

THE OLIVER WYMAN

PERSPECTIVES ON MANUFACTURING INDUSTRIES

MANUFACTURERS
ARE SEEING THE POTENTIAL
OF DIGITAL TECHNOLOGY
TO TRANSFORM THEIR
BUSINESSES MORE CLEARLY
THAN EVER BEFORE



THOMAS KAUTZSCH

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

DEAR READER,

Manufacturers are seeing the potential of digital technology to transform their businesses more clearly than ever before. But as the benefits of digital become more apparent, so do the challenges. Therefore, we'd like to take this opportunity to share a number of points about the digital revolution.

First, implementation is tough. How manufacturers should carry out a digital transformation is the theme of our Cover Story. The key to success will be to marry the entrepreneurial thinking of the digital world – where speed is a priority – with a traditional engineering culture, where quality comes first.

Second, most people's ideas of digital change are just the tip of the iceberg. Of course, productivity in factories will continue to increase through greater use of digital technologies. But most of the additional value will come in the white-collar world, where digital techniques will change the way manufacturers buy and sell, how they plan and make decisions, and how they approach topics such as warranty and quality control. The section "New Sources of Value" points to some of these opportunities.

Third, there's no place to hide anymore. Digital technology has already rocked industries such as retail and media, and automakers are preparing for the tsunami about to arrive with autonomous driving systems. The digital revolution is going much further – into sectors from agricultural machinery to construction, as we show in the "New Tech, New Strategies" section.

The ride is going to be exciting – in every sense of that word!

I wish you a thought-provoking read.

Yours sincerely,

PERSPECTIVES

VOLUME 11

COVER STORY

6



DIGITAL TRANSFORMATION IN MANUFACTURING INDUSTRIES

MANUFACTURERS URGENTLY NEED TO EMBRACE THE DIGITAL AGE

BY FUNCTION: NEW SOURCES OF VALUE

14



THE DAWN OF DIGITAL SALES

APPS AND ANALYTICS ARE TRANSFORMING HOW MANUFACTURERS SELL

18



EMBEDDING PROCUREMENT

THE WHOLE ORGANIZATION NEEDS TO THINK ABOUT PURCHASING

20



APPLYING MACHINE LEARNING TO MANUFACTURING

HOW TO DRIVE DIGITAL QUALITY CONTROL WITH BIG DATA AND ADVANCED ANALYTICS

22



STARTUPS INJECT TECHNOLOGY, ENTREPRENEURIAL SPIRIT

MANUFACTURERS KICK START THEIR DIGITAL TRANSFORMATIONS THROUGH SMART LINKUPS

24



ERADICATING WARRANTY COSTS

FIXES FOR FAULTY EQUIPMENT ARE NOW AVOIDABLE COSTS

26



SPLIT PERSONALITY

TURNING END-OF-LIFE PRODUCTS AND ASSETS INTO A BUSINESS

BY SECTOR: NEW TECH, NEW STRATEGIES

30



RAIL AT A JUNCTION

NEW TECHNOLOGY BRINGS NEW OPPORTUNITIES FOR TRAIN EQUIPMENT MAKERS

32



AUTOMATION NO LONGER ON AUTOMATIC

A QUIET SECTOR FACES DISRUPTION

34



NEW GAME IN FARM EQUIPMENT

PRECISION FARMING IS BRINGING NEW COMPETITORS FOR FARMERS' BUSINESS, AND CALLS FOR NEW STRATEGIES

36



BITS AND BRICKS

BUILDING INFORMATION MANAGEMENT IS TRANSFORMING CONSTRUCTION

38



TRUCK MANUFACTURERS: ARE YOU READY FOR DISRUPTION?

AUTONOMOUS DRIVING AND CONNECTIVITY REQUIRE NEW STRATEGIC THINKING FROM MANUFACTURERS TO SAFEGUARD COMPETITIVENESS

40



WIND TURBINE MANUFACTURING GOES MAINSTREAM

BECOME A GLOBAL GIANT OR A LOCAL SPECIALIST

42

RECENT PUBLICATIONS



DIGITAL TRANSFORMATION IN MANUFACTURING INDUSTRIES

MANUFACTURERS URGENTLY NEED TO EMBRACE THE DIGITAL AGE

A key to excellence for manufacturers has been their focus on reliability, incremental improvements, and close relationships with customers. However, the next era of competition will be digital, and that will entail change in everything from sales team management to designing products. Manufacturers will sell solutions, as well as metal. Development will be carried out by agile, risk-taking teams. And managers will have to trust data and analytics, where once they relied on people.

To succeed in the new age, manufacturers will need to step out of their comfort zones to learn new habits, acquire new talent, and build out a set of digital capabilities to implement organizational transformation (see Exhibit 1). Effective digitization will not take hold with piecemeal change, like when a robot speeds up a particular factory operation. Instead, the benefits of the transformation will come from new connections between disparate parts of an organization, ending silos, and facilitating real-time collaboration. The rewards could be big: Oliver Wyman estimates digitization could yield \$1.4 trillion in margin gains for manufacturers by 2030.

One way for manufacturers to get there is by pushing digital methods at strategic pressure points. These can range from a central team giving digital advice to business units, to placing digital experts in each unit in order to push change faster (See box on page 8). The right model will depend on the individual manufacturer: How effectively they implement change will determine whether or not they thrive – or even survive – as manufacturing goes digital. In particular, there are four critical areas that company leaders must pay attention to.

ANALYTICS EXPERTS NEEDED

One of the big digital contributions to manufacturing will come from new ways of using data. But many industrial companies, especially those selling to other businesses, have made little use of data analytics, which applies most naturally to the large-volume transactions of the consumer world. Instead, they rely more on experience and human judgment. In the digital era, they need to acquire the skills to manage highly connected machines and the data these produce. For example, data analytics can interpret the gigabytes of data generated each hour by sensors on a jet engine fuel pump, and compare its performance with data models and other pumps in the fleet. An alert can then indicate that a specific pump might need to be replaced sooner than usual to avoid potential malfunction.

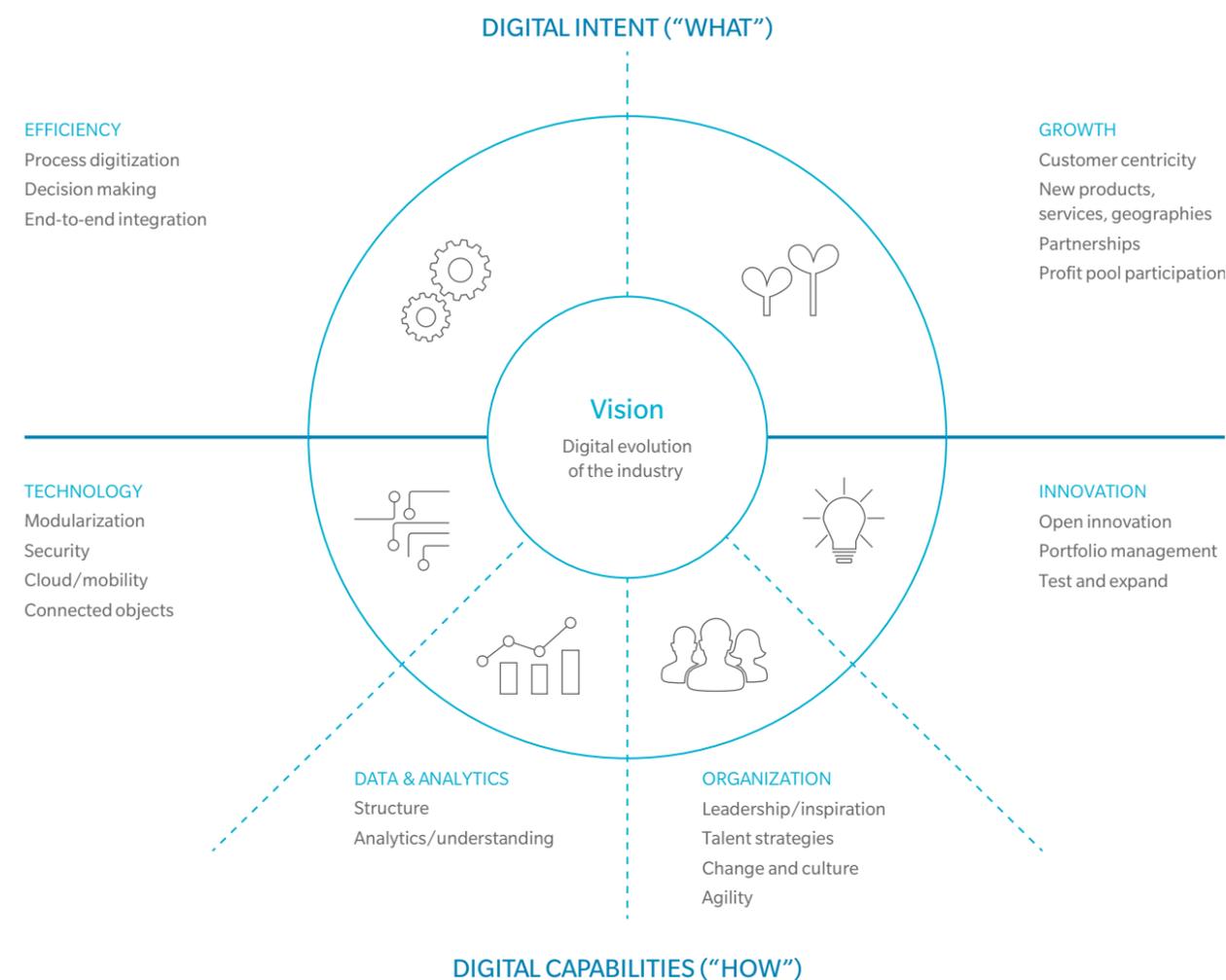
To take advantage of these capabilities, manufacturers will have to recruit new types of employee with the relevant skills. These staff members will understand the content and value of existing data pools, and will be able to handle large amounts of data. They must also be able

MANUFACTURERS WILL NEED TO STEP OUT OF THEIR COMFORT ZONES



Exhibit 1: The digital wheel
How digital plans and digital capabilities interact

DIGITAL CAPABILITIES NEED TO BE BUILT OUT TO EFFECTIVELY TRANSFORM THE COMPANY IN ORDER TO ACHIEVE DIGITAL GOALS



Source: Oliver Wyman

to apply sophisticated analytical techniques to data, including making full use of off-the-shelf analytics software. Management must develop the confidence to trust these insights and act on them. Firms will also have to train existing staff. Manufacturers are often located far from wired-in big cities, and many employees have spent long careers in the same company. Both factors will make the digital transformation that much harder. But eventually, the whole company needs to be on board and get used to working in new ways.

NEW THINKING, NEW PRODUCTS

The digital age will revolutionize products and how they are made, so staff will have to think differently about every aspect of their work. Currently, makers of machinery – say, equipment that packages products in a factory – often sell those machines along with post-sales services such as maintenance. In future, using digital tools, they will sell solutions for their customers' businesses, such as an improvement in packaging speed or quality.

THE CHIEF DIGITAL OFFICER – A NEW ROLE FOR A NEW ERA

Industrial corporations need a dedicated chief digital officer (CDO), a senior-level executive charged with the planning and execution of digital change. The CDO is in a better position than the chief information officer (CIO) to evaluate the organization's status: He is able to look at an organization from the outside. Given this perspective, the CDO can produce a vision for radical transformation and come up with a plan for implementing organizational change, including establishing new roles and allocating resources differently. The CDO needs to understand the company's various businesses, as well as its functions and how they interact. Also essential to the role are strong relationships within the organization, in the wider industry, and with external visionaries. This person must have a proven track record at implementing large-scale change – and being capable of thinking outside the box and in several dimensions. At the same time, the role demands mastery of digital trends and disruptions, mixed with creativity and startup skills. The CDO must promote digital leadership throughout the organization to generate momentum for cultural change. Moreover, the role is likely to be a temporary and come with an expiration date: If the CDO has done his job right and managers are thinking more digitally, then it is probable the CDO will no longer be needed.

One characteristic of the digital world is that agile development processes run on the test-and-learn principle. In a sprint cycle, for example, a development team is presented with a list of product improvements to achieve in a set time – often between one and four weeks. The updated prototype is then presented to the project manager, who provides feedback to start another sprint cycle (see Exhibit 2). This is a completely different attitude to what prevails in physical-world engineering, where less-than-perfect products can lead to critical failure, and flaws “in the metal” require lengthy reworking and testing.

Eventually, the test-and-learn process may turn out to be applicable to physical products too – not by simply imitating digital procedures, but by adapting aspects of this technique. But for now, manufacturers must house both traditional processes – linear, slow, risk-averse, and in-house – and projects where pace is more important than perfection. Another way to appropriate more digital thinking is to hold external competitions for ideas and solutions: crowdsourcing techniques maximize the number of brains at work on a problem; hackathons, with a prize for the best solution after a day, can also yield solutions quickly.

