence to new places, as sensor-equipped machines become increasingly autonomous thanks to decision-making software. Within corporations, functions that appear to have little to do with number crunching – such as sales and human resources – will be aided or taken over by robotization and artificial intelligence. (See Exhibit 1.)

Previous cycles of major change have overturned the industrial order. Technological change and disruption comes in waves, as global trends and innovations mutually reinforce each other. The result has been super-cycles lasting several decades, which have transformed the world, changed the way we work and live, and created new sets of global market leaders.

The wave that started in the 1910s was defined by oil, electricity, the automobile, and mass production. These enabled the development of the modern city, infrastructure,

Exhibit 1: Megatrends are global and sustained forces that will certainly impact and shape economies and societies



Source: Oliver Wyman analysis

and transport as we know them today. The cycle from 1960 – based on semiconductors, telecommunications, and automation – made possible globalization, outsourcing, and lean manufacturing. These techniques created our current global production systems, product proliferation, and mass customization. (See Exhibit 2.)

SPEED AND TRANSFORMATION

The next super-cycle will in many ways be faster and more dramatic, with some markets likely to grow at 40 percent a year for a decade. The growth will come from new sources, which will act as the launchpads for whole new ecosystems. Large manufacturers will find the new era challenging, and will need to figure out how to create products that allow them to participate in new markets – often outside their traditional comfort zones.

The speed of innovation will shorten product cycles. Since the big advances will come from software – which can easily be scaled, quickly and globally – there will be a tendency towards winner-takes-all markets, where the top product grabs overwhelming share. Competition to become this winner is already producing mega-startups.

Unlike in the past, when new enterprises faced pressure to launch an IPO if they wanted to expand, they are able to take the longer view, thanks to their ability to tap into rounds of private financing. More critical than financing will be finding the right talent – a challenge shared by both startups and incumbents.

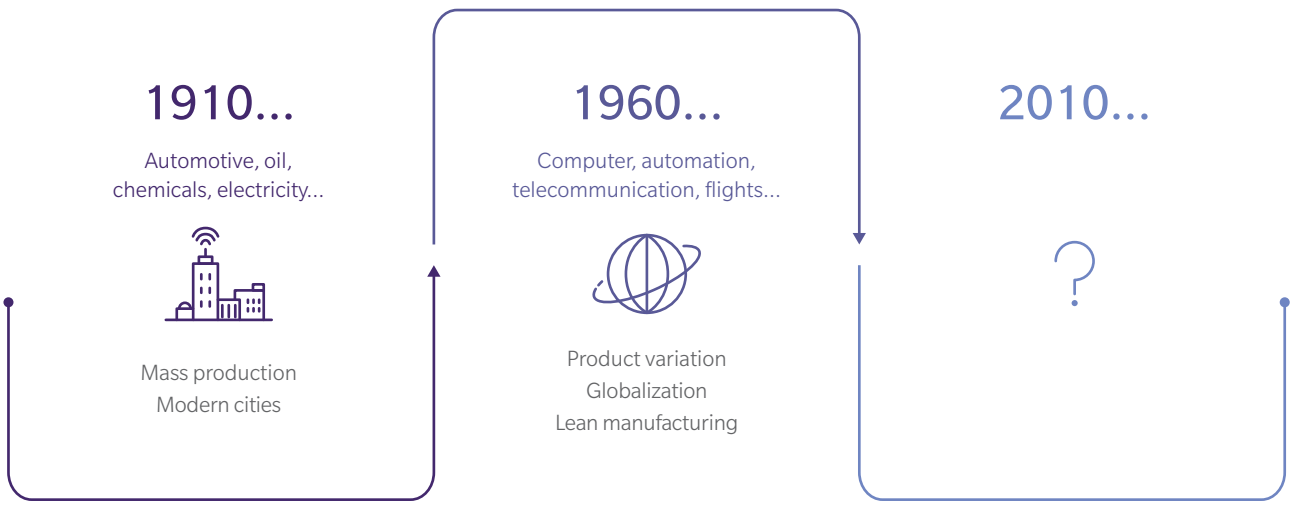
Some startups will be at the center of new industries. Genome sequencing, for example, can forecast a person's likelihood of developing particular diseases, thus enabling targeted preventive care. It can also enable more precise therapeutic interventions in patients with cancer or rare diseases. However, DNA decryption has been very expensive – until now.

Companies such as San Diego-based machine producer Illumina are pushing down the cost of genome sequencing, enabling an expansion of direct-to-consumer testing services. By keeping its product cost low, Illumina is helping to create a new ecosystem. We expect the market for such machines to grow around 20 percent a year, from US$4.4 billion in 2016 to US$22.1 billion in 2025. Future possibilities include the compilation of a large database of genomic information – a kind of Google of personal health care.

The growth in genome sequencing is the result of megatrends including health and wellness, life-science advances, and aging societies. Other sectors will feel the impact of different megatrends. A boom in drones, for example, will come thanks to advances in digital and data and in smart devices – though drones' potential applications in remote facilities mean they could also be linked to megatrends like resource scarcity and natural catastrophes.

The peculiar nature of change during a super-cycle can be seen in autonomous vehicles, whose influence extends far beyond the auto industry. Like other connected devices that

Exhibit 2: Megatrends appear in cycles



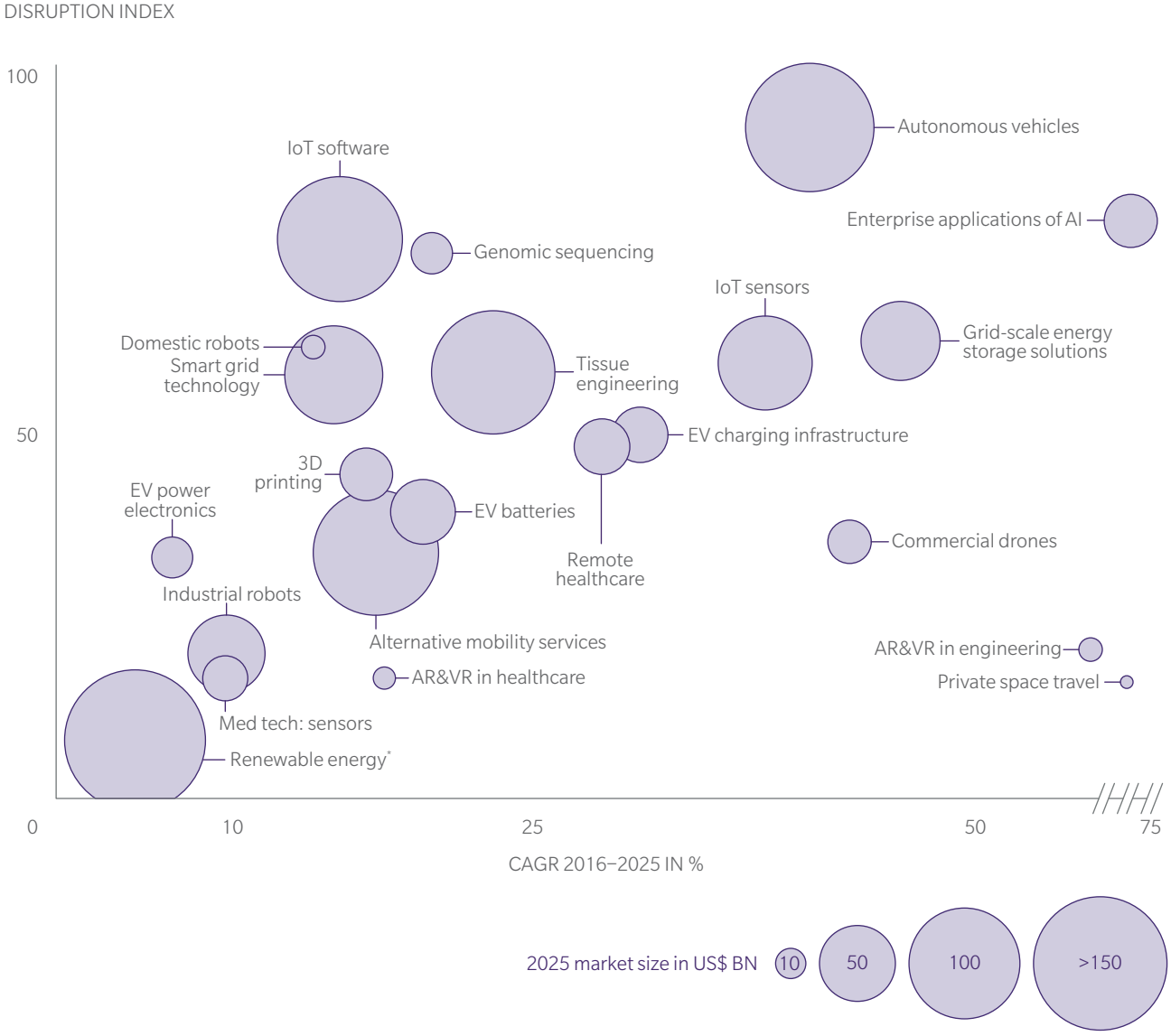
Source: Oliver Wyman analysis

form the Internet of Things (IoT), they will depend heavily on sensors to locate road markings, obstacles, and other cars. Processing all the data these sensors collect will drive growth in IoT software and platforms – a market that is worth US$34 billion now but is likely to grow 15 percent a year, to US$120 billion in 2025. (See Exhibit 3.)

Autonomous transportation will generate new product markets beyond driverless cars, such as freight vehicles, ships, trains, trams, and drones. Some of these will carry out deliveries – to consumers or between businesses – while others will take the place of regular cars driven by humans. All have the potential to trigger new service markets – and it is still unclear what shape these take, let alone which providers will dominate.

While most traditional automakers are working on autonomous technology, digital players such as Google, Amazon, and Apple are participating too. Some of them may end up dominating parts of future vehicle development: Waymo, the Google-backed autonomous-driving venture, has already logged 4.8 million km of test drives. In some

Exhibit 3: New markets worth more than US$1 trillion will emerge



* Include wind, solar, bioenergy, geothermal
Note: Minor overlaps to other markets may exist
Source: Goldman Sachs; J.P. Morgan; Bank of America Merrill Lynch; Markets and Markets; grand View Research; Oliver Wyman analysis

cases, drones will replace land-based transport. Ehang of China has developed a drone that can carry a passenger for 23 minutes, or a distance of 32 km. The first orders have come from Dubai, and we estimate that a quarter of individual transportation in the Gulf states will be carried out by drones.

NEW STRATEGIES REQUIRED

Megatrends will change the industry and the world we live and work in, bringing huge business opportunities. However, many of these will be seized by new entrants, some of which will grow into unicorns – private companies valued at US$1 billion or more. One reason for entrants' outsize role is that megatrends only have a limited impact at the beginning, before they eventually take off and break existing business models. The long buildup means that large companies can underestimate the power of megatrends or assume that they have already integrated them into their plans.

So, incumbents need to strategize in a new way in order to participate and lead in the new markets. They can start by taking an outside-in approach. Normally, they start with their competencies and assets and then work out what products they can make, and which customers might buy these. During a super-cycle like the one starting now, the focus should first be on megatrends. Firms will need to understand what impact these will have on customers, and how they can provide these customers with solutions. After that will follow the development of the required competencies and assets.

This will not be easy, since many of the opportunities lie outside incumbents' core businesses. Some have already begun to rearrange their skillsets to prepare for the super-cycle. That can mean buying software businesses to acquire new competences, as well as investing in startups that are pioneering technology with the potential to be at the center of a growing ecosystem. It can also mean selling off units – such as types of hardware – that are peripheral to their strategy for the new era. The nature of opportunities in this super-cycle means that incremental changes won't be enough, and a multitude of small investments is unlikely to work. Instead, incumbents must go all-in to meet the new demands.

HOW TO BENEFIT FROM MEGATRENDS

The megatrends will not all affect every manufacturer. But some of them will almost certainly have specific impacts on particular industries and corporations. The first step for a company to thrive in the new era is to identify which megatrends affect it and how. Then it can implement the outside-in approach and figure out the best approach to the new opportunities: which new markets to target and the different possible strategies for doing this. That might mean new business models based on new capabilities, which could be obtained through a variety of means: in-house development, partnering, acquisitions, or an in-house startup fund, to give some examples.

Now is the time to go beyond the optimization of existing businesses and reflect more fundamentally on where to play – and how to win – in the coming wave of megatrends.

US$1 TRILLION

WORTH OF NEW MARKETS IS EXPECTED TO DEVELOP OVER THE COURSE OF A DECADE

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MANUFACTURING IN A CHANGING WORLD

MANUFACTURING IN A CHANGING WORLD

BRINGING MANUFACTURING JOBS BACK TO THE US?

US MANUFACTURING IS IN BETTER SHAPE THAN TALK WOULD SUGGEST

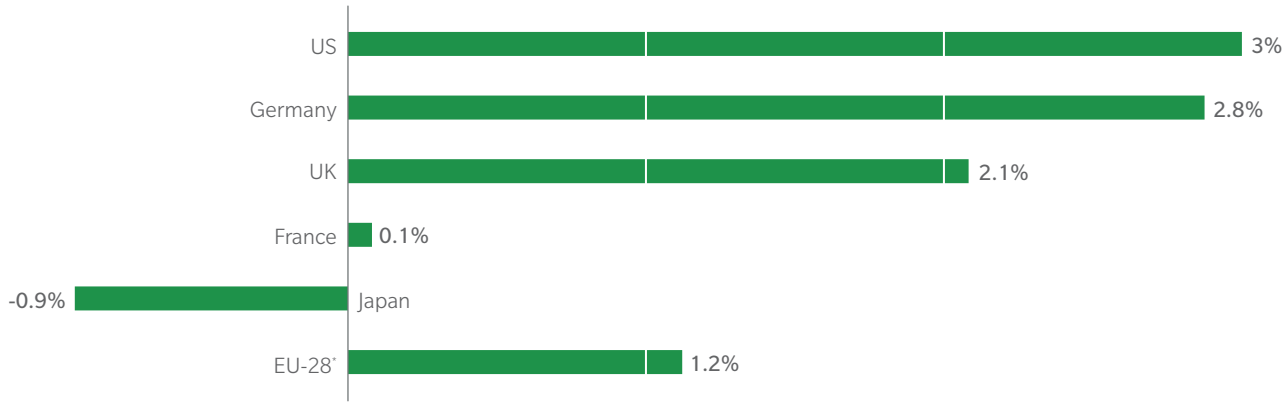
Thomas Kautzsch and Andrew Chien

Manufacturing employment in the United States (US) has shrunk 0.6 percent every year for the past 10 years, a trend that is due in large part to the widespread practice of offshoring by a broad spectrum of manufacturers: Over the past decade, textile manufacturing fell by 28 percent, lumber and paper production by 27 percent, and computers and electronics by 23 percent. Increasingly, large segments of the public in the United States feel that the US is losing its industrial base and that steps should be taken to protect American manufacturing jobs.