THE DIGITAL PLATFORM

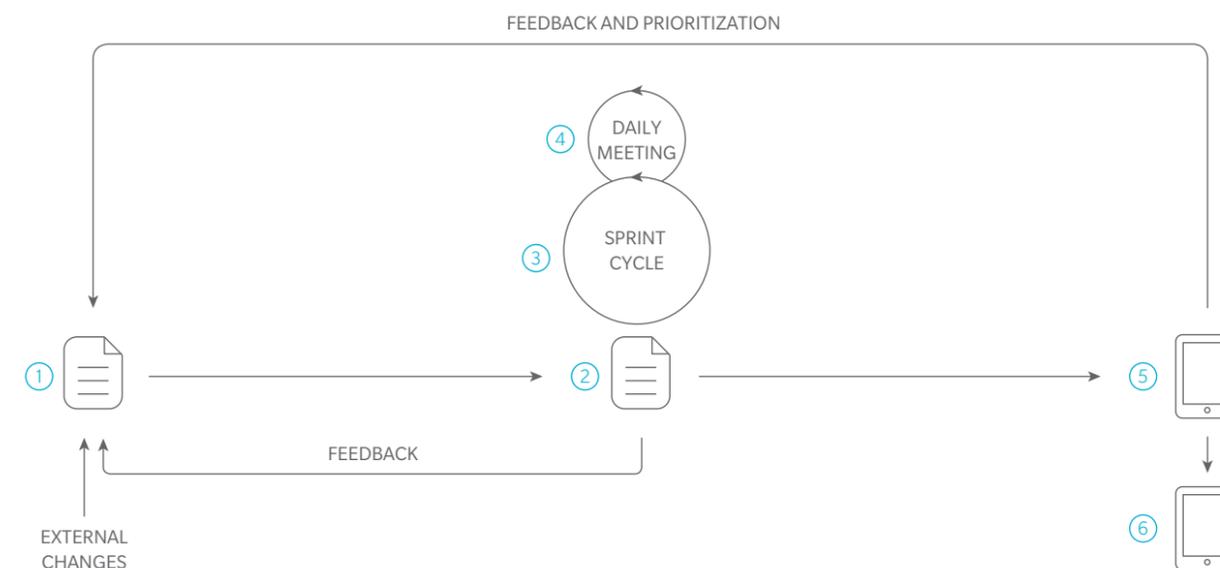
Innovation and digital solutions will rest on new, agile IT systems whose primary tasks include providing insights. This digital platform will need to work alongside legacy IT systems, which will be tasked with creating records, as retooling these would take too long.

The new system will handle vast quantities of complex data, which will be scalable and accessed via the cloud. Manufacturers will want to share information with other corporations, such as their customers. This can be done by integrating application programming interfaces (APIs) that open up a company's digital services. The data will often be unstructured: it will be gathered from plants and machines, describing physical phenomena such as how a machine is operating; or from social media, where customers might leave verbal comments. That means the volume and degree of complexity of the data will be far greater than in the past. The information and automated reactions will fundamentally change manufacturers' relationships with their customers, bringing them direct, real-time links via connected devices and sensors that report specific needs.

Exhibit 2: Agile product development Digital products can be engineered through new, faster processes

AS PRODUCTS ARE INCREASINGLY “DIGITAL”, AGILE ENGINEERING IS EMERGING AS PREDOMINANT ENGINEERING PHILOSOPHY, SUPPORTED BY PDM/PLM

ITERATIVE DEVELOPMENT PROCESS



- ① **PRODUCT BACKLOG**
List of prioritized product requirements which can be updated or changed at any time during the development process
- ② **SPRINT BACKLOG**
Derived from the product backlog the sprint backlog is a list of tasks that must be addressed during the next sprint
- ③ **SPRINT CYCLE**
A time period (typically 1–4 weeks) in which the development team works on the current task contained in the sprint backlog
- ④ **DAILY MEETING**
Time boxed meeting (usually 15 min) that allows the team to discuss their work focusing on current progress, planning and challenges
- ⑤ **PROTOTYPE**
At the end of a sprint cycle the functioning of the prototype is presented to the stakeholders
- ⑥ **FINAL PRODUCT**
The process is repeated until the final product meets all requirements of the product backlog

ADVANTAGES

- Frequent evaluation of current progress allows for timely changes
- Details and product requirements can be changed without any significant time delays in the next cycle
- Sufficient transparency of current requirements and tasks through the product and sprint backlog
- Documentation is kept to a necessary minimum

Impact:

- Lower development costs
- Earlier testing and integration
- Better quality products



Source: Oliver Wyman

Another capability of the new IT system will be to support simulation techniques such as digital mock-ups and digital twins. These are the digital equivalent of architectural scale models, and enable tests and trial runs to be carried out on a ship, car, or factory before they have been built. Only when a nearly flawless version has been developed through test-and-rebuild cycles will the product be constructed in the real world. In cases such as a manufacturing plant, the digital twin can be updated throughout the plant's lifetime, so that all changes made – servicing and the addition of spare parts for example – are documented, and the twin is always up to date. This approach is already revolutionizing the construction industry, where it is known as building information management (BIM).

However, a large firm with an established corporate culture cannot change its working methods overnight. The new digital capabilities will need to be built separately from legacy systems in a parallel

organization, and the company will have to operate a dual system, with digital technology kept separate from the legacy system, at least initially.

PUTTING IT ALL TOGETHER

Managing an organization with one foot in traditional manufacturing and the other in the digital world will require new roles, such as “content authorities” – experienced managers who can quickly make judgment calls about the feasibility of new ideas. “Tweeners”, who understand both business and the uses of digital technology, will act as mediators between these initially separate worlds. Once the digital world has gained critical mass, it can be integrated with the legacy business – or absorb it.

In the end, all parts of an organization will be connected to a common digital backbone that drives faster data exchange and decision making. It will be possible to do some of the work remotely or virtually, presenting an opportunity to attract talent in regions

MANUFACTURERS SHOULD PLANT DIGITAL SEEDS IN STRATEGIC PLACES IN THEIR ORGANIZATIONS



far from the physical headquarters. Work and resource allocation will center on nimble project groups instead of organizational charts and job descriptions. These pods will be able to react to external changes and deliver new innovations much faster than traditional structures. Digital culture and skills will be imported through partnerships with specialized firms or institutes – though the fragmented nature of manufacturing means that it tends not to attract as many digital startups as consumer industries do. Other agents of change may be as mundane as a casual dress code or a new office layout incorporating table soccer.

THE JOURNEY

To get things moving in these four areas, manufacturers should plant digital seeds in strategic places in their organizations. There are at least three models for this (see Exhibit 3). First come lighthouse projects. A small, central digital team defines the company's strategic direction and provides groups of digital experts to guide each business unit. The projects themselves are staffed by the business units, making them narrower in scope – but their relative lack of complexity means higher odds for an earlier success.

A more ambitious approach is the digital hub, where a larger-scale digital organization inside the corporation sends more formal groups of digital experts to the business units. They form part of the staffing for projects, and have a correspondingly greater impact on the digital transformation.

A third approach is the digital corporation. Like the digital hub model, this has a large central digital organization. But far more digital experts are placed in the business units, switching the whole

corporation into digital mode as fast as possible. The magnitude of the change means that this will require greater internal effort and have a greater chance of failure – but also the greatest potential for impact.

These methods have helped large firms in other sectors, which arrive in the digital age carrying their own, unique legacy baggage. A number of big European banks, for example, have picked versions of these models as they try to fight back against new, high-tech entrants trying to grab some of their business.

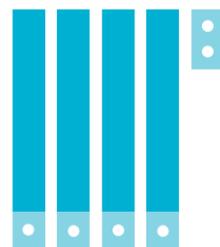
What transpires will depend on the archetype for digital transition that the company chooses – lighthouse project, digital hub, or digital organization. To drive this transformation, leadership needs to set the tone for a culture that values speed, responsiveness, and change. Leaders need to be open to new ideas, adapt quickly, and encourage different cultures in different parts of the organization. They need to move from command-and-control mode to principle-based leadership, where they set principles and objectives – and let the new teams find the paths to reach these.

Digital disruption has kept its distance from manufacturing till now, but it wasn't just being polite: applying digital techniques to the physical processes and sales methods of engineered products was complicated. But the technology is finally ready – and manufacturers need to be ready, too.

Exhibit 3: Turning an organization digital A number of different structures can help introduce digital change

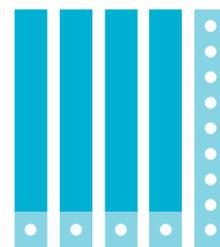
A PROGRESSIVE APPROACH USUALLY STARTING WITH SPECIFIC PROJECTS

① LIGHTHOUSE PROJECTS



- Dedicated central digital team defining strategic direction
- Informal or formal groups of digital experts in each BU
- Projects staffed by business units

② DEDICATED UNIT



- Dedicated digital team
 - Strategic direction
 - Support to the businesses
- Formal groups of digital experts in each business
- Projects staffed by BU with support from central team
- Functional reporting line to align staff in each business

③ DIGITAL COMPANY



- Digital organization
- Central team of specialists
- Staff in each BU delivering digital projects
- Projects staffed via digital organization with dedicated HC function

Source: Oliver Wyman

Wolfgang Krenz

is a Munich-based partner in Oliver Wyman's Global Automotive and Manufacturing Industries practice

Romed Kelp

is a Munich-based partner in Oliver Wyman's Global Automotive and Manufacturing Industries practice

Sébastien Maire

is a Paris-based partner in Oliver Wyman's Organizational Effectiveness practice

Kai Bender

is a Berlin-based partner in Oliver Wyman's Information Technology and Operations practice

BY FUNCTION: NEW SOURCES OF VALUE

- 14 THE DAWN OF DIGITAL SALES
- 18 EMBEDDING PROCUREMENT
- 20 APPLYING MACHINE LEARNING TO MANUFACTURING
- 22 STARTUPS INJECT TECHNOLOGY, ENTREPRENEURIAL SPIRIT
- 24 ERADICATING WARRANTY COSTS
- 26 SPLIT PERSONALITY



THE DAWN OF DIGITAL SALES

APPS AND ANALYTICS ARE TRANSFORMING HOW MANUFACTURERS SELL

Sales organizations were largely immune to earlier manufacturing upheavals, such as “lean” and “re-engineering,” given that their work centers on personal relationships with customers. And while manufacturers’ sales executives expect to benefit from new tools in the digital revolution, a series of interviews conducted by Oliver Wyman reveals they believe the attendant changes will be moderate and not disruptive. As a result, the vast majority are only starting to adapt their sales organization to the new possibilities (see Exhibit 1).

We, however, think digitization will transform selling, and that changes seen up to now – such as apps that provide product and contact information more conveniently – are only the tip of the iceberg. New technology will overturn established working habits, alter the products and services sold, and elevate sales to a higher order of involvement with clients. Sales reps of the future will think less about transactions for goods and more about how to boost a customer’s overall performance. Executed smartly, the digitization of sales could help manufacturers

46% OF THE OVERALL POTENTIAL OF THE DIGITIZATION OF MANUFACTURING SALES HAS CURRENTLY BEEN REALIZED



fight off lower-cost competitors in a world where growth in many markets has slowed. The changes can be divided into three key areas.

DIGITIZING CORE PROCESSES

First, digitization will boost the essential processes of sales: what to offer customers, when, and for how much. Of course, nearly all manufacturers employ some kind of customer relationship management (CRM) system, where they gather general business facts, past sales, and equipment in operation. But these often do little more than track customer information, and they lack true forecasting power. Current CRM systems are mostly about “getting the dots – and not yet about connecting the dots,” as one sales executive said.

Smarter use of data will change this. Instead of waiting until a customer expresses his needs, a manufacturer will be able to use analytics to predict those requirements from operating data. A firm that sells a customer, say, a conveyor belt, monitors how much it is running, the products it is used to manufacture, and developments in the customer’s overall business. Then the belt maker should have a better idea of what kind of new machine to offer, and when. Demand patterns can also help evaluate the potential for getting a customer to upgrade or to buy additional products. By anticipating a customer’s needs in this way, a manufacturer’s salesforce can make proactive offers, boosting its success rate and efficiency.

Analytics can also reduce the workload in the annual creation of a revenue budget for the coming years. This process involves reps, managers, and executives and often goes through several iterations, only to produce unreliable results. Data can help anticipate

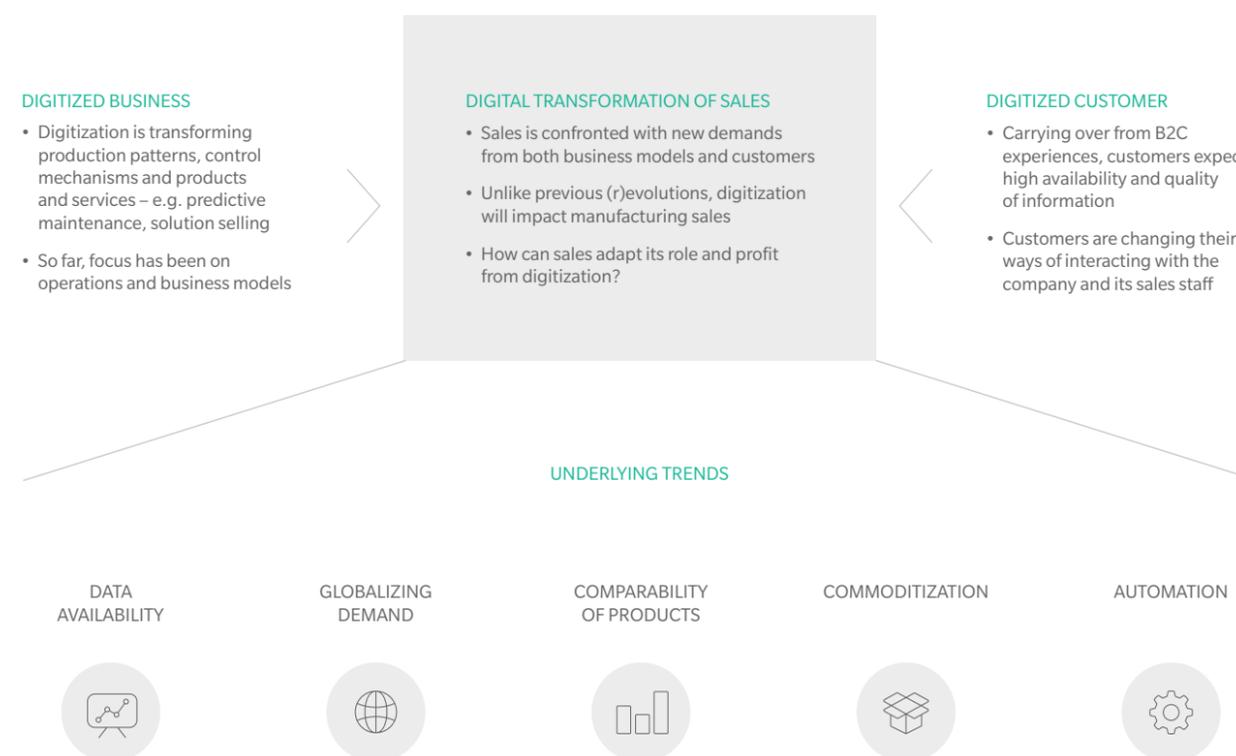
demand for different products – over months or years – and can thus help plan sales activities for different sectors, regions, and customers.

Digitization can also streamline the price quotation process, especially in segments where machines require customization. For instance, selling a machine that puts a variety of cookies into different sorts of customer-specific packagings often involves engineers having to design a technical solution before a price quotation can be given. Yet most of the time, the customer decides not to follow through and make the purchase, and the work gets thrown out. In a digital world, these quotations can be made based on statistical analysis without involving engineering. This not only reduces cost, but also provides real customer

value, as quotes can be generated on the spot.

These data-driven tools can be integrated seamlessly into the work routine of a sales rep by making them available to sales reps via mobile apps, dramatically improving the management of a sales force. Reps have typically planned their work based on a combination of intuition and their experiences with particular customers. They might enjoy visits to certain customers and give these more attention, while avoiding those that are difficult, even if potentially lucrative. A stream of hard data and insights should lead to more rational decisions, so that the right expert will call on the right customer with the right offer at the right time. Companies should not of course imagine that it’s enough just to equip sales reps

Exhibit 1: Digital pressure reaches sales
As production and customers become increasingly digitized, sales teams need to adopt digital tools as well



Source: Oliver Wyman interviews

with apps and iPads. Without integrated, data-driven, algorithm-based intelligence, reps will continue their old ways of working, online.

DIGITAL INTERACTION

The digital revolution will also force manufacturers to interact with customers in new ways. In their spare time, customer representatives are also consumers, and their experiences as retail shoppers affect their expectations when buying something for their company. Much retail purchasing is carried out online, where shoppers can refer to ever-expanding sources of information. Then, a consumer will likely customize a new car or cell phone using an online configurator. Someone considering a purchase on behalf of their company will expect similar facilities, including rapid, high-quality information, and the availability of different product varieties and add-ons. Reinforcing

the higher expectations, purchasing departments have become increasingly professionalized, which leads to more and broader information collection in the pre-purchase phase, before they even contact a sales rep. So, though the sales function has traditionally been a people-to-people job, some customers now want less personal consultation than before.

Manufacturers need to respond to these changing needs and develop ways to empower their customers. As one executive put it: “Help customers to help themselves.” One step is to cease focusing directly on sales, and instead provide facilities where customers can make their own journey to the right product or solution. Online “product-wikis”, for example, give technical specifications for different versions of a product, provide detailed documents such as manuals and fact sheets, and even offer online tutorials. All these sales channels need to be designed strictly

from the perspective of the customer journey. Also, as the customer uses different modes of interaction – mobile app, website, phone inquiry, or personal interaction –these channels need to be coordinated so that each one “knows” what the customer has done in the others (see Exhibit 2).

SELLING DIGITAL SOLUTIONS

Sales departments must also learn to persuade customers of the benefits of the new digital business models that big data is spawning. A maker of quality inspection equipment can also propose the use of process-integrated hardware, software, and deep data analytics – so that it sells a specific yield improvement, rather than just the equipment.

Selling solutions like these is very different from selling a physical product based on specs and price. It requires a deep understanding of the customer’s processes and economics in order to depict potential gains from the solution, an approach similar to that of a consulting firm. Sales staff, therefore, needs to be trained more broadly, so that they have expertise in fields related to physical products’ operation and performance, such as systems integration and software solutions.

Moreover, as discussions will now center on the customer’s overall business, contact will shift from the operational purchasing department and the technical buyer to the executive level. Sales staff needs to become more senior so that they can sit down with a client’s top executives and engage on the same level. Developing this sort of capability from an existing sales team is difficult, and manufacturers will often need to hire new talent. But getting this right is crucial. If a manufacturer does not have the ability to sell its digitally-enabled solutions, they will remain in the concept stage.

TIME TO ACT

Putting all this into practice will be hard, and it’s important to be aware that some changes are harder to implement than others. To spur progress, a firm can set up a lighthouse project, where a pod in the sales team is encouraged to charge ahead and work with the new digital tools, methods of interaction, and solution-based products. This will

IF A MANUFACTURER DOES NOT HAVE THE ABILITY TO SELL ITS DIGITALLY-ENABLED SOLUTIONS, THEY WILL REMAIN IN THE CONCEPT STAGE



create the opportunity for test-and-learn cycles that hone the new working techniques without being slowed down by organizational inertia. To get the new initiatives working in unison, manufacturers should design a central digital infrastructure that connects diverse information – from product features, to customer preferences.

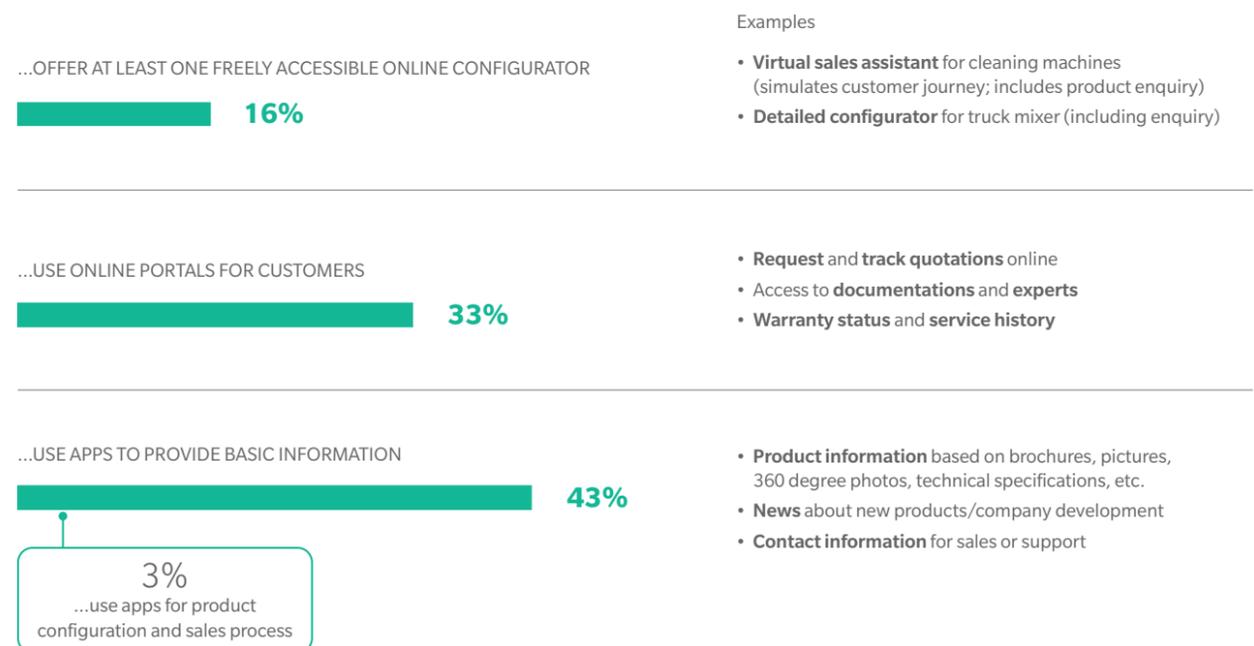
Eventually, the sales organization will need to be adjusted on three levels. For standardized off-the-shelf products, the sales process will become fully automated, saving time and money. Technical expert sales will to some extent be replaced by digital guides, such as product-wikis, but this sales role will continue in a more targeted way. A solution sales team of consultants and technical experts will become increasingly important, driving long-term personal interaction with senior management. The race to digitize sales has already started. As one sales executive put it: “It is almost too late to talk about quick wins.”

Wolfgang Krenz is a Munich-based partner in Oliver Wyman’s Global Automotive and Manufacturing Industries practice

Andreas Nienhaus is a Frankfurt-based principal in Oliver Wyman’s Global Automotive and Manufacturing Industries practice

Exhibit 2: New ways to reach clients
Use of sales-related digital tools by Germany’s 30 biggest manufacturers

BIGGEST GERMAN MANUFACTURING COMPANIES WHO...



Source: Oliver Wyman analysis



EMBEDDING PROCUREMENT

THE WHOLE ORGANIZATION NEEDS TO THINK ABOUT PURCHASING

Global competition is increasingly placing pressure on manufacturers to reduce costs, driving them to examine their procedures for obtaining components, which makes up more than 60 percent of their costs on average. Traditional cost-cutting techniques – like benchmarking, volume bundling, and supply-chain process optimization – have centered on the purchasing function. Trouble is, much of the low-hanging fruit has already been harvested. So continuing with traditional efforts is unlikely to boost performance much further.

To achieve greater value out of the supply chain, solutions need to go beyond the chief procurement officer. Manufacturers need to embed procurement throughout the company and its supply ecosystem, a policy known as holistic value sourcing. The aim is to ensure that decisions taken throughout a product’s life are made with purchasing in mind, meaning that all functions in an organization think about component procurement as part of their work. Such an approach can help mobilize the entire supply system to boost both innovation and overall performance.

CROSS-FUNCTIONAL SOURCING

Decisions over components start early on, at the engineering research-and-development stage, where early production costs can be reduced and the manufacturer can make decisions about what to buy and what to make itself. Increasingly, manufacturing is being moved to emerging markets, especially Asia, Eastern Europe, and Mexico – an option that in and of itself is likely to have a substantial impact on performance. Global expansion leads manufacturers to acquire competitors to further enhance geographical presence and scale, and integrate them into their

own production processes. The results are global, cross-linked supply chain networks, which can yield cost reductions – but whose complexity generates risks such as quality problems, production disruption, logistics breakdowns, and even financial default.

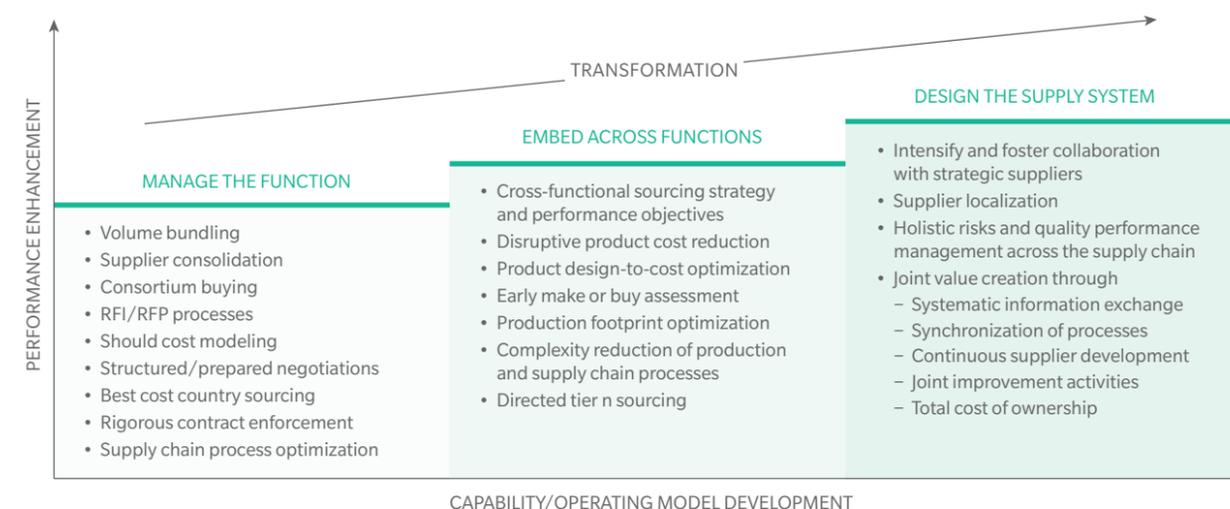
To address these challenges, procurement needs to be aligned with the company’s overall global strategy. Sourcing objectives should be shared across different functions. For example, product cost reduction objectives must be aligned globally between engineering, manufacturing, and purchasing departments. Frameworks and ways of working with suppliers should be cascaded to all functions, not just purchasing. And personnel should be rotated through different functions to promote collaboration and knowledge transfer. All this should be done while trying to reduce the complexity of production processes and the supply chain.