Despite the perception of it being in dire straits, the reality is that US manufacturing is much more robust and in better shape than what the public discussion would suggest. Indeed, manufacturing is on the upswing in the US. That is not to say traditional factory jobs will be returning to these shores anytime soon: Those traditional blue-collar jobs are never coming back – not however because they have disappeared to China or Mexico, but because of the effects of

Exhibit 1: Manufacturing productivity in the US has topped other nations

CAGR OF VALUE ADD BY MANUFACTURING SEGMENT (2004-2014)



*Compound annual growth rate (CAGR) for 2004–2013
Source: OECD, Oliver Wyman analysis

automation and digitalization, which have done away with the need for manual workers. But those very trends are giving rise to the need for a new kind of factory worker, one who is comfortable and has the skills to operate in a highly automated manufacturing environment. To take advantage of the manufacturing jobs that will be created in the coming years will require a significant upgrade in the skills and tech savvy-ness of the new manufacturing workforce.

A GLOBAL SECULAR TREND

Declining manufacturing employment is a fact in every industrialized country, and is taking place at similar rates: As noted earlier, the past decade saw 0.6 percent annual decreases in manufacturing jobs in the US, with 1.4 percent in the European Union (EU) and 1.3 percent in Japan.

The primary force driving this secular trend is increased productivity due to advanced automation. Productivity in the manufacturing sector in the US has increased 3.0 percent annually over the past 10 years, with 2.6 percent annual increases in value-add, despite diminishing employment. Value-added features and activities are ones that change the form, fit, or function of the product and that the customer is willing to pay to have done. Indeed, US manufacturing productivity exceeded that of other developed nations. (See Exhibit 1.)

US MANUFACTURING IS STRONG

America's annualized 2.6 percent increase in manufacturing value-add points to the industry's strength. Indeed, its value-add growth has outpaced that of the economy at large. US manufacturing is also gaining a greater share on the world stage and benefiting from global trade: Exports have grown 5.2 percent annually (as compared to the EU where manufacturing exports rose 4.5 percent, Germany 3.1 percent, and Japan 0.3 percent).

Moreover, the future bodes well for the sector. Deloitte's Global Manufacturing Competitiveness Index (GMCI) places American manufacturing on an upward trajectory. Ranked fourth in the GMCI in 2010, US manufacturing took second place on the index's 2016 ranking, behind only China. It is projected that the US will rank first in the GMCI in 2017 and is likely to maintain its leadership into the next decade.

The importance of supply-chain management is strengthening American manufacturers: US manufacturing is increasingly embedded in global supply chains. For example, the share of foreign components in US car exports increased from 24 percent in 2000, to 35 percent in 2011.

DIGITAL INDUSTRY SECURES US MANUFACTURING'S LEADING POSITION

The next wave of efficiency gains in global manufacturing will be driven by digitalization and big data. Greater automation will render low-cost labor less meaningful in deciding where to build and maintain manufacturing facilities. Instead, speed, customization, and proximity to customers will be key. Consequently, value-added activities will, to a certain degree, gravitate back towards industrialized countries. The US will be a major winner. The European sportswear maker Adidas, for example, just announced plans to build a "Speed Factory" outside Atlanta, in order to be able to

produce sneakers quickly and satisfy surprise surges in demand for product.

BLUE AND WHITE COLLAR JOBS

However, the kind of manufacturing "returning" to the US will be very different from the manufacturing of old. Highly automated and flexible, it will require few new blue-collar jobs. Adidas's Speed Factory, for example, will produce 500,000 pairs of shoes per year, while employing just slightly more than 100 employees. This tiny human workforce will be supplemented by the enterprise's true producers: Robots and 3D printing. A US$1.2 billion plant modernization program recently announced by Ford will create a mere 130 additional jobs in the US.

The requisite skills will change too: Jobs on the shop floor will require more skilled workers, with science, technology, engineering, and math (STEM) knowledge, problem-solving skills and programming familiarity. Such talent will be scarce, and the traditional blue-collar job will not return.

The greatest efficiency gains will occur in the white-collar sector: Traditional white-collar jobs will be at the center of the next generation of manufacturing efficiency gains. Increased automation and digital industry will bring lean process improvements to manufacturers' back and middle offices. Many administrative functions will be automated, and the need for human employees diminished. Fields affected will be sales and maintenance planning, production scheduling, pricing, and inventory management, along with many others.

WHAT CAN COMPANIES DO AND WHAT ROLE SHOULD GOVERNMENT PLAY?

Massive changes are coming to the workforce, changes that will affect companies and governments, equally. Firms can expect to see both a shortage in skilled workers and a glut in unskilled and unprepared candidates for jobs.

To meet the challenge, companies and governments must become more proactive in their approach to managing the workforce of the future. Firms should address the imminent shortage of necessary, skilled workers by instituting internal training/retraining programs to teach workers the skills they will need. Looking ahead, companies must seek to engage with STEM programs at local schools to ensure that graduating students are prepared to enter the workforce and to make a valuable contribution.

Manufacturers should be prepared to foster initiatives that reap the benefits of digital industry with respect to planning and administrative functions. This will mean retraining employees in analytics, big data, and modeling to prepare them for future job requirements.

Finally, it is critical that companies take the long view, particularly now when there is still time to prepare: Anticipate changes in skill requirements over the next three to five years and develop programs to address the shortcomings of your workforce.

Government can help reduce the shortage of skilled labor through increased support of organizations funding apprenticeship programs and initiatives for digital manufacturing education.

5.2%

GROWTH OF US MANUFACTURING EXPORTS ANNUALLY

PREPARING YOURSELF FOR THE FACTORY OF TOMORROW, TODAY

US manufacturing is actually healthier and in better shape than headline numbers and public perception would have it – which is not to say that old-time factory worker jobs are coming back to US shores. Indeed, it would be best to dispense with the fantasy of bringing back traditional assembly-line jobs: They are never coming back, not because of Mexico or China, but because robots and automation are taking the place of people on the factory floor.

Human beings will still be necessary in manufacturing, but to work in the factories of the future, they will need a significant increase in the STEM skills and aptitude they bring to the job. Today is the time for manufacturers, government, and workers to prepare for the automated and digitalized factory of tomorrow.

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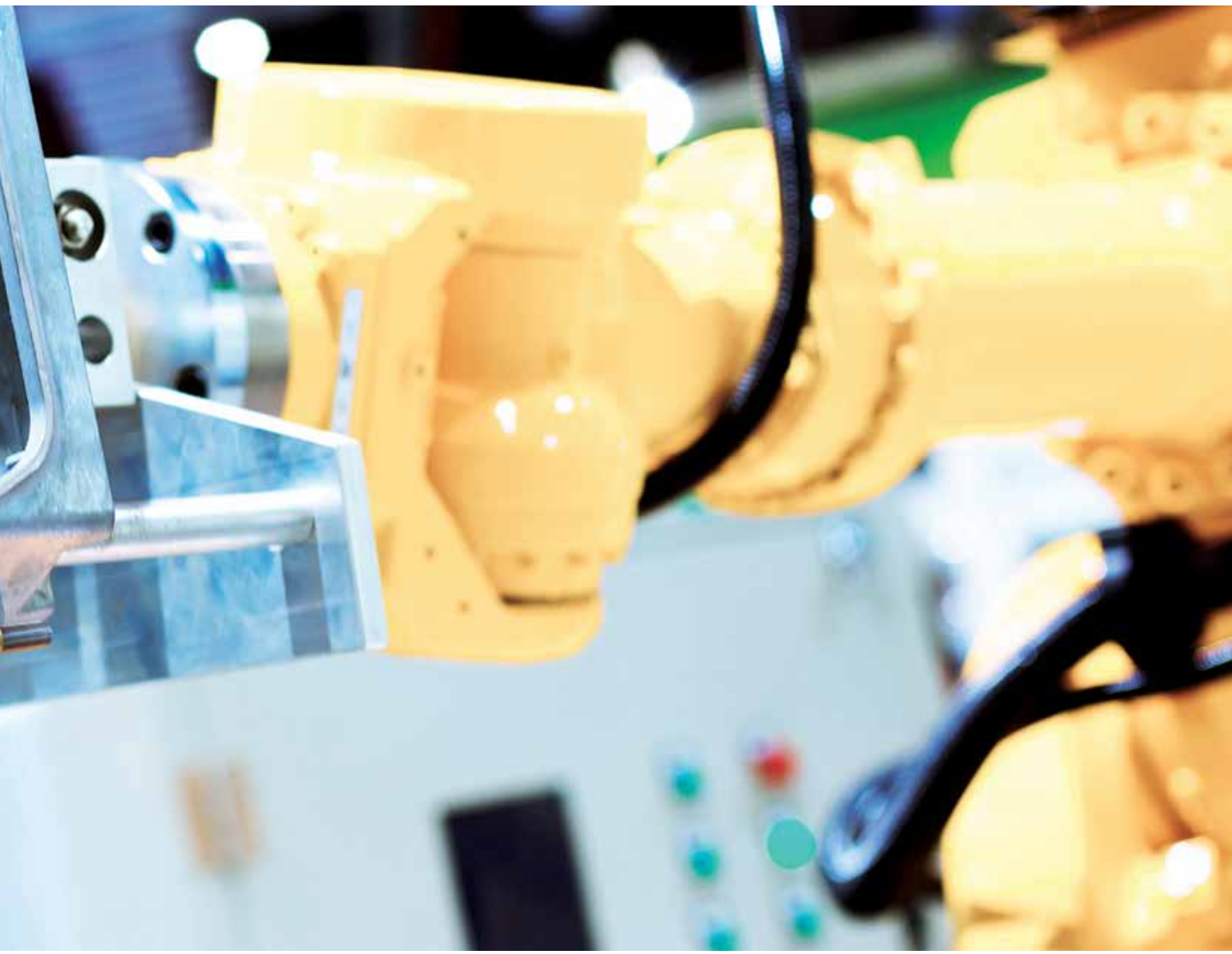
MANUFACTURING IN A CHANGING WORLD

PREPARING FOR DIGITAL AS THE NEW NORMAL

DIGITAL TRANSFORMATION OF MANUFACTURING COMPANIES

Juergen Reiner, Florian Deter, and Hendrik Vedder

Digitization is one of the greatest challenges organizations face today. This is especially true of industrial companies, with their legacy plants, assets, and products: Established cultures are often more focused on cost and quality, rather than customers and services. Industrial firms often struggle to find the right talent to push digital initiatives, given their rigid organizational structures. Even after a digital service is established, they have a hard time shutting down existing structures and channels, such as the online sales channel versus existing dealer structures. To prepare for a digital "new normal" and maintain a leadership position, industrial companies need to initiate a robust digital transformation.



Having watched other sectors being hit by the digital wave, manufacturing is only now experiencing digitization as the primary driver of change. As the world becomes ever more connected – the number of Internet of Things (IoT) devices is expected to increase by 250 percent by 2020, to more than 8 billion – and with new technologies finding their way into industrial operations, a "new normal" is emerging. The new business environment will be dominated by ecosystems that enable multiple producers and business-to-business (B2B) customers to connect. To compete in the future, manufacturers must digitize their processes.

Thus far, firefighting and ad-hoc management has been the industrial sector's modus operandi, especially at the manufacturing end of the value chain. The best way forward is for manufacturers to rethink their ways of working, their structures, and how they steer their daily work. Digitization can help with instituting best practices, such as launch management, and advanced analytics can increase process maturity and boost productivity.

Industrial companies can only maintain leadership in this more digitized environment if they undertake comprehensive transformation and address four strategic areas. First, they need to address and understand customers' key challenges, and second they need to develop intelligent products to help solve B2B customer issues. Third, companies must radically digitize their processes. With B2B customers expecting high quality and reliability, high-tech component manufacturers will have to modernize their inspection processes with advanced analytics and machine learning. Ultimately, as a fourth step, industrials need to become scalable, agile, and digital. (See Exhibit 1.)

It is crucial that manufacturers undertake digitization in a way that enables rapid responses to customer needs, ensuring consistent customer experiences across all business units, products, and channels. This means selecting sustainable and scalable technology.

Industrial companies need to alter their business models and enterprises in a structured way, defining a shared target picture and identifying impactful digital initiatives. A dedicated digital organization will need to be set up, and effective steering mechanisms and key structures, such as cybersecurity, will need to be implemented that pave the way for further transformations.

DRAWING A TARGET PICTURE

A first step is to draw a target of the results you're aiming for in the transformation and share it throughout the organization. Define each business unit's priorities, covering not just new, digital products, but also functions and processes that could be strengthened by digitization, such

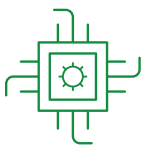
Exhibit 1: Digitization agenda for manufacturers

CUSTOMER EXPERIENCE

Establish one seamless, **digitally-enabled customer experience** across all business units and channels around all relevant customer needs.

INTELLIGENT PRODUCTS

Combine machines and products with **analytics** and **big data competencies** to generate insight and benefit for customers.



DIGITIZED PROCESSES

Digitally enable and **optimize core processes** to support superior customer experience and benefit from higher efficiency.

DIGITAL COMPANY

Develop an **organizational structure** and **culture** as well as a **governance model** to operate and change at digital speed.