Beyond decisions over where to source individual components, a manufacturer needs to identify strategic partners based on their potential to differentiate the company’s offerings and achieve competitive cost levels. This requires engaging across different functions of supplier partner organizations. The company needs

TO ACHIEVE GREATER VALUE OUT OF THE SUPPLY CHAIN, SOLUTIONS NEED TO GO BEYOND THE CHIEF PROCUREMENT OFFICER



Exhibit 1: Holistic value sourcing
Evolving approaches to procurement can create value throughout an organization



Source: Oliver Wyman

to align suppliers with its vision so that the supplier partner can be considered an extension of the manufacturer itself, with a clear understanding of how the supplier can contribute to value creation through innovation and how to best integrate activities along the value chain. This requires systematic communication and information exchange, which should concentrate on sharing plans and performance data, offering direct access to corporate leaders, and jointly creating value. In the end, this will illustrate the benefits that both parties can achieve through their long-term collaborative relationship (see Exhibit 1).

BEYOND SAVINGS

Procurement scope and goal setting need to go beyond savings and risk reduction. Focusing on the entire supply system drives growth via open innovation, gets products to market faster, supports international expansion, and sparks development of new products and services. For example, strategic suppliers can innovate on key components by introducing new materials, specifications, and processes. Joint research and development activities may yield unique capabilities – in which case the collaboration should include an agreement that ensures a degree of exclusive access to major innovations. Digital technology can

play an important role, synchronizing the procurement ecosystem to promote joint improvement opportunities, reduce risk, and enable mutual growth.

Excellence in the purchasing department drives improvements through a “procurement push.” By contrast, embedding procurement throughout an organization creates a “corporate pull,” which turns procurement into a strategic means of achieving overall business targets. The impact of a well-designed framework can be transformational, improving mutual profitability, driving innovation, accelerating products’ arrival on the market, improving service and product quality, and reducing operational and reputational risk. It implies corporate-wide shared objectives and, ultimately, C-level responsibility – and is something manufacturers must start on today.

Alan Wilkinson
is a Detroit-based principal in Oliver Wyman’s Global Automotive and Manufacturing Industries practice

Stefan Benett
is a Munich-based principal in Oliver Wyman’s Value Sourcing & Supply Chain practice

Christoph Möller
is a Frankfurt-based principal in Oliver Wyman’s Global Automotive and Manufacturing Industries practice



APPLYING MACHINE LEARNING TO MANUFACTURING

HOW TO DRIVE DIGITAL QUALITY CONTROL WITH BIG DATA AND ADVANCED ANALYTICS

If manufacturers want to sustain and grow their customer bases in a competitive environment, their products need to fulfill increasingly high quality and reliability standards. Automakers, for example, now have a target defect rate for the integrated systems of less than 1 percent. That's putting pressure on the original equipment makers (OEMs) and their suppliers who have to meet these targets – at the same time as products and manufacturing processes are becoming increasingly complex, featuring numerous activities that impact quality, performance, and yield. To prevent failures of components, systems, and ultimately the product, these manufacturers need reliable methods to find defects.

But quality control today is in many cases still performed by human inspectors, which limits its reliability and efficiency. Components such as turbine blades and welded joints are highly safety-critical, and their manufacturers typically perform quality inspection with systems such as 3D CT scanning that produces images in 100 or more layers. Inspectors then examine each of these for possible defects, such as porosity or shrinkage. But it's often difficult for people to distinguish correctly between a defect and image noise – random variations of brightness or color caused by something other than the object being examined. Some inspectors may be less skilled than others, and any inspector might be tired. As a result, complex defects can be either missed or detected very late in the manufacturing process. This lowers yield, increases the amount of rework needed, and can even lead to field failures.

A NEW ERA FOR QUALITY CONTROL

Advanced analytics based on the exploitation of big data provides an innovative approach for digital quality management. In machine learning, a neural network generalizes historical quality-control data and thus learns to identify defects such as porosities in casted parts. It also learns to ignore other structures that arise from things like complex geometry and image noise, which might appear like defects but are not. The system can thus predict quality-critical deviations with a high degree of accuracy. These insights are used to improve practices and to predict outcomes and interactions. In one case, a digital quality control system based on machine learning reduced the number of quality inspectors for a safety-critical component by 60 percent, while also reducing the risk of false defect detection and defect slippage by 21 percent.

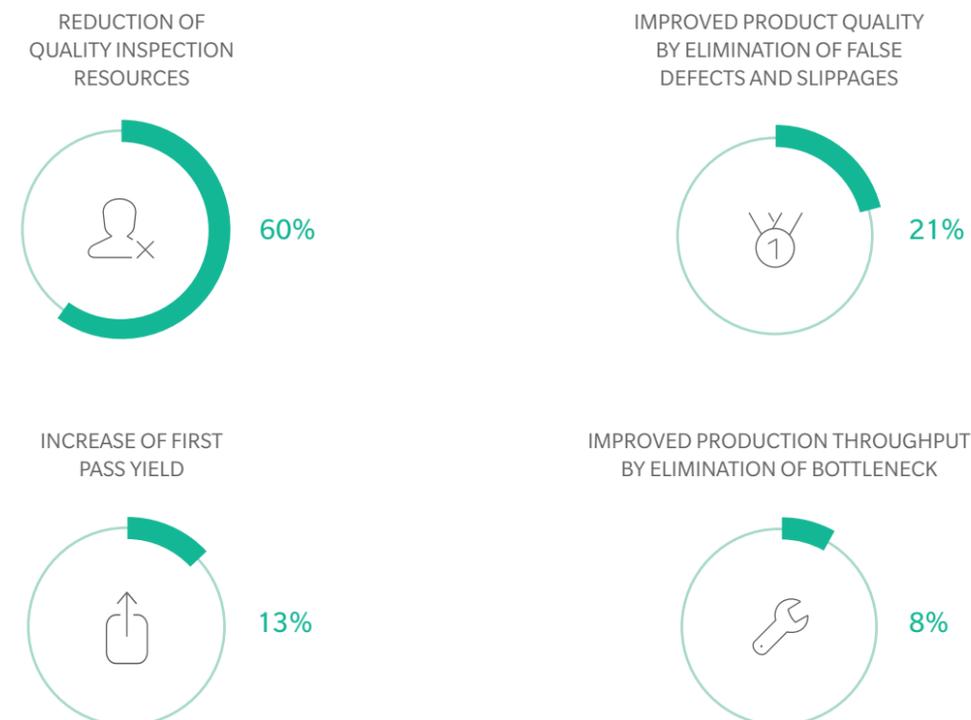
However, many engineering and manufacturing companies face difficulties leveraging advanced

60% OF QUALITY INSPECTIONS CAN BE REDUCED DUE TO DIGITAL QUALITY CONTROL SYSTEMS BASED ON MACHINE LEARNING



Exhibit 1: Machine learning boosts quality control Digital quality control tools can make manufacturing more efficient

APPLIED SOLUTION REFERENCE IN MANUFACTURING INDUSTRY



Source: Oliver Wyman analysis

analytics in technical products and processes. Some may not fully leverage the data they already have. Or they invest in data-warehousing programs that do not fit their manufacturing processes. Others lack the means to extract information that reveals essential correlations and characteristics in a system or process.

There are numerous benefits for those that can implement an innovative, advanced quality-management system. Automated digital quality inspection provides early warning of any shift in production processes; it helps uncover the root causes of problems and enables engineering improvements; and it reduces the risk of shipping nonconforming parts. As a result, it helps prevent product failure and reduces the costs of substandard quality. Ultimately, this will lead to lower warranty costs and greater customer trust in a firm's products (see Exhibit 1).

As the era of digital manufacturing arrives, advanced analytics will be a critical tool for realizing improvements in yield, particularly in areas with product and process complexity, process variability, and capacity limitations. Those manufacturing companies that successfully apply the new tools have an opportunity to set themselves apart from their competitors and generate additional value.

Florian Deter
is a Munich-based partner in Oliver Wyman's Strategic IT and Service Operations practice

Hannes Engelstädter
is a Munich-based senior manager in Oliver Wyman's Global Automotive and Manufacturing Industries practice working with the Harbour team



STARTUPS INJECT TECHNOLOGY, ENTREPRENEURIAL SPIRIT

MANUFACTURERS KICK START THEIR DIGITAL TRANSFORMATIONS THROUGH SMART LINKUPS

Industrial companies are increasingly collaborating with innovative startups, as they seek ways to introduce more digital tools into their organizations. A recent Oliver Wyman analysis identified 70 digital startups in France and Germany that have developed partnerships or commercial relationships with large manufacturing companies. The sectors include aerospace and automotive, and the startups are focusing on areas where these manufacturers either have been absent or else need support to implement digital solutions to improve productivity. The collaborations range from digital production optimization to connected wearable devices.

The new relationships highlight manufacturers' increasing awareness of both the importance of undergoing a digital transformation and the risk of being left behind. In a separate Oliver Wyman survey of more than 400 manufacturing and supply-chain executives, the most-cited obstacles to a digital transformation were cultural barriers, including lack of awareness in organizations of the potential of digital methods, and mistrust of digital tools, such as autonomous decision making. Another problem was the difficulty of forecasting return on investment: there are few existing cases to base calculations on, and results are expected only in the medium term or later.

The partnerships aiming to overcome these challenges include a leading aircraft manufacturer working with startups to develop collaborative robots that can assist technicians. Another startup

will integrate software into the product lifecycle management system of a large engineering company. An electronic startup has developed smart glasses for a multinational engineering company, so that its workers can receive alerts in real time and then control the various devices and machines being built along its supply chain. In total, two-thirds of the respondents to the survey said they have developed partnerships with third parties.

The contributions of the startups occur in the factory, tech devices, and information systems, and can be broadly divided into five groups. In the factory, production and warehousing processes will be optimized; and automation will play a greater role – featuring both collaborative and other robots. New information technology applications will augment reality through computer-aided design, simulation, 3D printing, and virtual reality; and a growing array of smart devices, tags, and wearables will be connected

70 DIGITAL STARTUPS
IN FRANCE AND GERMANY
HAVE DEVELOPED
PARTNERSHIPS WITH LARGE
MANUFACTURING
COMPANIES



Exhibit 1: Win-win partnerships Startups can contribute in several ways to large, established companies

TRANSFORM THE CULTURE

- Create an entrepreneurial mindset amongst employees
- Make the organization more innovative
- Create internal awareness of new market trends and emerging technologies

INCREASE COMPANY ATTRACTIVENESS

- Create an innovative brand that attracts customers, business partners and talents
- Position the company/brand in the digital age
- Become an innovation-driven partner, customer, or employer

SOLVE BUSINESS PROBLEMS

- Help corporate to solve pain points of their core business
- Develop innovative solutions with startups, to increase speed and reduce risk
- Get access to new business models, new technologies and talents

EXPAND INTO FUTURE MARKETS

- Explore new technologies and markets to stay ahead of competition
- Learn, gather information on new markets segments; to make future decisions
- Use startup collaboration to compete into emerging sectors

Source: "How do the world's biggest companies deal with the startup revolution", 500, INSEAD, February 2016. Winning together, a guide to successful corporate-startup collaborations, Nesta, June 2015. Oliver Wyman analysis

to networks – as will ubiquitous sensors and microchips. This will all be centered on big data and cloud-based platforms, which will provide data analytics and cybersecurity.

FIRST TECH GAINS, THEN A CULTURAL IMPACT

In addition to the immediate technology gains, manufacturers are looking for insight into the kind of digital innovations that can disrupt entire industries. They hope collaboration will help inject their organizations with an entrepreneurial mindset, so that employees are digitally fluent and can pivot swiftly. This could contribute to an innovative company brand that attracts customers, business partners, and talent. Startups, for their part, will gain enhanced visibility and status in the corporate world. They might also obtain access to their large partners' distribution networks and customer bases.

The forms of collaboration range from one-off events such as hackathons, to resource sharing and support through business incubators and accelerators, to longer-term arrangements like partnerships, investments, and acquisitions. Often, the relationship

starts when a manufacturer scouts emerging ideas, technologies, and market segments that could augment its business. It then establishes connections in the digital community to get direct access to entrepreneurs, inventors, and innovators. In the next step, a large company can provide financial and material support – workspace, for example – as well as advice during early-stage business development. Then it could invest or form commercial partnerships in order to keep exclusive access to the new innovations in their industry.

The most advanced industrial companies have developed programs with startups to challenge the status quo, experiment outside their core business, and become more innovative (see Exhibit 1). Soon this may be the new normal for manufacturers.

Eric Ciampi
is a Paris-based partner in Oliver Wyman's Manufacturing Operations unit

Philip Moine
is a Paris-based associate in Oliver Wyman's Global Transportation practice



ERADICATING WARRANTY COSTS

FIXES FOR FAULTY EQUIPMENT ARE NOW AVOIDABLE COSTS

Product failure warranty costs, resulting from poor quality, can often run as high as 5 percent of a manufacturer's revenue – sometimes equivalent to or exceeding the manufacturer's research and development expenditure. And when dissatisfaction with quality drives customers away, lost revenues can make that burden even heavier. Most companies, however, see these losses simply as a cost of doing business. This attitude is particularly common when they benchmark performance against others in the same industry, rather than seeing the costs as what the Japanese call *muda* – waste – that should be eliminated by lean manufacturing. Nearly 60 percent of companies say they either don't know or don't measure the financial impact of quality, according to a recent American Society of Quality report.

These attitudes are changing, as new digital techniques turn flaws – and the resulting warranty costs – into problems that can be solved. Though

product failures often appear to be isolated, one-off incidents, advanced tools and infomatics reveal them to be the result of systemic issues in the value chain. That makes warranty a close cousin to quality control, which seeks to catch defects before they reach the customer. Attacking warranty costs means delving into root causes that go back as far as the product design stage. To do this, more parts of an organization must think about warranty costs and how to reduce them.

Some tools to combat warranty expenses have an immediate impact, notably those aimed at improving its management and administration. Relevant data can be integrated in real time from external feedback, on social media for example, or from internal sources such as a call center. A few distributors can be given roles as sentinels that can sound early warnings of problems – an operation modelled on the way the United States Centers for Disease Control and Prevention react to outbreaks.

One automaker that applied this method reduced detection time by over 75 percent. These methods can help identify early warning signals for claims that are likely to be damaging. The firm can then intervene before low-cost claims swell into high-cost problems, and a single claim sets off a string of incidents.

DEEP SOLUTIONS FOR COMPLEX PRODUCTS

However, improvements like these can no longer keep up with the complexity of modern products and the increasing demands from customers. A greater impact will come from other, less direct methods, which work only over the long term. Where customers' use of a product is not well known, the cause of a recurring problem can be tracked down by applying analytics to data on warranty claims, failure, and product usage. Corrective action can then be integrated into ongoing operations.

On a more advanced level, risk-based prioritization can be built into product development. Traditionally, firms apply failure analysis techniques after a product has been designed, to try to figure out what could go wrong with it. Carrying out such analysis at an earlier stage enables a product design to take into account how it will withstand various stresses (see Exhibit 1).

These methods require different parts of an organization to work together in ways they are not used to. This is difficult, because in larger organizations, a business' complexity leads to a focus on narrow, functional objectives and metrics. Typically, marketing departments often push for increased product variation to drive sales. Procurement might push the use of a lower-cost component. And engineering, which likes to update products frequently, might make a late decision to use a relatively unproven battery design. The outcome is poorly integrated products and services, which result in warranty spills and an inability to get to the root cause.

FIXING PROBLEMS TOGETHER

Fuel lines made by one industrial supplier were breaking during normal use, leading to warranty claims on nearly 10 percent of the products. To fix this, various departments attacked what they saw as the underlying

UP TO 5% OF
A MANUFACTURER'S
REVENUE CAN BE LOST
DUE TO PRODUCT FAILURE
WARRANTY COSTS



cause. Engineering made the tube thicker. When that didn't work, manufacturing changed how the fuel line was assembled. Then purchasing decided the problem was a component in which it was hard to detect flaws, so they found a new supplier. Eventually the service group put out an alert for more inspections.

After several years with still no solution in sight, the firm realized that the basic design was flawed. And once the different functions got together, they solved the problem. The basic design was revised. An error-proof assembly process was developed. A new field service method was adopted, in which the technician could see better and not inadvertently damage part of the fuel line.

The organizational changes for such an approach need warranty and quality to be made key metrics in different parts of a firm. Continuous warranty improvement goals can be made part of each executive's objectives, and warranty oversight should be elevated to a position reporting directly to the CEO. The result may be higher customer satisfaction, lower costs, and new sources of competitive advantage. Moreover, the release of balance-sheet warranty reserves improves asset productivity and releases capital that can be deployed more productively or returned to shareholders.

While it may not be possible to eliminate warranty costs entirely, manufacturers should set themselves the goal of reducing warranty costs to zero. Only then will organizations drop the idea that they are unavoidable business expenses.

Andrew Chien

is a Detroit-based partner in Oliver Wyman's Global Automotive and Manufacturing Industries practice

Exhibit 1: Goodbye to warranty costs?

Several innovations mean that manufacturers can now aim to eliminate quality problems



1. WARRANTY PARADIGM SHIFT

Evolving view of warranty across the value chain rather than isolated "one-off" special cause incidents



2. KNOWLEDGE CROSS-FERTILIZATION

Adoption of high-tech industry development processes and techniques across sectors



3. RISE OF BIG DATA

Analytical techniques to correlate data from disparate sources such as internal functional databases, distributor/dealers, end users



4. ORGANIZATIONAL-WIDE ADOPTION OF LEAN

Broader application of lean variation management techniques to functions outside of manufacturing

Source: Oliver Wyman



SPLIT PERSONALITY

TURNING END-OF-LIFE PRODUCTS AND ASSETS INTO A BUSINESS

Mechanical injection pumps for diesel engines saw a rapid decline in the first years of this century, as tighter emissions regulations drove a need for more advanced fuel monitoring. As a result, one leading maker faced rapidly declining demand and margins on its US and European operations. Normal practice would have been to stop making them.

Instead, manufacturer moved the mechanical pump business to its Indian entity. The firm transferred all manufacturing equipment, and made the unit fully responsible for production, sales, engineering support, and the overall business case. Given this entrepreneurial freedom, the Indian entity found new markets for the pumps, which could now be manufactured at a lower cost. The European and US operations, freed from producing mechanical pumps, focused on advanced electric-injection pumps.

The aging of products and operational assets that require large, up-front investments can be a drag on performance. As a product nears obsolescence, volumes decline, resulting in a diminishing yield from manufacturing facilities, supply chains, and overhead, such as sales and engineering centers. When margins decline too far, production is halted. But a smart alternative is to split off operations of the end-of-life product into a separate entity. That creates revenue potential from assets that would otherwise have been sold off or shut down – and it produces a revenue stream from customers that wouldn't have existed.

OLD ASSETS, NEW IDEAS

Late-life businesses are tricky, lower-margin setups, so they need to follow several imperatives. First, since they cannot charge a premium for their products and

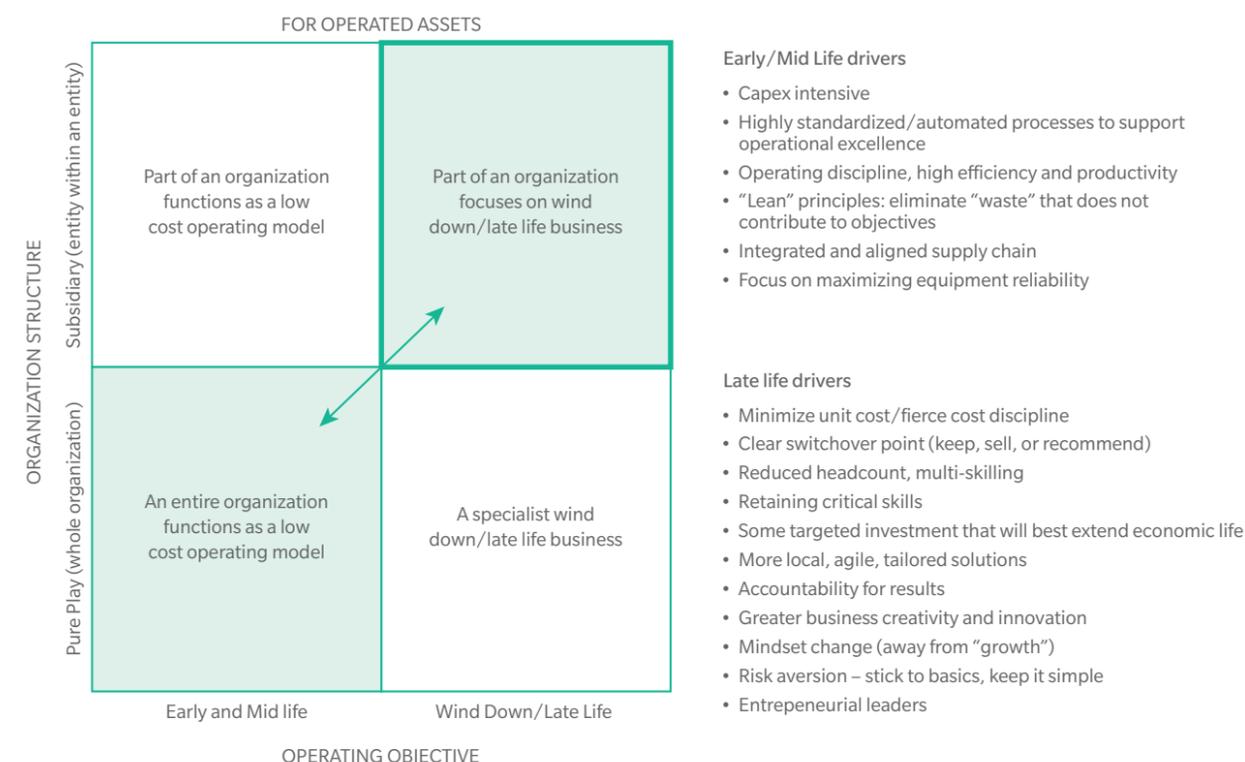
growth prospects are often limited, they have to focus on efficiency and cost reduction, and to streamline their operations. That means a low headcount – and multiskilled staff – and simplified operations and administration, while maintaining quality standards, which often is totally different from the original operation. Advanced, efficient manufacturing techniques such as flexible production setups are also important. To do this effectively calls for a world-class supply chain.

Most importantly, the late-life entity needs to be designed with great care so that it and the main company do not disrupt each other's businesses. While the new entity might take advantage of the existing distribution network, it needs to be clearly differentiated so that it has a distinct personality visible to employees and customers. Especially important is a clear switch-over point where the late-life unit takes over a product's business. Modularization strategies in the original product design will help smooth the transition from an old product to a new one, as it means products and components can be easily swapped in and out of different stages in the production process.

GENERIC DRUG MANUFACTURERS COME OUT WITH A VERSION FOR A FIFTH OF THE PRICE OR LESS



Exhibit 1: New potential from old assets
How to organize a late-life asset operation



Source: Oliver Wyman

This late-life entity also needs the freedom to decide its own strategy – targeting promising niche markets, for example – and responsibility for its results (see Exhibit 1).

One sector where the model has worked is pharmaceuticals. Established global drug giants spend vast sums on research and trials on a new drug in the hope of receiving a stream of revenues for 20 years or so while it is under patent. Once the patent expires, generic drug manufacturers come out with a version for a fifth of the price or less, annihilating the original maker's revenue stream. Some firms have decided they might as well pull in revenues from the generic market. Novartis, for example, gets a subsidiary, Sandoz, to do this. Rules of engagement between the two include a handover date when Sandoz takes over the business of a certain drug. Moreover, the arrangement enables Novartis – via Sandoz – to pursue generic versions of its competitors' drugs when they go off-patent.

In many cases, however, the late-life spinoff is not given enough freedom to pursue its own market strategy and act in an entrepreneurial fashion. It is forced to stick to established norms or rules, and is thus unable to create the independent business model required for success. Alternatively, it might not get enough focus and attention.

Few firms have decided to use the late-life operational model, and even fewer do it successfully. But if managed well, the late-life operation can provide both new revenues and lessons in streamlining for the main company: Low-cost businesses are forced to be very efficient.

Joern A. Buss is a Detroit-based partner in Oliver Wyman's Global Automotive and Manufacturing Industries practice

BY SECTOR: NEW TECH, NEW STRATEGIES

- 30 RAIL AT A JUNCTION
- 32 AUTOMATION NO LONGER ON AUTOMATIC
- 34 NEW GAME IN FARM EQUIPMENT
- 36 BITS AND BRICKS
- 38 TRUCK MANUFACTURERS: ARE YOU READY FOR DISRUPTION?
- 40 WIND TURBINE MANUFACTURING GOES MAINSTREAM



RAIL AT A JUNCTION

NEW TECHNOLOGY BRINGS NEW OPPORTUNITIES FOR TRAIN EQUIPMENT MAKERS

European rail has long functioned along national lines: an incumbent national railroad company worked with single suppliers of vehicles, tracks, and signaling systems. This model has spared rail the disruptions that have hit some other industries, but it is now under attack. The standardization of components is increasing the potential of scale effects and driving down prices. Rail liberalization in Europe has invited new competition from overseas. And players from the digital world are entering the business, providing applications that improve security or provide better customer information.