Source: Oliver Wyman analysis

as in sales or indirect production. Review existing initiatives to come up with a clear agenda for transformation and prioritize the most important initiatives. Industrials need to examine where digitization yields the greatest value and find an effective balance of product and process initiatives.

CLASSIFYING DIGITAL INITIATIVES

To get things going, firms must first identify initiatives with the potential for closing the digital gap, and push them as priorities. This ensures that key areas are addressed and have an impact on digitization goals. In the case of new digital products, for example, identifying what is most impactful requires understanding customers' needs throughout their journey. Companies first must examine which customer needs are not being addressed, what competitors are doing to meet those needs, and then prioritizing the ones that can be quickly implemented. In digitizing manufacturing processes, it requires examining concrete use cases, including the applicability and business case of a given digitized process.

Based on this approach, a high-tech company defined a comprehensive road map for a digitally integrated customer-interaction product and laid out a sprint plan in only two months. The firm analyzed key manufacturing support functions and identified 10 high-priority initiatives, including a mobile maintenance app for equipment documentation and a "digital shift book." These changes yielded immediate improvements in customer interaction and production uptime.

True digital transformation, however, requires going beyond such lighthouse projects and recognizing the greatest inhibitors to substantial change. While institutionalizing rapid scalable development of digital products calls for a clear digital operating model, another key is ensuring information security.

CREATING INDEPENDENT DIGITAL UNITS

In their simplest form, digital organizations consist of guidelines and a standard-setting function specifying how business units should implement digital. In a more ambitious setting, however, they can be empowered to consolidate digital ambitions across business units and push initiatives to maturity. The second approach holds out the greatest promise, enabling agile development at speed and at scale.

Digital units can then be equipped with dedicated staff and competence centers, providing agile, cross-functional product teams to ensure quick time to market. An independent digital IT function would provide standards and technical infrastructure. Business units would be represented through digital product owners that would operate at the interface between business and scrum teams taking over product responsibility.

Digitized operations need to define governance and operations principles, clarify how personnel collaborate, and promote a dynamic culture and mindset – across traditional functional setups. This establishes the digital unit's basic structure so that it benefits industrial companies.

Digitizing an industrial company is not simple. It involves rethinking established structures, processes, and steering mechanisms. But for industrials that want to remain competitive and flourish under the "new normal," the time for developing digital transformation programs is now.

8 BILLION

INTERNET OF THINGS DEVICES EXPECTED BY 2020

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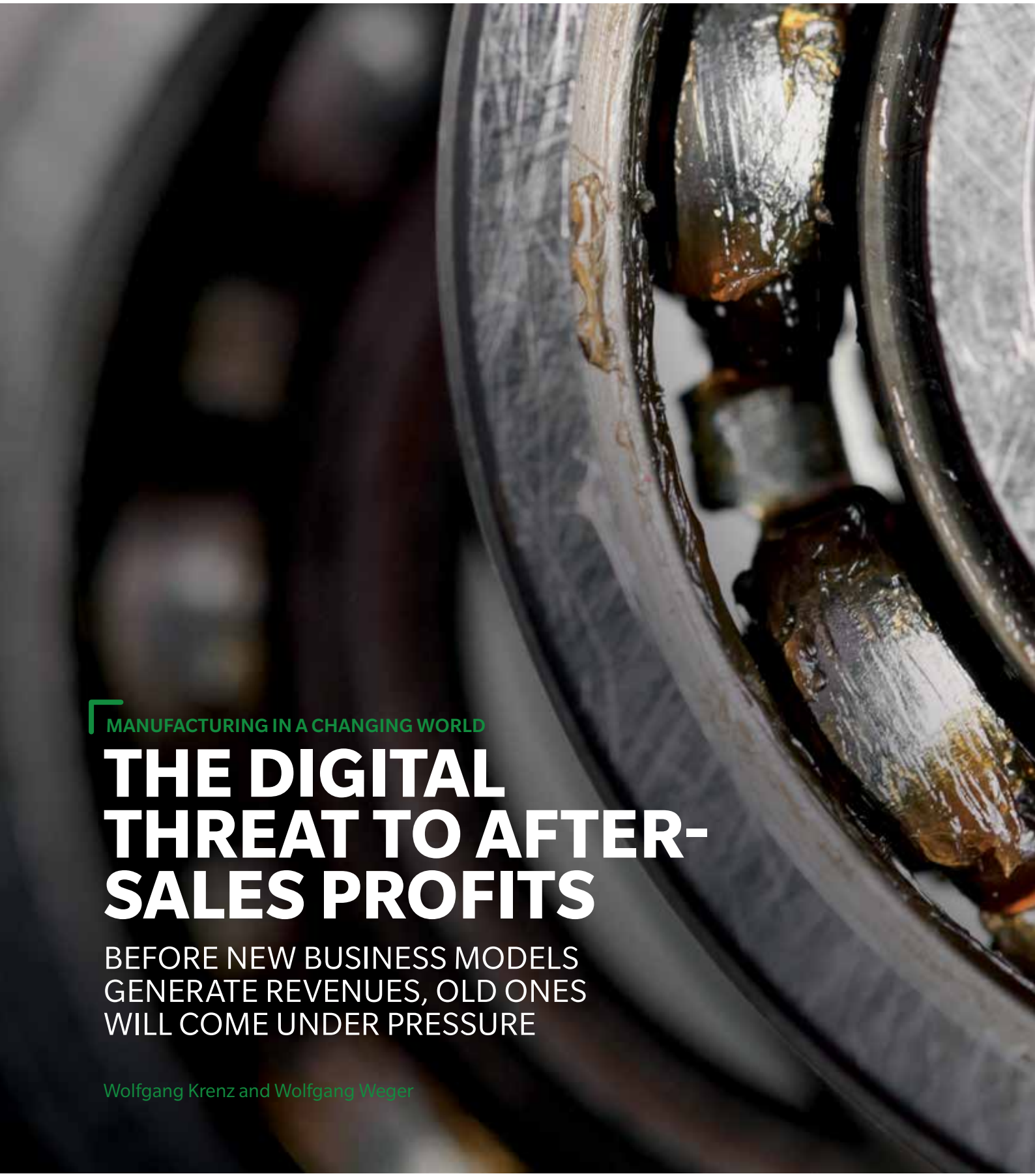


MANUFACTURING IN A CHANGING WORLD

THE DIGITAL THREAT TO AFTER-SALES PROFITS

BEFORE NEW BUSINESS MODELS GENERATE REVENUES, OLD ONES WILL COME UNDER PRESSURE

Wolfgang Krenz and Wolfgang Weger

After-sales businesses – such as spare parts, repair, and maintenance – typically generate at least 30 percent of a machine manufacturer's total profits. But digital technologies are transforming the after-sales business and squeezing profits. To mitigate the impact, manufacturers need to understand the threat to each branch of their after-sales business and develop counterstrategies. (See Exhibit 1.)

The pressure on after-sales revenue is a sobering reminder that digital technologies do not only have an upside potential. Eventually, digital opportunities will come through new business models, but few such new models have been implemented so far – and their contribution to profits has been marginal. Given that reality, manufacturers must play defense and focus on digital threats, which will not wait for new business models to take off.

SPARE-PARTS SALES WILL DECLINE

The challenges are clearest in spare parts, which often account for 80 percent or more of after-sales profits. Four digital developments are responsible for the pressure on the business.

First, condition monitoring will reduce the volume of spare parts needed. Traditionally, parts have been replaced after machine failure or at defined maintenance intervals based on age or length of use. Today, machines are equipped with sensors that provide early warning of a looming failure, such as vibrations that indicate a problem with a bearing, or else measure wear in a part, such as brake-disc thickness.

The result is a fall in demand for spare parts. Fixing a component before it causes the machine to break down often prevents greater damage, so a smaller-scale repair and fewer parts are needed. And, if worn parts are exchanged only when necessary, fewer are needed over the machine's lifecycle.

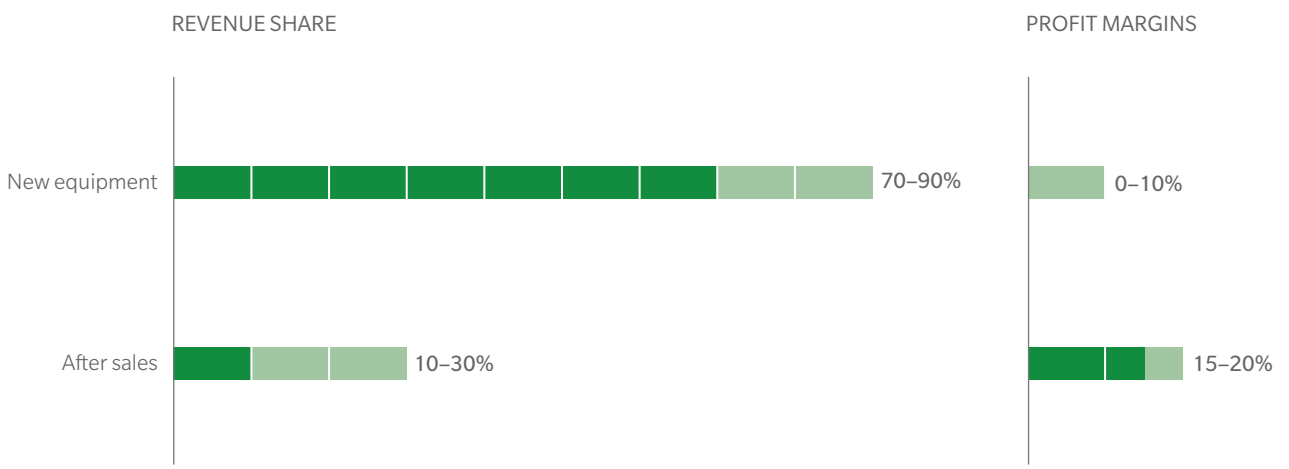
Full-service contracts, based on condition-monitoring and remote maintenance, present a second digital risk to spare-parts profits. These contracts are gaining in popularity as users increasingly consider the total cost of purchasing and owning machinery. Wind turbines, for example, are often sold together with service contracts that cover 10 to 15 years of a turbine's 20-year lifetime.

These contracts contribute to revenue if a manufacturer can charge enough for the service, and are a way to lock customers into consuming its spare parts. However, spare-parts profit suffers, as these parts are not sold separately at higher margins but instead are included in the contract. Moreover, full-service contracts are typically negotiated in the original sale of the equipment, and are exposed to the same kind of price pressure.

NEW WAYS TO OBTAIN PARTS

The third digital development which threatens spare-parts profits is 3D printing. This lets other firms – contract manufacturers, spare-parts distributors, and even customers themselves – print spare parts for faster availability and to avoid expensive stocking of parts. Deutsche Bahn, for

Exhibit 1: Typical revenue shares and profit margins of German machinery companies



Source: Oliver Wyman analysis

example, has started to print spare train parts, ranging from air grilles to headrests. It is planning to print more than 2,000 in 2017 and more than 15,000 in 2018.

3D printing services, such as Protiq, are expanding. Parcel-delivery service UPS has launched an on-demand manufacturing network that offers 3D printing services in select locations in the United States.

3D printing could be particularly relevant for proprietary parts with a design that is specific to a manufacturer. The customer will no longer be reliant on the manufacturer, reducing its pricing power and revenues. In a best-case scenario, the manufacturer will lose only the revenue from the sale of the part itself and may be able to recoup some of the value through its intellectual-property rights on the design. Third parties would need to pay to download the design in order to print it. However, if third parties can scan existing parts and then produce exact copies, then the manufacturer will lose this business entirely.

Online-trading platforms represent a fourth digital threat. Online merchants may increasingly fulfill users' needs for catalog parts – such as screws, drives, and sensors – which many customers have traditionally bought from the machine manufacturer out of convenience. Such digital platforms combine lower prices, price transparency, strong delivery service, and tailored integration with industrial procurement processes. For example, a customer can establish different internal buying roles with specific limits and approval procedures.

Established e-commerce companies, such as Amazon, Alibaba, and Mercateo, have set up online spare-parts platforms as they move into industrial services. Traditional spare-parts distributors, including Eriks, Zamro, and RSComponents, have set up e-branches too.

DEFENDING THE OLD, EMBRACING THE NEW

To manage these risks, equipment manufacturers must understand their exposure, analyzing their after-sales profit streams, segment by segment. They should then prioritize high-risk areas and add a deeper level of analysis focused on customer behavior, competition, pricing dynamics, and exposure under different scenarios. By understanding their exposure, manufacturers can develop targeted defense strategies to prevent or delay the erosion of after-sales profits.

For example, manufacturers might mitigate the impact of online parts suppliers by using more proprietary parts. They could also offer convenient kits for repairs – a single box containing all necessary proprietary and catalog parts. And they can expand their own online parts offering to match or beat independent online platforms by better tailoring it to the requirements of their respective customer groups.

30%

OR MORE OF A MACHINE MANUFACTURER'S PROFITS TYPICALLY DEPEND ON THE AFTER-SALES BUSINESS

Of course, digital technologies do not only create threats. They also present opportunities to improve operational efficiency and customer service. Machine manufacturers could design smart-service contracts that become a basis for upselling and the creation of additional value. For instance, performance contract pricing can be based on a machine's in-service time. Manufacturers can also provide tips on machine optimization and software updates for additional fees. A well-designed full-service contract with variable pricing based on performance parameters could even be more lucrative than selling spare parts to that same customer.

Rolling out such innovative solutions will require changes in the mindset and behavior of manufacturers and customers. These transformations will take time – more time than for some of the digital risks to unfold and eat into profits. But if machine manufacturers do not implement such changes in the long run, they will have to base their profit models on new equipment rather than after-sales contributions – or will have to accept lower profitability. Regardless of this longer-term challenge, manufacturers today depend on after-sales profits, which are driven by spare-parts sales. The short-term priority is clear: Protect the current business.

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BY FUNCTION: NEW SOURCES OF VALUE

BOTS FOR BUSINESS: BEYOND THE SHOP FLOOR

BOTS CAN BOOST MANUFACTURERS' PERFORMANCE, FROM THE BACK OFFICE TO THE SALES FORCE

Juergen Reiner, Markus Mentz, and Daniel Kronenwett

Manufacturing firms will be investing hundreds of billions of euros into the Internet of Things (IoT) and digital automation over the next five years, as they seek to enhance their shop-floor productivity and efficiency. In the past, non-production processes – in sales, customer service, finance and administration, and strategic procurement – have not typically been the main focus of robotization.

But that is starting to change, as robotic process automation – or "bots" – and artificial intelligence (AI) increasingly become capable of performing tasks that previously could only be done by humans. Bots will carry out a significant share of repetitive back-office processes and administration – executing them faster, more reliably, and with greater compliance. (See Exhibit 1.) And they will also progressively address jobs with a lower degree of standardization, for instance in sales and customer service. Financial benefits will be significant. Bots could increase revenues, cut the cost of some processes up to between 60 percent and 80 percent, and improve productivity up to 50 percent.

Exhibit 1: Exemplary use cases for bots and artificial intelligence performing on human tasks

	TASK BOTS (RULE-BASED)	SMART BOTS (GOAL-ORIENTED, REACTIVE)
SALES/QUOTATION	• Basic quotation process • Creditworthiness checks • Account updates • Follow-ups with customers	• Analytical support for sales staff • Lead generation • Cross-selling recommendations • Configuration suggestions • Pricing and discount suggestions
AFTER SALES	• Service alerts to customers • Customer service history update	• Service and spare parts recommendations • Warranty and complaint handling • Digital customer self-service
STRATEGIC PROCUREMENT	• Web "crawling" • Flaws detection • Supplier registration • Account and contract updates	• Demand forecasting • "RfQ machines" • Auction handling
FINANCE/ CONTROLLING	• Basic financial reports • Account reconciliation • Invoice processing • Dunning	• Insights generation for management • Fraud investigations • Early risk warning
HR/ADMIN	• "Answering" basic HR questions • Automated onboarding	• Candidate screening • "Interviewing" via chat bots • Legal contract check-up • Compliance monitoring

Source: Oliver Wyman analysis

AUTONOMY AND BEYOND

An important characteristic of basic bots is their autonomy. Take invoice processing and control, a procedure that typically requires the extraction of data, such as a sum to be invoiced, bank details, and the reason for payment. Each piece of information relies on a different source, such as a supplier database, a file of financial details, and internal information on pricing and discounts.

Software is now able to extract data automatically from scanned documents or photos. A number of startups such as Gini have already emerged in this area, developing software that scans or photographs paper and digital documents and extracts relevant information, such as invoice or contract data. This is then used to fill in forms and pay invoices in a way that merges seamlessly with existing corporate systems.

When controlling invoices and payments, a bot can now have its own system ID so it carries out cross-checks itself. Bots are also system agnostic: Until now, workflows have typically been part of a single IT system; but bots can carry out processes across different systems and databases. That means a bot can automatically maintain and update a manufacturer's supplier databases, discounts, and negotiation statuses.

Taking the example of a European bank, where the potential for process acceleration in the sales back-office function was identified. Robotization significantly reduced throughput time in repetitive tasks, such as customer address changes or customer account opening/closing. In this case, the equivalent of about 100 full-time employees were freed up to address higher-order tasks and work in growth areas.

Advanced bots have two more characteristics that differentiate them from traditional enterprise software: They are goal oriented and reactive to the environment. They are enriched by machine learning, natural language processing, and the ability to process unstructured data, so they can act as cognitive virtual agents to work towards a desired outcome.

This lets them carry out a range of significant tasks that go beyond traditional software. In human resources, for

example, they can automatically screen job candidates using text processing and facilitate a conversation with them. They can automate onboarding processes for new employees, and answer basic questions – such as vacation status – via chatbots. They can monitor actual and scheduled hours worked to flag timesheet issues, and use optical character recognition to automatically evaluate contracts and legal documents. Other applications will come through finance departments, where bots will be able to automate standard processes (for instance, around account reconciliation) and will enable smart robotization in planning, reporting, and risk management.

HUGE DATA, POWERFUL ALGORITHMS

Kreatize, a Berlin startup, has set up an AI-based platform for strategic procurement. Manufacturers often need to search around numerous offers before ordering a specific component, a process that is often manually done. The Kreatize platform enables a manufacturer to upload specifications of a component. The platform then figures out the best process for making the part, and matches the manufacturer with an appropriate supplier. This idea could be extended to setting up online procurement auctions and issuing invitations to suppliers automatically.

In customer service, some manufacturing firms already start the follow-up service and spare-parts process based on a trigger point, such as an alert over oil pressure or the state of a tire. Customers get recommendations for spare parts and additional services grounded on an analysis of their existing, connected machines and their historic spending patterns.

Smart bots will be able to use deep-learning algorithms and AI to improve text and voice recognition. Communication with customers, suppliers, and corporate decision makers will then be done through chatbots. In sales, data pattern analysis can be used to suggest prospecting areas or cross-selling opportunities to sales reps. The price quote process can be robotized and enhanced with a chatbot that automatically delivers a proposal with a price based on past quotes, automated creditworthiness checks, or a customer's business history. This kind of bot will even be capable of making decisions based on accumulated experience.

DEVELOPING A FORMAL BOTS STRATEGY

Three out of four international decision makers believe bots with AI will play a fundamental role in increasing revenues and cutting costs. In German-speaking countries, one in five businesses already use AI or else have a pilot program in place. Global revenue with machine learning and cognitive-computing solutions will multiply by five times, to more than 21 billion euros by 2020, according to Bitkom.

UP TO 50%

PRODUCTIVITY IMPROVEMENTS BY USING BOTS

To generate value, companies should identify high-impact value pools and use cases, and launch agile pilot-based approaches. The best places to start are processes featuring high-volume, repetitive, rules-based processes that leverage large sets of structured data and feature limited room for human discretion. Smart bots can then be used on unstructured data and more complex decision trees.

But a plug-and-play approach is not the right approach. Instead of setting up bots here and there, companies need an overall digital transformation plan that takes into account their skills and organizational structures. And they have to be ready to invest into robotization tools and machine-learning software that will be able to handle analytics, automation of a number of internal processes, and interaction with humans.

Tech with human characteristics often provokes fears of mass job losses. But companies using bots usually do not reduce their number of employees. Instead, they train them for higher-order tasks or deploy them to improve system intelligence. Moreover, bots may dampen the trend towards global outsourcing that first began 30 years ago. While delegating part of a process to an external third party in a low-cost country reduces costs, it brings its own set of challenges, including time delays, poor communication, and lost efficiency. Bots could well slow the trend of offshoring, and replace it with a new one: Cybershoring.

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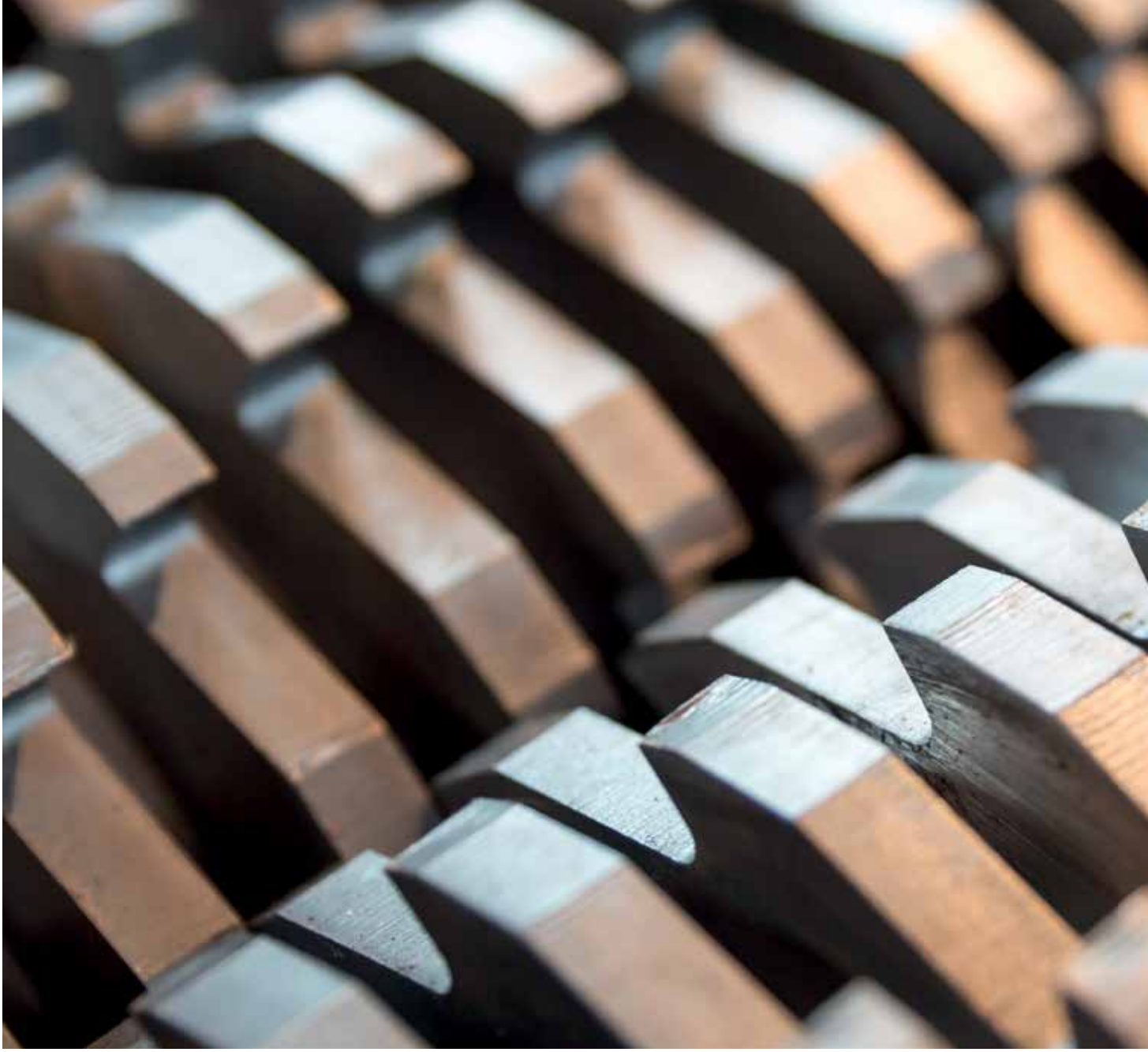
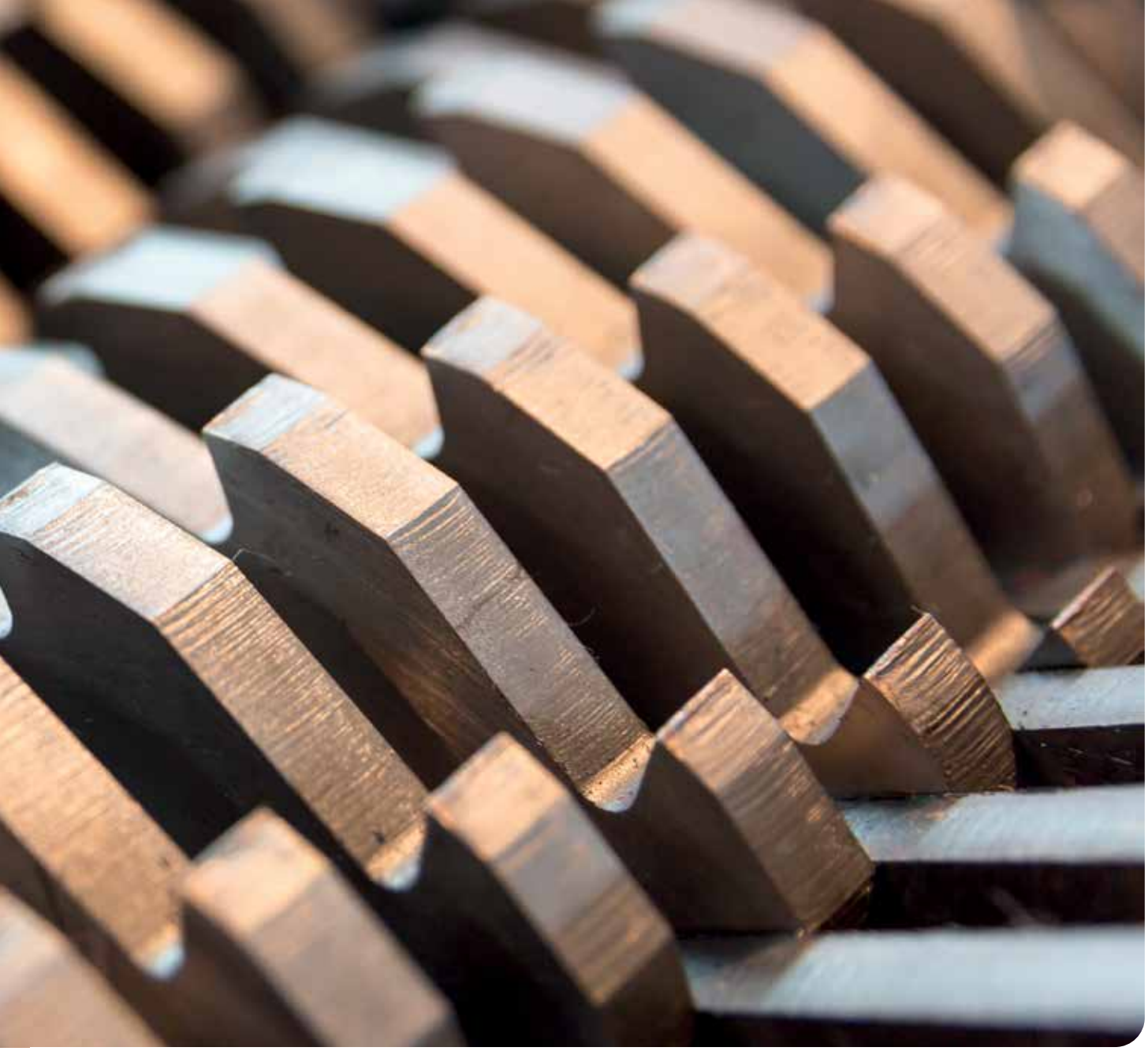


BY FUNCTION: NEW SOURCES OF VALUE

CUTTING PRODUCT COSTS AT THEIR ROOTS

A NEW FOCUS CAN SLASH COSTS AND PRESERVE VALUE

Christian Heiss and Federico Ucci



For years, manufacturers attempted to cut the cost of making a product by taking aim at individual parts or raw materials and the companies that supplied them. Cut the price of the things that go into making a product and a company could lower the manufacturing costs and increase profitability. But those fixes are temporary, and need to be constantly renegotiated.