The changes mean that established equipment manufacturers need to transform their business models and make sure they are competitive in the fields where they operate. Rolling stock makers have a particular challenge. Though rail cars and locomotives are the mainstay of the industry, margins hardly rise above 7 to 8 percent at most global rolling stock vehicle manufacturers. In contrast, aftermarket services and control and signaling systems routinely command double-digit margins, because they provide high added value without the costly assets needed to produce machinery. So equipment makers need to increase their presence in these technology-heavy businesses, (see Exhibit 1), if necessary through acquisitions: Alstom SA of France, for example, recently acquired Signalling Solutions Ltd. of the United Kingdom.

HOW TO CUT COSTS

To reduce costs, a global search is needed for new components suppliers. Deutsche Bahn has been procuring wheels in the Ukraine and rolling stock in Poland. In November 2015, it said it would set up

a procurement office in China to get access to Chinese suppliers of replacement components such as wheels. Digital manufacturing techniques can also cut costs. One prerequisite is the modularization and standardization of construction. Standardized modules can then be used in different products, driving economies of scale. Later, data streamed from rolling stock in operation will provide feedback for the design of updated versions. Longer term, rail suppliers might become primarily designers, outsourcing the 3D printing of modular components to smart factories.

ESTABLISHING MARKET PRESENCE

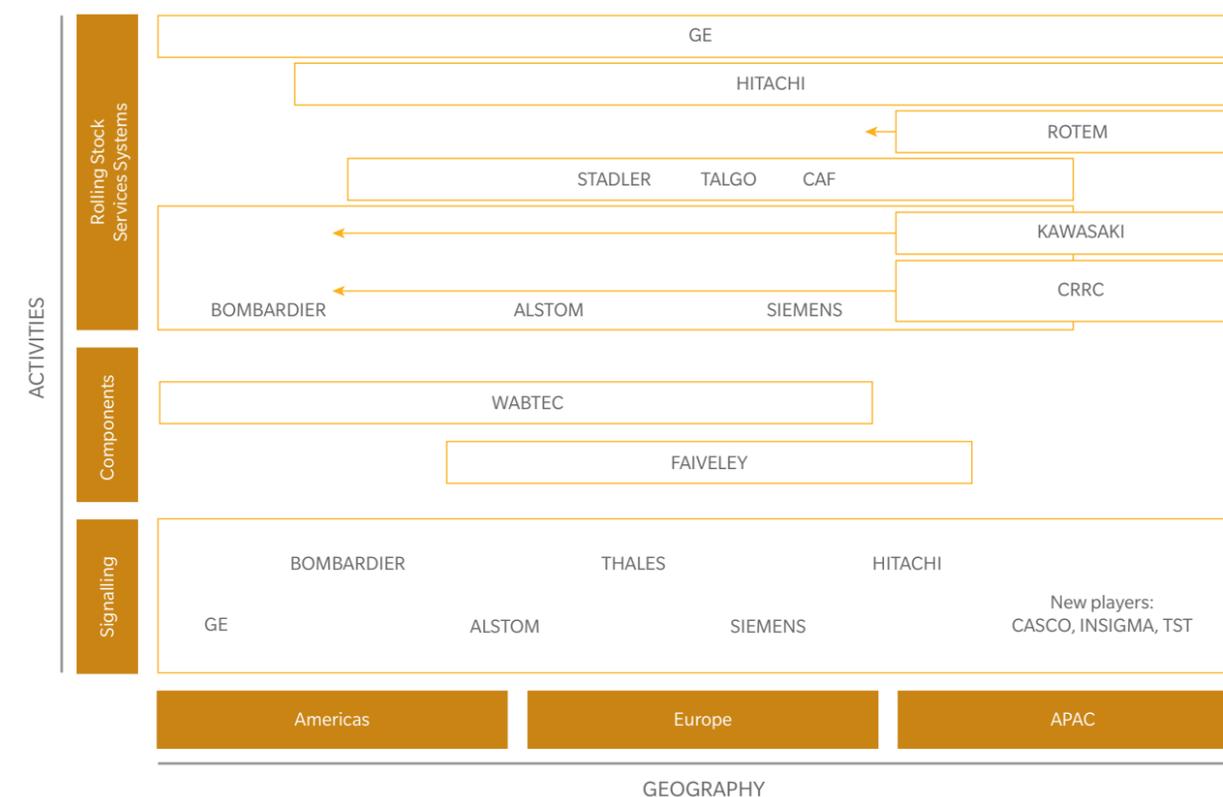
In sales, equipment makers must go beyond one-off transactions and tenders, and instead concentrate on long-term relationships and strategic partnering. Key customers in a given regional market are critical, as they often operate amid a complex ecosystem of stakeholders, influencers, and decision makers. Transport in and around Paris, for example, involves city and regional governments, several rail service operators, plus multiple engineering and construction companies. Incumbent suppliers often have local facilities, and

THE NEXT DECADE IS LIKELY TO SEE GLOBAL CONSOLIDATION THAT WILL CHANGE DRAMATICALLY THE RAIL SUPPLIER LANDSCAPE



Exhibit 1: The rail industry turns international
A new generation of global player is starting to compete in different continents

EXCERPT OF PLAYERS



Source: Oliver Wyman analysis

have established working practices with the operators' technical staff. They are plugged into the political circles where important decisions are made. And they have built connections with the national engineering and construction contractors. That means they are often best positioned to sustain such relationships and accumulate knowledge of clients.

To participate in markets like this, other equipment makers need to adopt the same approach, or else find partners that are well positioned. Once manufacturers have found markets, they should deepen their presence through enhanced downstream offers, including ownership of cost-saving services, such as predictive maintenance, and ways to enhance reliability, such as spare parts inventory management.

Some of these moves may involve mergers and acquisitions: The next decade is likely to see global

consolidation that will change dramatically the rail supplier landscape. To fare well in the upcoming wave of mergers and acquisitions, rail equipment suppliers need to become more fit and better focused, addressing areas of weakness such as overcapacity and investing in the things they do best. Though disruption is arriving late to the rail industry, it's coming down the line.

Joris D'Inca
is a Zurich-based partner in Oliver Wyman's Global Transportation practice

Gilles Roucolle
is a Paris-based partner in Oliver Wyman's Global Transportation practice



AUTOMATION NO LONGER ON AUTOMATIC

A QUIET SECTOR FACES DISRUPTION

The industrial automation sector has contributed to productivity increases and work safety for many years. As a result, the sector has expanded faster than most other sectors, and players have experienced significant growth at fairly high profit levels. Trends such as digitization, globalization, and changing customer requirements will lead to continued market growth — but they will also pose a challenge to established players' business models.

The industrial automation sector has grown significantly over the past years and is expected to continue to grow significantly until 2020 (at a compounded annual growth rate of more than 6 percent), to overall revenues of more than €200 billion. A deeper look into the development of industrial automation players nevertheless reveals some interesting insights. German firms, renowned throughout the industry as leading-edge technology players, have in many cases lost share to Asian players, and more importantly have seen lower profitability levels (~9 percent from 2008–2014), as compared to other European, North American, and especially Asian players (22 percent from 2008–2014, see Exhibit 1). With a few exceptions, Asian players such as Keyence, Fanuc, SMC, and Inovance have outperformed German manufacturers.

MEGATRENDS WILL ENCOURAGE AN INCREASED COMPETITIVE DYNAMIC

The industrial automation space has long been a sector where most players experienced growth and profitability and where trends have not been disruptive. In addition, competition was fairly restrained as

compared to other industries. This allowed players time to steadily develop their portfolios and business design. However, this is likely to change as the challenges grow. Yet the level of competition will depend on each company's position in the very heterogeneous market, and will vary by business design archetype and segment covered. We expect an era in which weaknesses in business design will be revealed and exploited more quickly.

Some of the developments and moves are likely to include the following: First, there will be a dynamic towards horizontal and vertical integration and a shift in strategic control points. These developments are all results of the current digitization and Industry 4.0. It will be critical for incumbents to maintain strategic control and broaden their offering, respectively. At the same time, challengers or leaders in adjacent industries such as Product Lifecycle Management (PLM) and Enterprise Resource Planning (ERP) will try to take advantage of this trend.

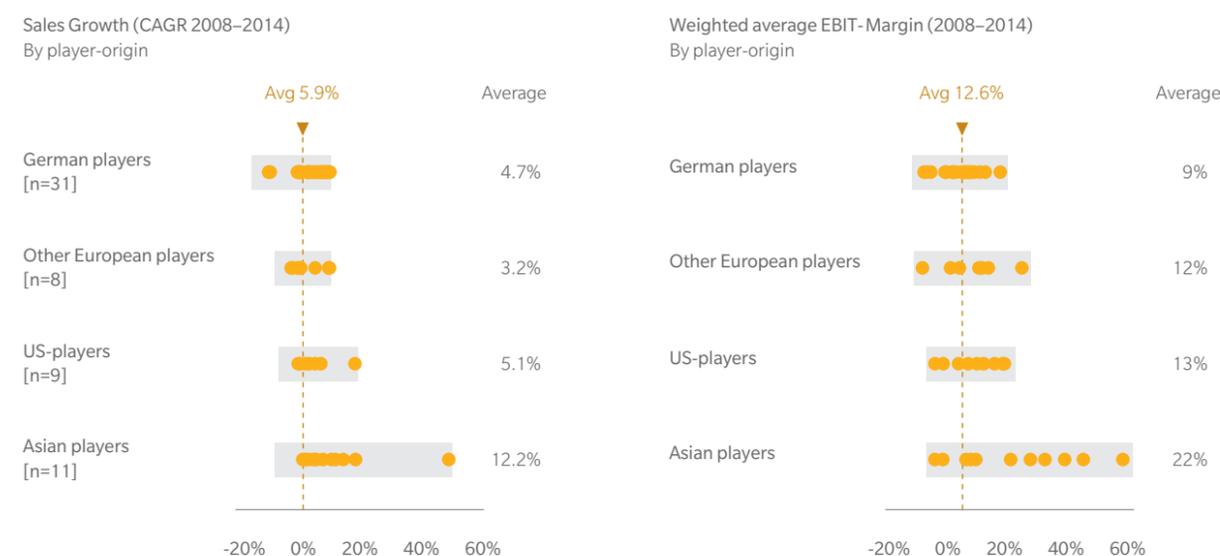
+22%
AVERAGE EBIT-MARGIN
FROM 2008–2014
OF ASIAN
AUTOMATION
PLAYERS



Exhibit 1: Regional differences

Performance in industrial automation varies greatly, with Chinese firms particularly successful

PLAYER PERFORMANCE BY ORIGIN DIFFERS SUBSTANTIALLY



Note: Sales ranges: Germany (€18 MM–€19 BN); other European (€400 MM EUR–€18 BN); US (€96 MM–€13 BN); Asian (€206 MM–€5 BN). Limited availability of financial data for some companies (not all years are available) – differing coverage of financials (average EBIT-margin based on different year).

Source: Oliver Wyman analysis

Second, “product to solution” has been a trend for many years, but one can observe an increased dynamic of medium-size players, especially drive technology providers, to really get there, as those players are well aware that their current position is at risk, and they may need additional scale to succeed in the future.

Third, “fit for function” has been a trend ever since the emergence of China as a growth market. Nonetheless, many European players have not found the optimal recipe to enter the market. One could expect a second wave of mergers and acquisitions (M&A) in emerging countries to address this issue and at the same time to enhance the often European-centric footprint. This is a step that many medium-size players have struggled with for a long time.

ROBUST BUSINESS DESIGN AND SCALE ARE ESSENTIAL

While overall market development is positive, automation players will need to find answers

to key strategic questions that are related to ongoing and emerging trends. They will need to redefine their business models to exploit profitable growth opportunities.

For full liners such as Siemens, ABB or Schneider, finding the appropriate business design to take advantage of digitization and maintain strategic control will be the key priority.

For many medium-size players, the degree of challenge will vary. But in general, we see strategic challenges in such areas as completion of product/solution portfolio, building scale, and creating a footprint to address globalization.

Not all challenges can be addressed organically. Consequently, we expect to see a surge in partnership and M&A activity.

Wolfgang Weger

is a Munich-based partner in Oliver Wyman's Global Automotive and Manufacturing Industries practice



NEW GAME IN FARM EQUIPMENT

PRECISION FARMING IS BRINGING NEW COMPETITORS FOR FARMERS' BUSINESS, AND CALLS FOR NEW STRATEGIES

Times are hard for farm machinery makers. Amid a long price slump in agricultural commodities, they are likely to record a third straight year of poor – even declining – sales in 2016. Commodities forecasts and indicators provide little hope for any sort of upturn in the coming years. And emerging markets are likely to be a source of limited opportunity for European and North American manufacturers, at least in the short term: India's main demand, for example, is still for low-tech, domestic machines, such as those made by Tafe.