More importantly, they do not lead to a better product; in fact, quite the opposite at times. Despite decades of cost-cutting efforts across all industries, as much as 25 percent to 45 percent of all costs in engineered products add no value to the product or customer, according to our research. Those findings would indicate that manufacturers are not only looking at cost-cutting incorrectly, they are wasting a lot of time and effort doing it.

Exhibit 1: The next generation of product cost reduction will address non-value-added costs

Source: Oliver Wyman analysis

What would be a more productive way to cut costs? Look at the product itself, the function it is expected to perform, and ways it could do it more efficiently. Take, for instance, controlling temperature on train cars. A passenger train car manufacturer could attack the problem by simply asking the maker of the insulation panels to cut the price they charge. But in the new environment, the more effective way to reduce costs would be to rethink the entire thermal control function and how cars are heated or cooled. Is there a way to insulate more efficiently? At the end of that question may be a solution that allows a manufacturer to not only cut costs, but also increase prices on a more competitive product.

The focus in next-generation cost reduction is the consumers of the product, whether in a business-to-consumer or business-to-business environment. Understanding customer needs can result in not just a cheaper product, but a better, more effective product when it comes to fulfilling customer expectations.

Does a product do more than customers actually see and appreciate? Instead of traditional, component-based savings, manufacturers are taking aim at functions and components that increase costs but add little value and are irrelevant to the customer. Technical specifications and customer requirements should correlate, and where they do not manufacturers may find potential areas of over-specification and costs that do not add value. For instance, there is no need to design a train car body to function properly at 120 kilometers per hour if the train will only run at 90.

THE OLD WAY

Cost cutting has been a priority for decades in industries subject to global competition, such as consumer electronics and the automotive industry. Traditionally, efforts followed a company's organizational structure: The purchasing department was instructed to cut prices on materials; production was asked to reduce production costs; and engineering was told to "design to cost." Setting targets for each organizational function was an easy approach, as managers could be instructed to meet targets for their departments.

Not surprisingly, many of these efforts produce sub-optimal results. For example, an automaker's purchasing manager may be able to obtain a 2 percent price reduction on wiring harnesses if a supplier does not pack them in the correct assembly sequence. But this gain translates into a burden for production, which then has to pay for someone to unpack and sequence the harnesses for assembly. In

this case, savings in one department led to higher costs in another.

Even when manufacturers create cross-functional initiatives, in which teams from procurement, engineering, production, and quality-control tackle the costs of wider systems, modules, or product groups, they are apt to come up with short-term solutions if managers are only asked to focus narrowly on simply cutting costs.

Both of these approaches lead teams to neglect potential quality and assembly readiness issues. Suppliers are often brought into the process too late and thus have little impact on design choices. For instance, a supplier may be developing a manufacturing process that reduces the number of parts and material needed. But cost-cutting efforts by the manufacturer will not take that work into account if the supplier is not involved early on in the process. Worse still, suppliers are chosen based solely on cost and not capabilities and quality.

Additionally, cost reduction is traditionally limited to a specific project. Thus, an action that reduces the cost of one product may be left out of another product line or the next version of the product. Plus, this approach risks cutting out features that customer's value.

ASK THE RIGHT QUESTION

The key is often whether the efforts are asking the right questions to begin with. Take, for instance, an automotive drum-brake supplier who faced problems several years ago with glued brake pads. The initial solution, which was approved during the car's launch phase, involved the addition of rivets to help secure the pads. The solution was taken into the Failure Modes and Effects Analysis (FMEA) and slated to be implemented in all future drum brakes. But the problem in the end was not the glue; it was the surface of the pads in combination with the specific adhesive.

Uncovering the root cause was not as easy as adding the rivets, but tracking back to determine the underlying cause made the prices on the brakes competitive again for all models on which the pads were used. Nowadays this solution is almost industry standard and the rivets have been eliminated entirely.

The next-generation approach is liberated from organizational structures, and its focus on such root causes achieves a long-term impact, affecting future products. Our consultants have determined that there are more than 20 areas that can be studied that will help attack causes of costs in manufacturing, including specification flow down, functionality interference, advanced test simplification and technical-margin rationalization. For automakers and consumer-electronics manufacturers who face increased cost pressures because of a rapidly changing business environment, increased competition, and disruptive technologies, this new approach allows them to go far beyond the cost-cutting approaches they currently have in place.

25-45%

OF ALL COSTS IN ENGINEERED PRODUCTS ADD NO VALUE TO THE PRODUCT OR CUSTOMER

Next-generation cost reduction will also help medical equipment and precision equipment manufacturers. These firms have been reluctant until now to attack costs, equating cost reduction with quality risks. With the new approach, features that add substance to a product will be exempted, and the focus will instead be on those that add to cost but not the ultimate value.

In this new world, cost cutting will lose its negative implications and become an exercise to make products more efficient and customers happier.

This article first appeared in IndustryWeek.

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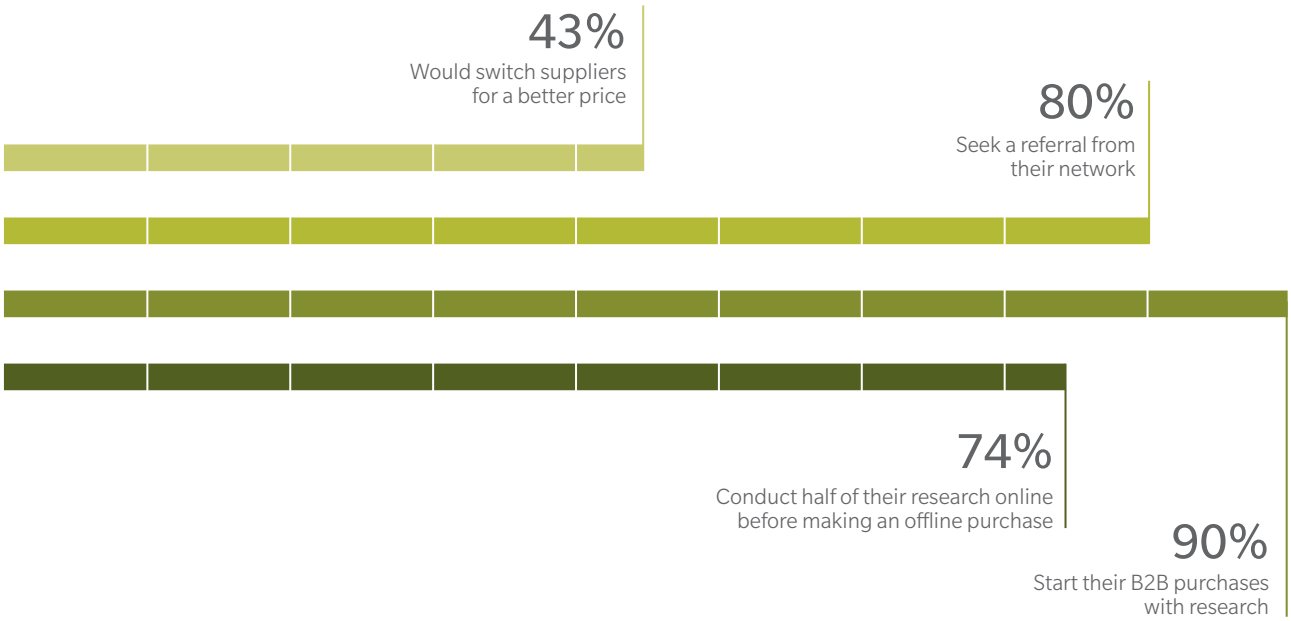
BY FUNCTION: NEW SOURCES OF VALUE

SURPRISING OPPORTUNITIES IN B2B PRICING

NEW TOOLS CAN HELP SALES FORCES ACCESS ADDITIONAL VALUE

Wolfgang Weger and Henning Tielker

Exhibit 1: How B2B buyers purchase today



Source: Forrester Research

Over the past 10 to 15 years, manufacturing companies have implemented a range of improvements across various parts of their business. They have optimized their cost structures, globalized their supply chains, augmented their after-sales businesses, and made other improvements. But one function remains under-managed and unimproved: pricing.

A tremendous gap separates best-in-class and average players in pricing and commercial effectiveness, which means there is ample room for manufacturers to improve margins. While companies in theory know how to set correct prices, most struggle to implement the right governance systems and decision-support tools. The task is all the more difficult as the pace of decision making is likely to increase going forward. Introducing advanced analytics and other tools to support real-time decision making can lead to margin increases of between 5 and 10 percent.

PRESSURE TO CHANGE PRICING METHODOLOGY AND SET-UP

Problems related to business-to-business (B2B) pricing are typically the result of a combination of factors. Outdated pricing systems are often based on "cost-plus," and do not fully take into account the external market environment. This often makes prices less competitive in some segments and prevents the full exploitation of margin opportunities in others.

Tools that do not support efficient and effective decision making are another source of problems: The tools may be able to show a variety of key performance indicators, but are not really helpful in making pricing decisions. And sometimes the pricing function is weak in terms of global reach and alignment, or else it lacks the analytical and strategic capabilities needed to manage the process in a complex external environment. As a result, prices are hard to explain and justify, particularly when comparing different products, customers, geographies, and transaction types. Prices often seem to be based on gut feeling, instead of analytics and a customer's willingness to pay.

Another force for change is online purchasing. B2B sales are today still largely conducted offline, but online sales will account for 27 percent of total B2B manufacturing trade in 2020, according to Frost & Sullivan, a market research firm. And already today 74 percent of buyers conduct half of their research online before making an offline purchase, according to Forrester Research. (See Exhibit 1.) Sooner or later this will have a substantial impact on B2B commerce, whether players like it or not, and management will need to rethink pricing and commercial effectiveness. Setting up

and properly maintaining the optimal online pricing system will soon be indispensable.

The growing importance of the online channel will bring with it other challenges. Companies will need to set up their commercial function, including pricing, for a multi- or omni-channel environment. Just managing prices via direct orders – phone, email, or personal visits – or in an online shop will no longer be sufficient to compete. Online marketplaces are also growing, with online retailers expanding into B2B environments and platforms serving as aggregator or comparison sites. They will heavily influence how companies manage price points in their traditional sales channels, which have been sales agents, wholesalers, and foreign subsidiaries or affiliates.

While it is theoretically manageable to set correct price points across channels, most companies struggle to implement the correct governance systems and decision-support tools. This will remain difficult, because the pace of decision making is likely to increase. Moreover, the digital disruptors of the online retail world are certain to arrive, bringing with them very different cost structures and objectives, yet many companies have still not figured out what is the correct response, both in terms of offerings and price points.

NEW WAVE OF TECHNIQUES

To overcome these challenges, the pricing and commercial function needs to be better equipped to deal with this more complex environment. Several levers can improve pricing as part of a sustainable, ongoing effort. First, a more analytical approach combined with an advanced pricing system can help go beyond the traditional cost-plus method. The criteria related to product, customer, and order type that drive price perception and sensitivity should be clearly identified. This can then help to replace a one-size-fits-all pricing approach in order to better target all available margin pockets. To achieve this, the pricing methodology needs to make greater use of the company's own data and incorporate information from the outside on factors such as customers' needs and willingness to pay.

Second, a more global approach to pricing should allow discretion at the levels of region, business unit, and sales rep. A lot of knowledge still resides with staff on the ground – for example, the competitive intensity and price levels in a particular region. Prices for similar products and customers can easily fluctuate by between 10 and 20 percent depending on a particular customer's situation and the business objectives the company is pursuing vis-a-vis that customer. So it is important to have a degree of local input on pricing. This should be combined with a harmonized approach, including clear rules, such as price lists, discount structures, and surcharges.

27%

OF TOTAL B2B MANUFACTURING TRADE WILL BE MADE UP BY ONLINE SALES IN 2020

A third lever is tailoring tools to meet the needs of the sales force in real time. Such tools would have simpler metrics highlighting the business evolution or potential white spots of a customer – that is, product areas where the customer's demand is not being met. Concrete price recommendation tools would guide the sales force in setting prices. Also useful would be visibility and control tools that help track sales-rep pricing performance. If management and sales teams design these tools together, they can make them much more powerful than off-the-shelf tools: They will be user-friendly and not be perceived as an administrative burden, and will be used proactively by both the sales force and management.

Companies today are wary of raising their prices above industry inflation levels, given customer resistance to hikes in prices. But price increases may be more palatable if they are tailored to individual products and customers, and are based on strong analytics, enabling salespeople to justify the increases. Implementing new and easy-to-use tools is critical toward making price changes stick. To generate such tools, senior management must pay greater attention to pricing and invest in the necessary capabilities. The payoff can come quickly.

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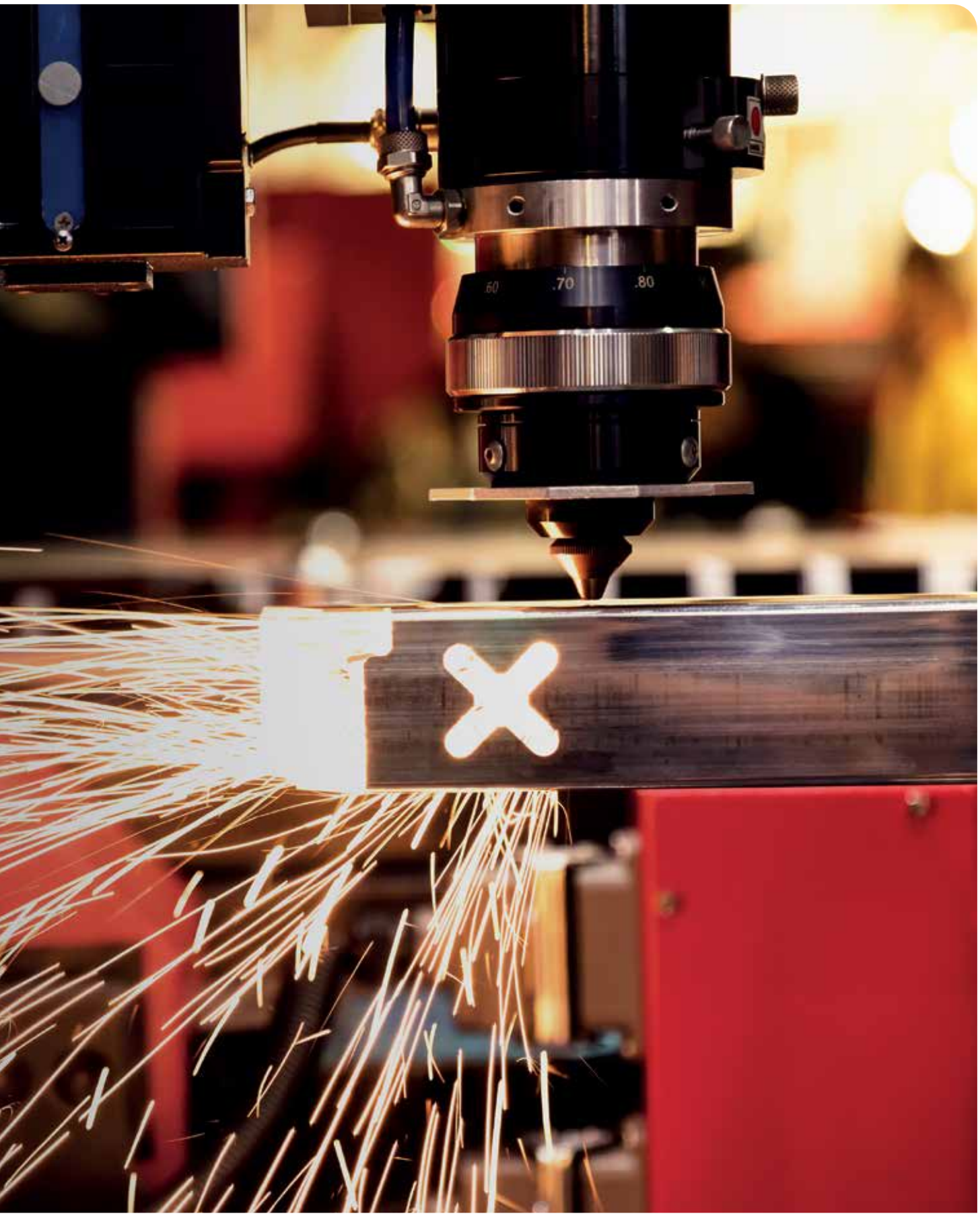
BY FUNCTION: NEW SOURCES OF VALUE

QUALITY AND RELIABILITY IN A COMPLEX WORLD

MACHINERY MANUFACTURERS MUST ADAPT AS THEIR SUPPLY CHAINS GO DIGITAL

Richard Hell


60
.70
.80

The machinery industry is becoming increasingly digital and agile. At the same time, however, customer focus – together with product quality and adaptability – are becoming more important market differentiators. Machinery manufacturers now must deal with the digitally spurred challenges of quality management, integration of ecosystem partners, and systems reliability to position themselves ahead of the competition.

Traditionally, manufacturing machine makers kept a tight rein on their individual products and the value created by them. But digitalization is now changing all that. As production machines become integrated seamlessly into supply chains, clients are looking for greater insight into operational data and the ability to take active control of their machines and production centers.

One outcome of this process has been greater collaboration between equipment/machine systems providers, machine manufacturers, and component suppliers in terms of systems integration and risk sharing. But along with digitalization and integration comes a hidden cost: Machine makers will need to deepen their understanding of functional and operational constraints across the entire value chain. Only then will they be able to offer customers the higher levels of quality, reliability, and flexibility they are seeking.

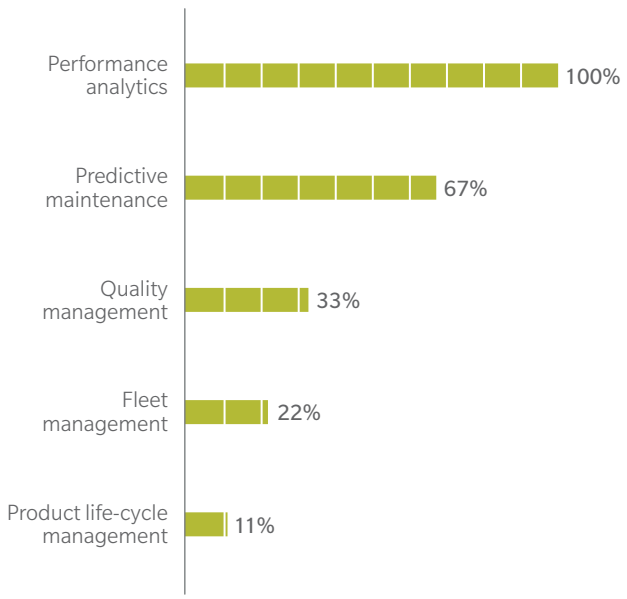
THE BENEFITS OF TRANSPARENCY

A major benefit of digitalization is the ability to analyze and optimize machine performance in real time, using data generated by embedded sensors or cyber-physical systems that is then fed into industry clouds. (See Exhibits 1 and 2.) Leveraging this production data can lead to significant performance and cost improvements: Real-time monitoring of the latest networked paper manufacturing machines, for example, minimizes energy and material waste. It also avoids unplanned downtime as third parties can provide targeted offers for auxiliaries, spare parts, and maintenance services.

The enhanced transparency of manufacturing systems and their operations will enable customers to see new potential improvements and act immediately. Instead of being content with a normal bottling machine, for example, a beverage maker might instead require that the machine be designed to continuously optimize its own operation and be adaptable for instantaneous changes, such as handling the latest on-trend bottle designs.

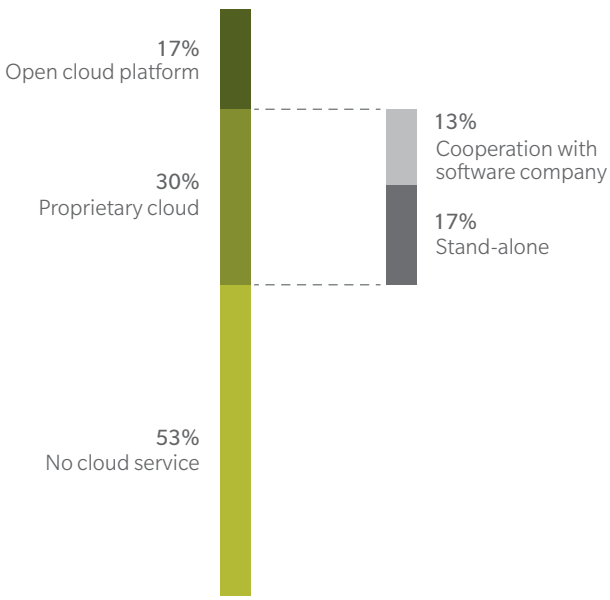
While this may be ideal from a customer perspective, it will put unprecedented pressure on machinery manufacturers to better understand the entire manufacturing system within which the machinery operates, from technical constraints to functional behavior and performance boundaries.

Exhibit 1: Use cases of proprietary cloud offerings for machine manufacturers



Source: Oliver Wyman analysis of proprietary manufacturer cloud service offerings

Exhibit 2: Cloud offerings of 30 German manufacturers



Source: Oliver Wyman analysis of manufacturer cloud service offerings

DIGITAL CHALLENGES FOR QUALITY AND RELIABILITY

Digitalization will enhance machinery manufacturers' ability to visualize their own supply chains, enabling them to improve transparency into component suppliers and thus the quality of their machines. Such close working partnerships will be especially important as machinery manufacturers' clients demand ongoing enhancements tailored to their production activities.

Manufacturers are likely to see a rise in quality and reliability concerns, as an increasing number of interfaces between system components and value chain partners introduce greater variation in the component structures of machines. Machine manufacturers will have to be attuned to relationships, interactions, and potential gaps in transparency to determine how the quality and reliability of its machines within a production system might be impacted. And, in turn, this information will need to feed into performance optimization data.

Reliability engineering and testing will need to be designed and executed with a functional orientation – going beyond the boundaries of individual component groups to cover the scope of an entire system. Advanced risk management will be used to qualify and quantify high-risk areas and prioritize the most critical areas for review.

A VIEW TO NEW BUSINESS MODELS

By taking an integrated, responsive approach to quality, reliability, and risk management, manufacturers can generate more value for customers in refining machine and production system performance, which in turn could lead to new business models. In aerospace, for example, airlines are switching to usage-based pricing models for engines, paying a fee to the manufacturer for each takeoff and landing, rather than buying the engines outright. Machine manufacturers could move from selling one-off machines, to generating ongoing revenue based on machinery uptime and other key performance indicators. So, for example, a client that wants to use automated welding equipment might pay per successful welding point rather than buying an automated weld line.

Machinery manufacturers also could increasingly take on the role of systems integrators, managing a downstream supply chain that is seamlessly integrated with and responsive to changing real-time customer needs. Doing so would require adopting advanced analytics and artificial intelligence to build improved models and simulations, but could result in powerful new sources of value.

30%

OF 30 SURVEYED GERMAN MANUFACTURERS PROVIDE PROPRIETARY CLOUD SERVICES

In sum, technology developments like cloud computing and the Internet of Things are quickly moving beyond consumer-facing products to envelop the entire production value chain. Machine makers may find this new level of integration and digitalization challenging, but keeping pace with the functional and operational evolution of production systems will be critical to meeting their customers' digitally enhanced needs for seamless, transparent, and real-time information and adaptability.

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BY SECTOR: NEW TECH, NEW STRATEGIES

CONSTRUCTION MACHINES IN THE DIGITAL AGE

CONSTRUCTION EQUIPMENT MAKERS NEED TO FIND THEIR PLACE IN SMART-BUILDING SITES

Romed Kelp and David Kaufmann

At first glance, giant earth-moving excavators and bulldozers would not appear to have much in common with the microchip-based worlds of drones and multi-dimensional imaging. But in the Digital Age, they will all be connected and have to work as a team.

Construction equipment itself has lagged in digitization, but it is about to undergo the same digital disruption that has hit information-based industries and is now being felt in the automotive and commercial-vehicle sectors. The first wave of digitization is already arriving in construction machines, which are becoming increasingly automated and connected, enabling operators to deploy them more efficiently. A bigger change will come as construction projects go digital, in particular through building information modeling (BIM), which will accelerate the deployment of smart, connected heavy machinery.

Equipment manufacturers' success will be determined by how effectively they apply digitized machines in this connected ecosystem. Digitization is not about to replace construction machines, but customers are likely to select the equipment providers that best execute the new digital possibilities.

NEW ERA, NEW VALUE

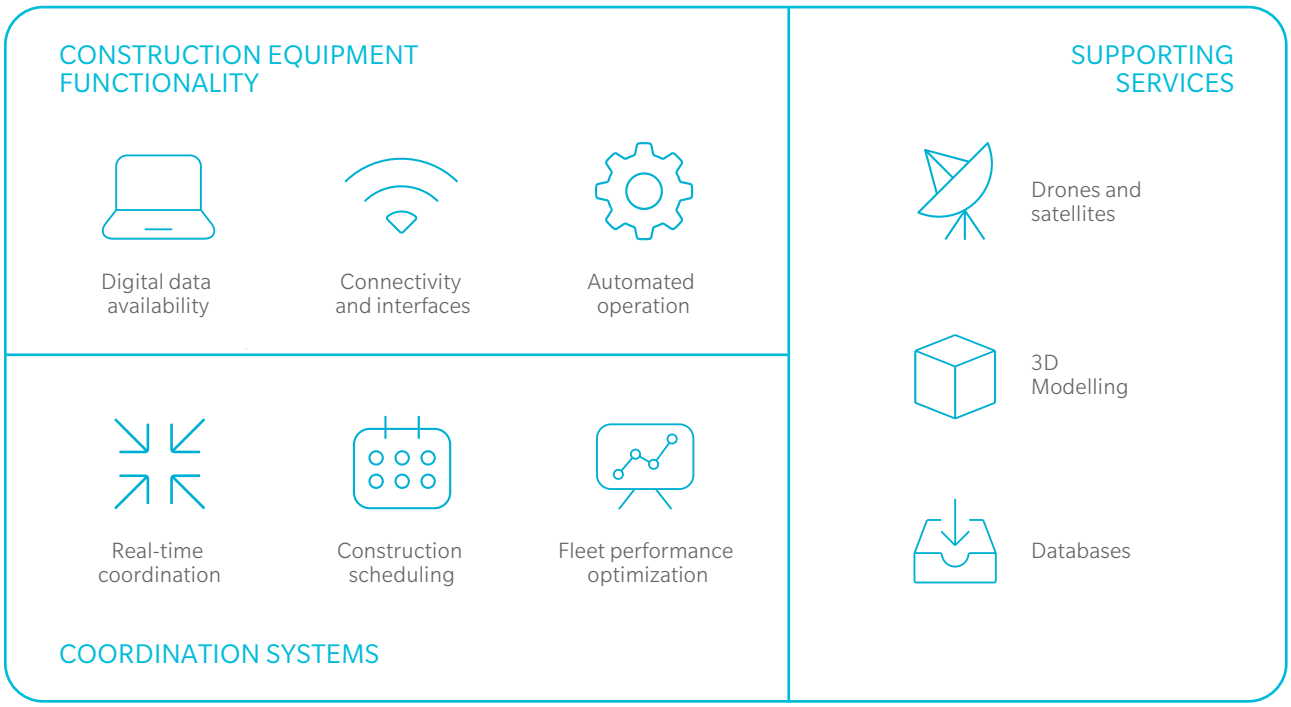
The changes will open up new possibilities after a few lean years. European construction equipment sales peaked back in 2007, while global sales reached a high of US$102 billion in 2011 and were likely just US$72 billion in 2016. Global demand is expected to grow at about 5 percent per year until 2020, but this will still leave construction equipment sales well below its peak. Digitization – whether or not it boosts sales of machinery – will give equipment makers an opportunity to broaden their product offerings and thus provide extra sources of value. Players that seize the initiative will do better in the new era than those who wait for change to happen to them.