An even bigger challenge is arriving, and how farm machinery makers deal with it will decide whether or not they thrive in the longer term. The agricultural economy is on the cusp of a production revolution centered on precision farming, which will see farms making increasing use of information services, big-data analytics, and webs of sensors. This is not natural territory for agricultural equipment manufacturers, who traditionally use their superior understanding of agricultural processes to offer vehicles and maintenance services. To master the new battlefield, they must figure out a way to combine their strengths with new technology to deliver comprehensive solutions (see Exhibit 1).

They face competition from two other groups. Agrichemical players such as Monsanto have branched out into information services to help farmers make better, faster decisions. They relay images from fields to monitor pests, and use sensors to gather data on rainfall and soil conditions. Analytics then combine these with historical information, such as seeding and yields per acre. Other competitors come from the world of digital technology. Trimble, for example, integrates farm data to bring maximum effectiveness to operations such

as nutrient supply and field terracing, and links this to farm management systems.

THINK ABOUT SOLUTIONS

Machinery makers can provide services like this too, by broadening their range of technology and integrating it effectively. John Deere, for example, has added digital, seeding, and other partnerships to its in-house capabilities. Equipment manufacturers, therefore, need to think about their position in agriculture solutions – whether to act as an integrator, a supplier of equipment to another integrator, or something in between. Only a few of them will be able to offer fully integrated services on their own. Most will either be part of someone else's solution, or arrange solutions with partners that have complementary skill sets.

Putting together these alliances and groupings will call for a rapid increase of mergers and partnerships. Indeed, the sector for agriculture-related services and equipment has been alive with mergers and partnerships in recent years. Since 2000, Trimble has acquired more than 100 companies across a broad array of capabilities and sectors, including energy, logistics,

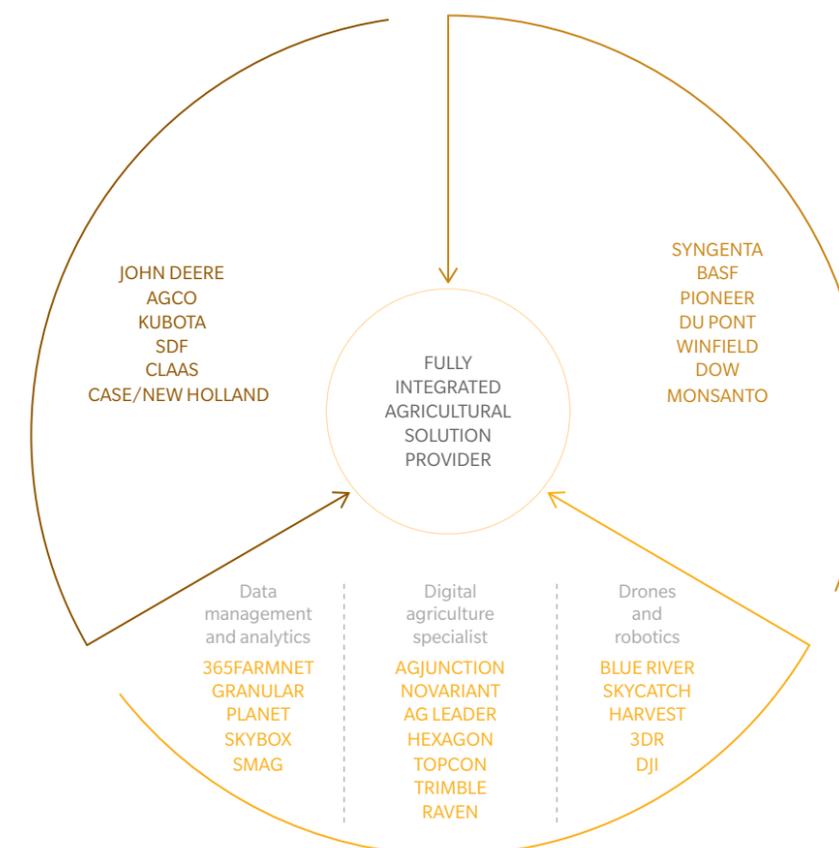
THE AGRICULTURAL ECONOMY IS ON THE CUSP OF A PRODUCTION REVOLUTION CENTERED ON PRECISION FARMING



Exhibit 1: New players, new strategies
Digital management systems mean change for traditional makers of farm machinery

PLAYERS WITH DIFFERENT BACKGROUND FIGHT FOR THE POLE POSITION FOR INTEGRATED SOLUTIONS

AGRICULTURAL EQUIPMENT OEMS	TECH PLAYERS	AGRICULTURAL CHEMICALS
<ul style="list-style-type: none"> • Most competitors favor an open approach leveraging partnerships, with open API • Only selected players have developed a controlled and closed solution, relying on in-house capabilities and only selected partnerships 	<ul style="list-style-type: none"> • Consisting of original tech providers who have widely developed partnerships with OEMs and gained agricultural know-how • New tech players including many startups 	<ul style="list-style-type: none"> • Besides agrochemicals, offer cloud and software-based prescription services to farmers, mainly through acquisitions and partnerships



Source: Oliver Wyman analysis

construction – and, of course, agriculture. In 2013, Monsanto bought a digital startup called The Climate Corporation, which makes a platform for precision farming solutions.

Most equipment makers are already moving in this direction, but others will have to learn to adapt. They have been the farmer's ultimate partner for decades: A strong aftersales network, product

reliability, and knowledge of farm processes will remain strengths – but only as part of integrated farming solutions.

Romed Kelp is a Munich-based partner in Oliver Wyman's Global Automotive and Manufacturing Industries practice



BITS AND BRICKS

BUILDING INFORMATION MANAGEMENT IS TRANSFORMING CONSTRUCTION

In the buildings of the future, lights will turn themselves on as people enter rooms, and off as they exit. Doors will open only for a face they recognize electronically. And walls will shift to create different-size rooms. The building of the future will also be faster and easier to construct. A sophisticated design process will come up with the optimum design, including selection of the right materials and components. Construction management will be easier, and costs transparent – and lower.

The key enabler of these buildings is a digital tool that promises to revolutionize the building process and the final product. Building Information Modeling (BIM) centers on a digital version of a scale model, which allows architects, contractors, and customers to

design and build more efficiently. It also makes it easier to construct buildings that go beyond mere edifices, and that use connected sensors to optimize services for the people who live or work in them. That means a world in which buildings save money, minimize their environmental impact, and maximize comfort.

Unlike the classic 2D drawings used by architects, the new digital mock-up is not constrained by physical space, so it contains far more information. Components and functions are planned from conception to demolition, enabling digital management of the building throughout its lifespan. All participants – and their suppliers – can provide input. Operating in real time, the mock-up is alive and collaborative.

That means it can run digital simulations, allowing rapid test and redesign before – and during – physical construction.

REAL-TIME TEST-AND-LEARN

As a result, everything in the construction process becomes easier to optimize – materials selection and procurement, the supply chain, and management of the site. Notably, BIM can be used to order more precise quantities of materials and components for just-in-time delivery – extending the idea of lean production to building sites, and lowering costs. Each phase of the operation is easier to control, even with a greater range of participants.

In addition to faster, lower-cost construction, the result is more sophisticated buildings. BIM helps to design a building and choose its materials to reduce energy consumption – and maximize the production of energy via solar panels. The finished building features smart lighting and heating systems, as well as security systems based on face and fingerprint recognition technology. Walls are flexible, so that tenants can create the spaces they need. The buildings can also help maintain those parameters that are quality-of-life considerations, such as air quality and noise.

The way buildings are valued is already coming to depend on their services more than the bricks and mortar. As BIM is implemented over a building's entire lifetime, the builder will remain involved in the management of the building for far longer than he is today. Sales offers can include guaranteed completion times and building performance, such as its conforming to a growing number of parameters subject to certification – energy use, effects on health, and environmental impact. To regulate these better, governments are likely to progressively make BIM compulsory.

For companies that fully implement BIM, the cost reductions should rise to between 15 and 25 percent on a work's life cycle, depending on its type. To make the most of the opportunity, constructors should develop a strong understanding of the disruptions that BIM will trigger. They should first figure out the immediate digital opportunities in their specific

15–25% COST REDUCTION
ON A WORK'S LIFE CYCLE
FOR COMPANIES
THAT FULLY
IMPLEMENT BIM



business models, so that they can reduce costs, construction time, and quality problems. They should also identify likely changes in customer needs, and figure out digital responses. This could involve bringing in skills from outside through acquisitions or partnerships. Above all, they need to recognize that the changes signal an unavoidable, major shift in the industry. This will see constructors focusing on clients' needs, seeing beyond traditional market formulae, and taking new risks. And every step of the way has to be digitized.

Exhibit 1: House-building in the future

BIM is 20% driven by technology and 80% by collaboration and integration

TECHNOLOGY ENABLEMENT



COLLABORATION AND INTEGRATION



Source: Oliver Wyman

Kai Bender

is a Berlin-based partner in Oliver Wyman's Information Technology and Operations practice

Florian Deter

is a Munich-based partner in Oliver Wyman's Strategic IT and Service Operations practice

David Kaufmann

is a Paris-based principal in Oliver Wyman's Construction & Infrastructure team



TRUCK MANUFACTURERS: ARE YOU READY FOR DISRUPTION?

AUTONOMOUS DRIVING AND CONNECTIVITY REQUIRE NEW STRATEGIC THINKING FROM MANUFACTURERS TO SAFEGUARD COMPETITIVENESS

After attacking the car industry, tech players are now taking on commercial vehicles. Deep-pocketed giants Google and Tesla are planning to offer autonomous trucks. Startups like Ottomoto and Peloton have announced offerings for 2017 such as retrofit kits that take over a wide range of driving tasks. These advances, combined with disruption in the logistics sector, will transform the shipment industry, as truck fleets organize delivery more efficiently and coordinate driving to save fuel. Incumbent truck OEMs invest massively, so that by around 2030+, there is a chance that trucks will become fully autonomous (see Exhibit 1).

To cope with this disruption, truck manufacturers will need to meet a radically new kind of demand for their products. A basic requirement will be autonomous, connected trucks capable of processing data to handle increasingly complex logistical demands. These advances will make the truck a much less personalized vehicle than it is today: a truck will function as a machine

BY AROUND 2030+,
THERE IS A CHANCE
THAT TRUCKS WILL
BECOME FULLY
AUTONOMOUS



with internet access that runs as near as possible to 24 hours a day; and it will become a commodity whose value is defined by total cost of ownership (TCO) and performance, accelerating a trend that began years ago. But if truck makers are able to grasp the changes currently underway, they will be able to place themselves at the leading edge of a transport and logistics revolution.

NEW WAY OF DOING BUSINESS

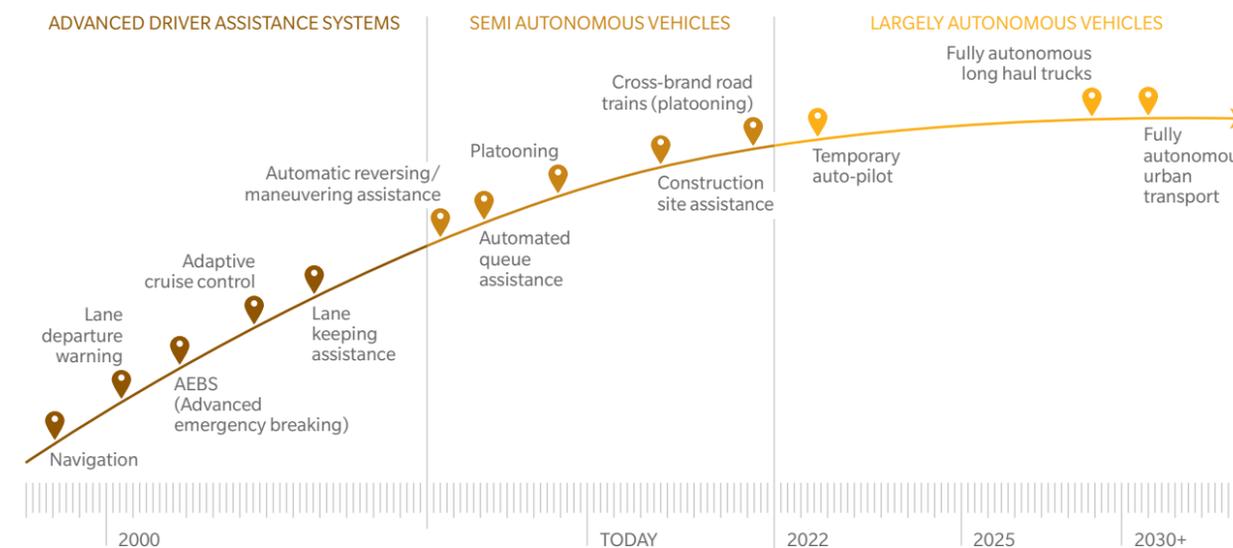
Autonomous and connected trucks by themselves will not generate large new sources of revenue. In truck manufacturers' traditional domain, these will be must-haves – necessary just to safeguard their positions and remain competitive, including against new tech entrants. Instead, product differentiation will come from a new way of doing business. Traditionally, truck makers sold hardware and then aftermarket products. In the future, availability and uptime guarantees will play a major role, facilitated by data-driven, predictive remote maintenance services that reduce downtime from wear and tear.