Most of today's construction machines track information such as idle time and fuel consumption, enabling managers of building sites and public-works projects to make better decisions on the use of their fleets. However, a first major change will come from part or full machine autonomy going mainstream after 2020. A compactor, for example, will be able to adjust its operations to different surfaces and environments, such as the presence nearby of sensitive structures. It will also be able to carry out much of its work automatically – or at least with minimum human input, often remote. Predictive-data diagnostics will make maintenance smoother and less costly: To avoid unplanned downtime, for example, components will be replaced before they malfunction, but not so early as to be wasteful. Operators will also be able to coordinate groups of machines more easily, so that they operate as one, speeding up each phase of a project.

THE CONSTRUCTION SITE OF THE FUTURE

The second stage, which will begin in the early- to mid-2020s, will take fleet coordination even further, using operational and performance data from equipment to help coordinate construction projects. The construction schedule might then be adjusted iteratively, taking into account various factors, such as the work being done by the machines and physical location of the machines needed for the next stage of the work. Construction companies could ask machine manufacturers to create common data standards to facilitate scheduling that involves different makes of equipment.

Exhibit 1: The future digitized construction industry will be more connected and will shift to integrated systems



Source: Oliver Wyman analysis

A third major change will come as construction machines acquire new, highly automated capabilities, and BIM goes mainstream. BIM uses a virtual construction site, consisting of a digital model of a building project that includes construction schedules and costs. The modeling enables construction companies to implement a version of lean production, with just-in-time delivery of materials and components. Engineering and construction costs are expected to be reduced by around 20 percent thanks to better coordination of all the input factors. So BIM is both a challenge for makers of construction machines – because it demands more advanced, digitized equipment – and a means to helping customers boost the efficiency of construction and reduce costs. Construction equipment companies will need to adopt and integrate a "smart construction site" approach, where all aspects of building (including machinery) are connected to the BIM and to each other. And to leverage new efficiencies and reduce costs, they will have to stop operating in silos. (See further information on "What is BIM?")

CONSTRUCTION MACHINERY FIRMS NEED TO PUSH DIGITAL SOLUTIONS

Equipment manufacturers need to figure out the best approach to succeed in this new era. It is essential for them to digitize their machines, so that they can be connected to the digitized environment. But that alone will not be enough. Digitized machines will be more transparent to their customers in terms of performance, breakdowns, and costs. Hence, new strategies will have to be found to cope with this transparency.

So, equipment manufacturers that limit themselves to basic digitization might find their offerings treated as commodities. They will provide more value if they integrate further capabilities and fully become part of the "smart construction site." These could include digital systems to schedule construction in real time and coordinate fleet performance beyond their own machines. Or, they could provide support services such as drone-based monitoring of performance and progress. Some equipment makers might try to offer all such services in an integrated package to provide a strong, differentiated offering and capture a large portion of the new value pool. (See Exhibit 1.)

Strategic intent will not, however, be sufficient. The new construction capabilities will generate new competition, both from traditional rivals in the equipment industry and from new digital players and software systems providers. Surviving will require quick, effective implementation of digital tools and services, which will in turn require new skill sets. To stay ahead – and even keep up – equipment makers will need to engage with a world far beyond the traditional construction site.

20%

REDUCTION IN BUILDING COSTS EXPECTED FROM BIM

What is BIM? Building information modeling (BIM) is a digital tool that promises to revolutionize construction in terms of operations, offers, and client experience. BIM is a 3D representation of a building or infrastructure project, which allows architects, engineers, contractors, facility managers, and owners to design, build, and operate more efficiently. Phases, components, functions, and costs are planned from conception to demolition, enabling digital management of the entire construction project throughout its lifespan. That includes, for instance, just-in-time delivery of materials, machines, and diverse components.

Operating in real time, the digital mock-up is alive and collaborative, and lets all project participants provide inputs over three defined stages. It allows digital simulations to be run, enabling rapid testing and redesign before, during, and after physical construction. Progress can be monitored with support from technologies such as drones and 3D laser scanning. BIM will also facilitate prefabrication, and it will soon connect with geographic information systems (GIS) for additional data input on the environment.

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BY SECTOR: NEW TECH, NEW STRATEGIES

BUILDING TECHNOLOGY: MORE DISRUPTION AHEAD

SMART SERVICES AND SOFTWARE WILL ALTER THE COMPETITIVE LANDSCAPE

Wolfgang Weger and Xavier Ruaux

Building technology is entering a new era thanks to smart services, software, and the Internet of Things (IoT). Traditional product-centric suppliers will be greatly challenged by a host of emerging competitors and digital disruptors. To survive and prosper over the next decade, these incumbents will need to master or acquire digital capabilities and rapidly enhance their commercial effectiveness, organizational flexibility, and operational excellence.

Building technology includes the automation systems, electrical distribution, HVAC (heating, venting, and air conditioning), lighting, and safety/security in buildings. The sector is now undergoing a fundamental transformation that will severely challenge traditional industry structures and businesses. "Enhanced building technology" is currently in an explosive growth mode, with the market projected to reach US$600 billion in 2025. By that year, we expect that nearly half of the industry's market value will migrate to new emerging markets beyond products and hardware, including smart services, software, and the IoT.

Ten years from now, the building technology business will look completely different: Software and services will increase in relevance and in some cases replace hardware;

products will in many instances become commoditized as increased functionality moves into the cloud; and traditional channel structures will break up.

As a result, from an incumbent's perspective, the competitive landscape will become far more complex and dynamic. Incumbents will face off against novel business designs, including giant digital disruptors such as Google and Amazon, large-scale telcos and software companies, and smart-services startups. All will be competing for customer access, channel or strategic control, and new value spaces.

Not all incumbents are prepared to address these fundamental challenges and to drive their own destiny. But the rapid pace of development means that there will be no time to sit and ponder. Incumbents will need to master digital strategy and capabilities and enhance their commercial effectiveness, organizational flexibility, and operational excellence in short order.

THE PAST DECADE

The building technology sector has been fairly stable over a long period, with a well-established industry structure comprising product providers, service companies, and wholesalers. The sector rebounded from the financial crisis of the late-2000s and has grown moderately, driven primarily by the residential building construction segment. There have been substantial differences in regional growth rates, however, with virtually no growth in Europe, moderate growth in the Americas, and high growth in Asia. Historically, the global market has been relatively "protected" from external threats thanks to geographic technical norms that ensure good practices and safety, strong relationships between equipment manufacturers and specialized wholesalers, and prescription power for electricians.

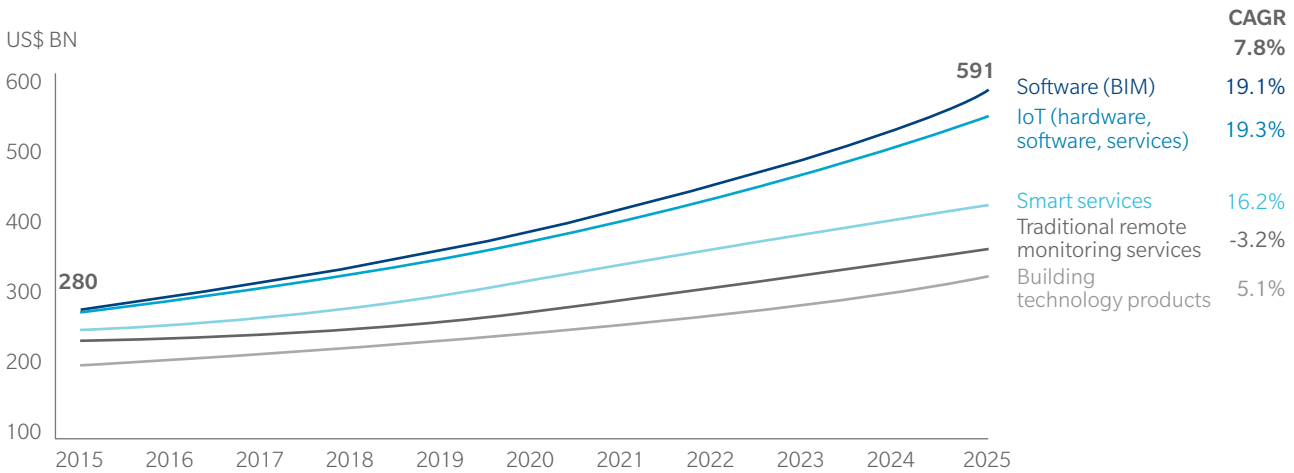
Overall sector profitability is high, with profit margins averaging 11 percent over the past five years. However, there is a significant range in performance across companies, indicating differences in strategic position and levels of operational and commercial excellence. One key contributor to corporate growth has been high levels of mergers-and-acquisitions (M&A) activity, with the goals of sector consolidation through portfolio enhancement, regional expansion into new geographies, and moves toward emerging technologies.

Thus it appears that incumbents should be in a fairly good position to embrace new growth opportunities and continue improving operating performance and financial returns. The breakneck speed of emerging technology trends, however, will force incumbents to move much faster than they may desire; indeed, they will need to rethink everything if they are to play a significant role in the industry a decade from now.

NEW CUSTOMER AND TECHNOLOGY TRENDS

Disruptive technologies and changing consumer expectations around connectivity, energy efficiency, and security are the drivers of the fundamental changes now occurring in the building technology sector. These drivers

Exhibit 1: Potential value migration in the enhanced building technologies market, 2015–2025



Source: Memoori, Freedonia, IHS, Navigant, Transparency Market Research, Oliver Wyman analysis

are leading to the creation of sizable new value spaces and strategic control points, and the emergence of new business designs. Within the next few years, many traditional rules of the business will no longer be valid.

We expect that the sector will grow tremendously through 2025, but the vast majority of growth will come from areas outside of traditional building technology products. In particular, IoT products and services, building information management (BIM) software, and smart services are poised for stellar growth. (See Exhibit 1.)

Enhanced building technology will attract new types of companies: Digital disruptors and software companies, telcos and utilities, and smart-services startups all have potential points of entry that will enable them to challenge traditional industry structures and established strategic control points. This new breed of competition poses a serious threat to incumbents. That more than half of the traditional building technology market will be in Asia adds to this challenge.

THE PATH FOR INCUMBENTS

Thus the nature of the business will be radically different 10 years from now. Software and smart services will gain significant share as they take over traditional hardware functionality and replace traditional on-site services. Increased cloud functionality will enable cheaper solutions and replace some traditional hardware and products.

Furthermore, the changing purchasing patterns of younger generations, combined with compelling offers from digital disruptors, will likely lead to the breakup of traditional channel structures. Online business will become the dominant channel both for B2C and B2B and will erode the traditional boundaries between the two universes.

What this means is that the business models that enabled building-technology incumbents to grow profitably in the past no longer guarantee future success. While some areas are better protected, we believe that traditional B2B equipment manufacturers, facility management, and wholesale channels will face significant pressure.

To fend off emerging competitors, incumbents will need to master four interlinked areas: Digital business design, commercial effectiveness, organizational agility, and operational excellence:

Digital business design: Incumbents will need to tailor their business designs to capitalize on emerging trends, find new sources of profit, and maintain strategic control in the face of new competitive threats. New offers will need to be personalized to specific uses, such as less product push and more customer-centric focus on usage in the building. These proposed solutions will need to be increasingly sophisticated, and data management and cybersecurity will be increasingly important.

Commercial effectiveness: Incumbents will need to respond to the commercial models of digital distributors and multi-channel challengers. This could involve redesigning their pricing models and go-to-market systems. Creating and maintaining customer loyalty and managing the leading generation of user "communities" will become key goals.

Organizational agility: Incumbents will need to embed elements common to fast-moving organizations, as they will have to increase their speed and agility in areas such as customer-facing interaction and product development, as well as product launches. Interdependence between actors on the value chain will rise in importance with the increased use of collaborative tools within and without the company (such as BIM) as well as strategic partnerships.

Operational excellence: In-house cultural change will be required to foster innovation, entrepreneurial spirit, engagement, and retention. Product commodification and the need to defend against lower-cost players will make flawless execution a priority, as well as the competitiveness and differentiation of offers.

The building technology industry is still highly fragmented. Thus M&A and partnerships could be a way to build up both the scale and capabilities across these four areas quickly and meet the industry's bold new future head on.

US$600 BILLION

MARKET SIZE FOR ENHANCED BUILDING TECHNOLOGY BY 2025

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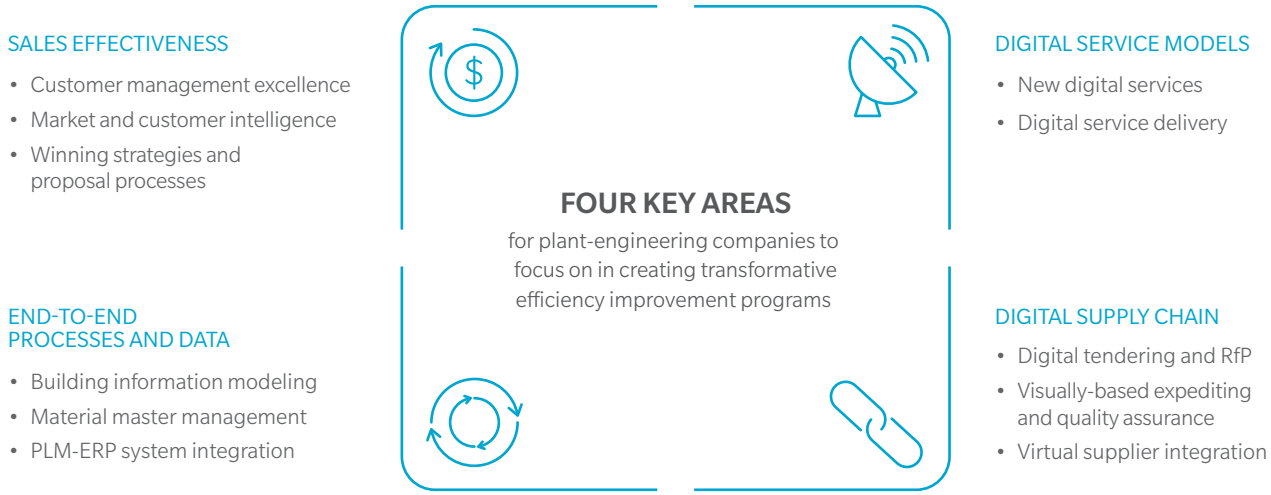
BY SECTOR: NEW TECH, NEW STRATEGIES

PLANT ENGINEERING: LOOKING BEYOND RESTRUCTURING

FIRMS MUST PRIORITIZE EFFICIENCY AND GROWTH

Nico Hartmann, Wolfgang Weidner, and Bo Kaunitz

Exhibit 1: Typical agenda in plant engineering



Source: Oliver Wyman analysis

Established plant-engineering companies in Europe, the United States, and Japan have to find ways to efficiently deliver the newly generated order backlog. After showing only moderate growth over the past decade, the global market has now picked up again in 2017.

Meanwhile, Asian rivals, particularly those based in Korea and China, have increased revenues on average of 7 percent annually between 2011 and 2016, and emerging markets players currently have 40 percent of the global market. German companies have fared even worse than those in the rest of Europe: Their revenues declined an average of 2.1 percent per year between 2011 and 2016, and profitability is lagging too, at an average earnings margin of 4.4 percent.

To bring their capacity into alignment with costs, most major European plant-engineering firms have cut workforces by between 15 and 30 percent. This has involved site closures, divestments of unprofitable businesses, overhead optimization, and shifts of capacity to lower-cost countries. Now, in times of strongly improved general market conditions, these companies will need to rethink overall strategies to deliver projects with reduced capacities, remain competitive, and participate profitably in the new growth. They will have to transform traditional business processes, and make the most of new digital technologies by exploiting data in their operations. There are four key areas that they should address immediately. (See Exhibit 1.)

PUSHING SALES EFFECTIVELY TO REGAIN MARKET SHARE

European plant-engineering companies have strong prospect pipelines again. Still, they face increasing pressure from emerging competitors, so they must both select the right opportunities to bid on and increase their rates of success. Doing so will require a better understanding of client and project requirements, which can be gained by drawing closer to customers and building systematic intelligence on markets and accounts. Holistic customer segmentation can improve firms' client-base knowledge through the better use of data in such areas as past sales, future potential, and profitability, and in enhanced qualitative information on buying behavior, products, and service. Firms thereby will be empowered to develop deeper market strategies and tailor activities to meet customer demands.

Traditionally, European plant-engineering firms have considered their superior technological competencies to be their unique selling proposition, and have focused sales efforts on these. In the future, by dividing roles between business development and sales, firms should be able to simultaneously leverage technical strengths and improve customer management.

DEVELOPING NEW DIGITAL SERVICE MODELS

Recently, customer demand has shifted from just building additional capacity, to increasing overall equipment

effectiveness and productivity. Consequently, plant-engineering companies should develop new, digital service models that offer additional value to clients. In particular, service delivery can be made more efficient by digitizing existing services to apply big data, machine learning, and process automation. The industry has already seen some rollouts, including: Remote maintenance and services, condition-based services, the extensive use of sensor data, as well as the use of machine-learning techniques.

The digital age also provides opportunities for new services, such as automated asset inspection via drones and georeferenced orthophotos analyzable for front-end engineering design. Digital twins of the real plant will form the basis of future service models that last the entire lifecycle of a plant. Such developments present new opportunities, but European plant-engineering companies will have to become adept at identifying them and investing early to develop new capabilities.

TAKING A MODULARIZED APPROACH TOWARD DESIGN AND BUILDING

Digitization of plant-engineering value creation and processes will be a third lever of efficiency, with building information modeling (BIM) the key driver. Companies will need to build end-to-end integrated processes that match the requirements of BIM, and adjust IT systems accordingly. This will improve design-to-construction, design-to-procure, and the reuse of equipment in a modularized plant and product configuration. Companies will see reductions in both product costs and lead time of more than 10 percent.

With the modularized execution approach, it will be necessary to further integrate engineering and construction functions to increase on-site efficiency and ensure efficient designs in the early phases of a project. This will be particularly critical for small and midsize plants, as well as those that are more standardized. Moreover, effectively aligning different technology and engineering disciplines will produce higher-quality designs at a lower cost. Systems for 3D CAD are already migrating onto the cloud, allowing engineers to work on the same, integrated data model. Note, however, that while such changes will promote efficiency, they will also require new methods of collaboration.

DIGITIZING THE SUPPLY CHAIN TO CREATE VALUE

Finally, plant-engineering companies should digitize supply chains to boost efficiency and reduce lead time. The scope of digitization efforts would thus be expanded to include not only BIM but also a company's supply-side operations. Stronger integration of supplier standards into plant-engineering value creation and digital requests for proposal (RfP) will increase supplier efficiency and reduce the costs of materials. Plant-engineering companies can further reduce their process costs for purchasing, expediting, and logistics by greater transparency along the value chain. Smart glasses, for example, together with more strategic cooperation between companies and their suppliers, could offer new, sight-based methods of quality control and expediting, and could accelerate these processes significantly.

To go beyond cost cutting, established plant-engineering companies will have to make significant efforts to transform their businesses at a time when market conditions are likely to remain difficult. If they make the right investments now, however, they could see their competitiveness enhanced in the near future.

>10%

REDUCTION IN PRODUCT COST AND LEAD TIME THROUGH END-TO-END AND DIGITAL PROCESSES

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BY SECTOR: NEW TECH, NEW STRATEGIES

DIGITAL STARTUPS SHAKE UP PLANT ENGINEERING

NEW TECH COMPANIES ARE BRINGING OPPORTUNITIES AND THREATS

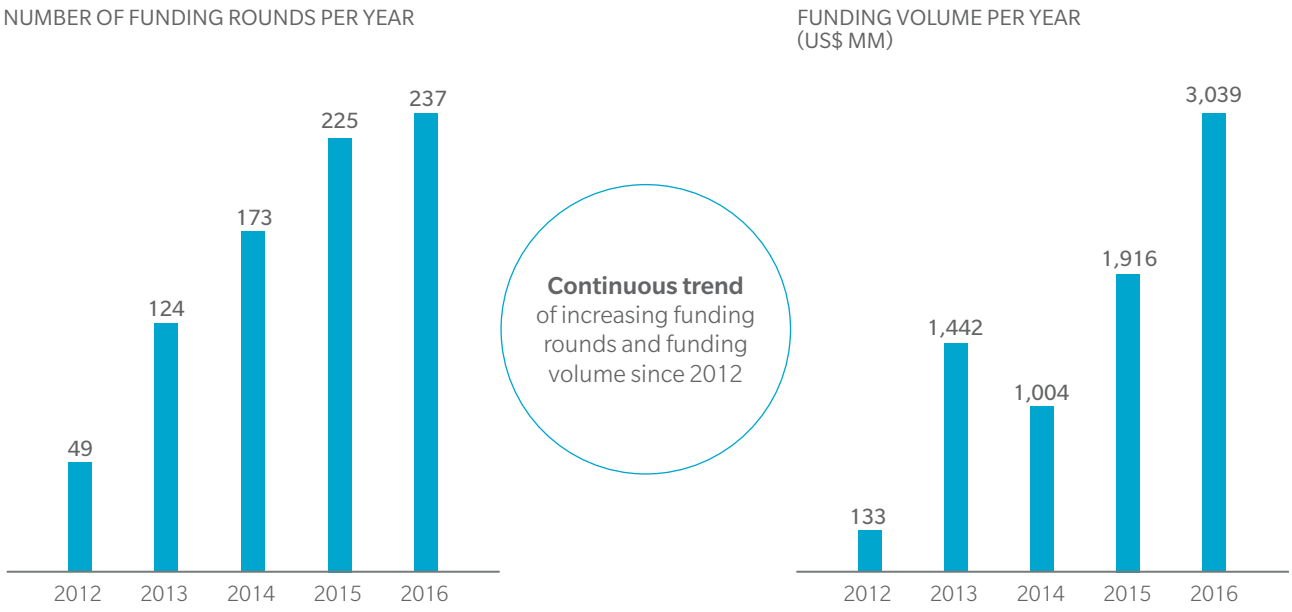
Nico Hartmann, Wolfgang Weidner, and Florian Deter

Every fifth day, a digital startup relevant to plant engineering is founded, bringing with it the potential to transform business models and the industry value chain. In 2016, 237 funding rounds were carried out, according to Oliver Wyman research – five times as many as in 2012 – in technology clusters ranging from cybersecurity to cloud computing. Their funding volume for the year was more than 20 times as high, and the total investment over the five-year period was US$7.5 billion. (See Exhibit 1.)

STARTUPS AS ENABLERS AND PARTNERS

Many of the new enterprises could be enablers and partners for plant-engineering incumbents, making them potential investment targets. Partnering with and funding the right startups early on will lead to competitive advantages in the short-to-medium term. On the other hand, the

Exhibit 1: Funding flows into startups



Source: Crunchbase, Oliver Wyman analysis. Considering startups that were founded in 2012 or later, which received funding >US$1 million

new platforms could enable competitors to sharply increase their levels of technology and innovation, presenting a threat to established companies. To understand the disruptive potential of startups, take a look at the plant-engineering value chain and the impact digital startups can have at each stage.

In business development and sales, firms that can anticipate customers' needs before they are even aware of them, can then approach those customers proactively with tailored proposals. Tools such as 6sense's Buyer Intent Network capture data from search engines, trade publications, blogs, and other sources, and use advanced analytics to establish buyer intent and find new potential orders. Platforms like this also help understand customers' businesses better, improving cooperation. Consequently, plant engineers can increase their hit rate with customers, boosting revenues and reducing the cost of business development and sales.

BETTER COLLABORATION THROUGH TECHNOLOGY

Technology and engineering processes, the largest source of value creation in plant engineering, will benefit from new kinds of cloud-based collaboration. Open platforms will transform the way engineers – including suppliers and freelancers – work together. They will allow fresh eyes to develop and exchange ideas openly in agile, cross-functional teams that share big data analyses to spark innovation. Such platforms will help augment the value of plant-engineering firms' products and also reduce costs – for example, by integrating with low-cost engineering centers.

One startup, Pivotal, has raised US$1.7 billion from investors including General Electric, Ford, and Microsoft. It offers a platform-as-a-service that enables teams to update and scale applications in the cloud. Another startup, Onshape, has developed a 3D computer-aided design system in the cloud. That means design teams can work more flexibly and in remote locations, expanding their horizons for collaboration. Already Scotrenewables Tidal Power, the world leader in floating turbines, is planning to move its next-generation design process online using Onshape's system.

Procurement and supply-chain management will be influenced by new technologies that help stronger integration with suppliers. Today, manual processes in purchasing, logistics, and expediting still require large numbers of employees, who add limited value. Many processes will be automated in the near future, allowing better integration with suppliers. Smart glasses, for example,

let a remote expert look at goods to be expedited through the eyes of the supplier or local representative. The expert can thus handle multiple cases in parallel. Atheer, another digital startup, provides a virtual-reality platform for smart glasses so that remote experts can inspect supplies and send precise visual instructions based on real-time augmented reality, live video, and other inputs.

As a result, plant-engineering companies could have a more strategic and collaborative relationship with their suppliers, enabling them to shift their attention to purchasing and negotiation.

EVERY 5TH DAY

A DIGITAL STARTUP RELEVANT TO PLANT ENGINEERING IS FOUNDED

THE MANY USES OF DRONES

Construction will be affected by the more-physical digital developments, such as drones, which can be used to surveil sites. They can perform pre-feasibility studies to provide georeferenced and orthorectified maps, as well as 3D models that incorporate geological characteristics. Drones can also track work on-site, providing input for progress curves and deviation analyses, which will make construction more efficient. In addition, they will contribute to health and safety compliance. One startup in this field is DroneDeploy, a provider of cloud-control software for drones, which carries out automated flight-safety checks, workflows, and real-time mapping and data processing.

However, the overall digitization of construction work – through building information modeling (BIM) and eventually robots that perform physical construction work – will strengthen the position of construction companies. So, while drones will help plant-engineering firms increase efficiency on increasingly complex construction sites, they are also part of a trend that could jeopardize incumbents' share of the value chain.

As investment in new plants declines, enhanced service represents an opportunity for plant-engineering companies to generate new and profitable business. Digital technology can transform some aspects of service by overcoming the distance to remote locations. Israeli startup Fieldbit Hero has developed an interactive visual collaboration platform for field services that enables real-time augmented reality interactions between experts and field technicians. Remote experts can see a physical machine and then guide a local technician step-by-step through complex fixes. This increases remote resolutions and the first-time fix rate. It also reduces the need to train local technicians and improves the profitability of the overall service.

After-service, too, will be facilitated by drones that inspect remote assets. US startup SharperShape uses light detection and ranging – which measures distances using a laser pulse – to manage remote assets using drones, thus reducing the costs and risks of manual inspection. This technique is already used by electricity companies to inspect power lines. Drones also have the potential to inspect plants in industries such as oil and gas, wind power, and chemicals.

TIME TO STRATEGIZE

As well as partnering and acquisitions, established plant-engineering firms will have to improve their internal processes to prepare for the short-term future. That could mean increasing cross-functional collaboration, acquiring new competencies, and developing talent and workforce strategies to boost expertise in fields such as data analytics.

But digital startups will be an important part of the future. So far, most are concentrated in the United States, which accounts for 77 percent by number and 85 percent by funding volume. However, European startups such as Darktrace and Graphcore are also in operation after attracting significant funding. Plant-engineering firms should keep a lookout as more sprout up.

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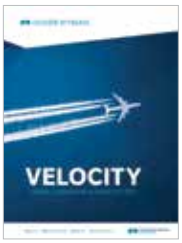

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