New technology will also help to control and minimize risk. Autonomous driving will result in fewer accidents and fewer periods of inactivity, thanks to the disappearance of limits on driving time. Workshop times will be minimized by backend digitization, such as automated ordering and delivery of parts. Truck manufacturers will also offer customers leading-edge logistics support services based on full connectivity.

Exhibit 1: New tech means new trucks

The march of autonomous driving technology will change how trucks are used – and what they need to do

ROADMAP RANGING FROM ASSISTANCE TO FULL AUTONOMOUS DRIVING – STRONG IMPACT ON OEM BUSINESS MODEL WHEN FULL AUTONOMOUS TRENDS “STANDARD”



Source: Oliver Wyman

Value will be maximized by real-time sourcing, analytical combinations, and the intelligent provision of vehicle, freight, and traffic data. These services could include freight monitoring, idle-capacity data, vehicle-to-warehouse communication, and automated arrival notes. All of this will require a profound understanding of logistics pain points and value levers.

A further leap could lead to services beyond those currently available, services that have greater potential to differentiate and disrupt. Truck manufacturers could extend the concept of availability guarantees to the kind of on-time guarantees offered by the rail industry. They could even offer utilization guarantees by teaming up with digital freight-matching platforms for spot shipments.

TRUCK OEMS SHOULD START THE STRATEGIC DISCUSSION NOW

Given the fast pace of new digital players, truck manufacturers also need to think urgently about their business models. First, they must develop a clear understanding of their future strategic positioning, from that of a pure truck manufacturer, to one in which they

are providers of integrated logistics solutions. That will mean analyzing products and business models where they can be the leaders (but may need to develop additional critical capabilities) and where cooperation, mergers, or acquisitions might be wiser. In addition, the profit model and sales approach of solution-driven businesses need to be evaluated clearly – as do the digitization requirements of major fulfillment processes along the backend value chain.

Truck manufacturers are facing disruptive challenges and have to move fast. The good news is that it's not too late – but the hour is slipping away. The time to act is now.

Romed Kelp

is a Munich-based partner in Oliver Wyman's Global Automotive and Manufacturing Industries practice

Daniel Kronenwett

is a Munich-based principal in Oliver Wyman's Global Automotive and Manufacturing Industries practice



WIND TURBINE MANUFACTURING GOES MAINSTREAM

BECOME A GLOBAL GIANT OR A LOCAL SPECIALIST

The wind industry is expanding. At the same time, the industry is also maturing, raising the prospect of stiffer competition and a wave of mergers. Turbine manufacturers need to figure out what their strengths are – and then position themselves ahead of the action.

The wind turbine manufacturing business looks stronger than ever before, with the industry sporting an average annual growth rate in excess of 30 percent for the past two years. International turbine makers are now all profitable, posting average margins above 5 percent. And following years in which wind was considered economically unviable, the lifetime cost of an onshore wind farm is less than that of a coal-fired power plant.

But wind's graduation from nice idea to mainstream industry is going to trigger serious competition. The European onshore market is increasingly saturated, which means wind turbine manufacturers will have to look for new markets. The competition in these will drive down prices at a time when governments worldwide are already reducing wind subsidies or cranking up competition through tendering procedures.

To survive in the new era, wind equipment firms need to position themselves correctly. We think turbine manufacturers can remain competitive in the long run only by adopting one of two business models: "Global Full-Liner" or "Local Dominator."

GLOBAL FULL-LINER: INTERNATIONAL SCOPE AND ECONOMIES OF SCALE

Opportunities in new markets are going to require global scale. One growth area will be offshore wind farms, which benefit from stronger winds and do not encounter resistance from affected residents. But they

are large scale and difficult to construct, making them high-risk endeavors. To be entrusted with such projects, turbine manufacturers will need the engineering depth and financial strength to cope with the inevitable hitches during rollout. The ability to supply plant components and systems – such as substations and grid connections – can also be an advantage.

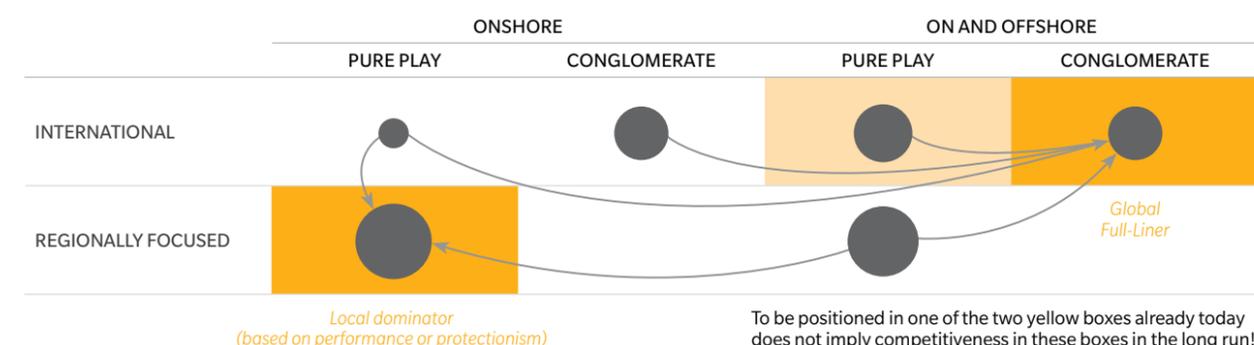
Other growth will come from the US and the emerging markets. In those markets, seizing business will mean engaging in international competition, which will call for scale in the form of an international footprint. Wind operations that are part of a conglomerate may be able to leverage expertise and commercial muscle from the group's other businesses.

More generally, scale will be of benefit in the tougher competition of the future. Economies of scale can reduce operational costs by purchasing source materials in larger lots and making processes more efficient through automation and digitization. And higher revenues will absorb the robust research and development (R&D) budgets needed to boost the performance of both individual turbines and wind parks – incrementally and through disruptive technologies. Some equipment

2% OF CHINESE WIND TURBINES WERE EXPORTED IN 2014



Exhibit 1: Winning formulas
Turbine manufacturers need to pick the right strategy in a maturing industry



Note: Size of circle indicates market share of players who are lined up in these positions today
Source: EWEA, Société Générale, Oliver Wyman analysis

makers have let innovation spending slip in recent years, as part of their drive for profitability: Western manufacturers spent just 1.9 percent of their revenues on R&D in 2015, down from 4.5 percent in 2011.

LOCAL DOMINATOR: MARKET INTIMACY AND LIFE-CYCLE ECONOMICS

The other way to survive is through local dominance in the onshore segment. A manufacturer that focuses on just a few local markets can perfectly tailor its products to the local climate, grid conditions, and regulatory requirements. It can concentrate on a relatively narrow – yet profitable – product portfolio, avoiding the complexity and greater risks of the offshore segment. High local market share also enables a manufacturer to support a dense service network and provide wind farm operators with superior service. Such networks also operate more efficiently, as technicians spend less time on the road and more on the turbines.

Moreover, a high local market share helps turn a wind turbine manufacturer into an integral part of the local community, with close relationships to customers and regulators. That can give the company a head start on new opportunities, such as subsequent waves of repowering (see Exhibit 1).

M&A IS MORE THAN JUST CONSOLIDATION

One way for turbine manufacturers to position themselves correctly is through merger-and-acquisition

(M&A) activity. Previous waves of M&A often served to get outsiders into the business, and had little impact on the industry's overall structure – which is still relatively fragmented, even as it matures. Future deals will have to aim squarely to get a wind turbine manufacturer into the right business model. M&A activity that increases a company's size but fails to position it in one of the two sustainable business models will not do the job. M&A could also be the way Chinese companies become global players. In 2015, five of the top 10 manufacturers by global capacity installation were China-based, but this strong showing is misleading. Turbine imports accounted for less than 1 percent of the Chinese market in 2014, indicating that Chinese authorities have closed their market to foreign competition.

Internationally, Chinese turbine makers are not competitive: Their exports were equivalent to less than 2 percent of the Chinese market. Overseas acquisitions would bring them new technology and operational know-how, especially in running international sales and service networks, and would also expand their global scale and market access. The coming wave of mergers will dwarf past consolidation activity. But there may only be a limited number of available partners who can meet suitors' specific needs. The time for wind equipment makers to act is now.

Wolfgang Krenz is a Munich-based partner in Oliver Wyman's Global Automotive and Manufacturing Industries practice

RECENT PUBLICATIONS FROM OLIVER WYMAN

For these publications and other inquiries, please email industries@oliverwyman.com
Or visit www.oliverwyman.com and our Oliver Wyman Ideas app: <http://apple.co/1UBhSPE>



PERSPECTIVES ON MANUFACTURING INDUSTRIES

A collection of viewpoints on industrial companies' challenges and trends, as well as their opportunities and potential courses of action.



THE OLIVER WYMAN AND EUROCLEAR BLOCKCHAIN IN CAPITAL MARKETS REPORT

The prize and the journey.



THE OLIVER WYMAN CMT JOURNAL, VOL. 3

Our latest thinking on the opportunities and challenges in communications, media, and telecommunications.



WOMEN IN FINANCIAL SERVICES 2016

The financial services industry is lagging in unleashing female leadership potential.



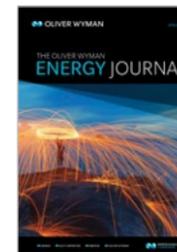
DIGITAL INDUSTRY

Challenges and opportunities of Industry 4.0 for manufacturing companies.



INCUMBENTS IN THE DIGITAL WORLD

How incumbent organizations can ultimately win in a marketplace transformed by digital disruptors.



THE OLIVER WYMAN ENERGY JOURNAL, VOL. 2

The latest thinking from across Oliver Wyman's Energy practice on how shifts underway will create new risks and opportunities not just for the energy sector, but also for every company and person that depends on it.



THE OLIVER WYMAN RETAIL JOURNAL, VOL. 4

Retail is an industry in transition. In this journal, we focus on the future to help us understand where the next upheaval is likely to come from and how retailers can be prepared.



THE OLIVER WYMAN AUTOMOTIVE MANAGER

Perspectives on the latest trends and issues in the automotive industry.



TEN DIGITAL IDEAS FROM OLIVER WYMAN

In this collection of articles, we showcase ten digital ideas from across our firm for how business leaders can improve and grow their businesses.



THE OLIVER WYMAN RISK JOURNAL, VOL. 6

A collection of perspectives on the complex risks that are determining many companies' futures.



THE OLIVER WYMAN TRANSPORT & LOGISTICS JOURNAL 2016

Perspectives on the issues facing the global transportation and logistics industries.



THE MARKETPLACE REVOLUTION

Shattering the foundation of the \$3 trillion sick-care marketplace.



THE OLIVER WYMAN AND MORGAN STANLEY WHOLESALE BANKING AND ASSET MANAGEMENT OUTLOOK 2016

Wholesale banks and asset managers – learning to live with less liquidity.



MRO SURVEY 2016

Innovation and adoption in the aviation maintenance, repair, and overhaul sector.



MODULAR FINANCIAL SERVICES

The new shape of the industry.

CONTACTS

ALAN WILKINSON

Principal

alan.wilkinson@oliverwyman.com
+1 248 455 7288

DAVID KAUFMANN

Principal

david.kaufmann@oliverwyman.com
+33 1 4502 3716

JOERN A. BUSS

Partner

joern.buss@oliverwyman.com
+1 248 455 7246

SÉBASTIEN MAIRE

Partner

sebastien.maire@oliverwyman.com
+33 1 4502 3086

ANDREAS NIENHAUS

Principal

andreas.nienhaus@oliverwyman.com
+49 69 971 73 527

ERIC CIAMPI

Partner

eric.ciampi@oliverwyman.com
+33 1 4502 3234

JORIS D'INCA

Partner

joris.dinca@oliverwyman.com
+41 44 553 3749

STEFAN BENETT

Principal

stefan.benett@oliverwyman.com
+49 89 939 49 276

ANDREW CHIEN

Partner

andrew.chien@oliverwyman.com
+1 248 455 7259

FLORIAN DETER

Partner

florian.deter@oliverwyman.com
+49 89 939 49 572

KAI BENDER

Partner

kai.bender@oliverwyman.com
+49 30 399 94 561

THOMAS KAUTZSCH

Partner

thomas.kautzsch@oliverwyman.com
+49 89 939 49 460

CHRISTOPH MÖLLER

Principal

christoph.moeller@oliverwyman.com
+49 69 971 73 489

GILLES ROUCOLLE

Partner

gilles.roucolle@oliverwyman.com
+33 1 4502 3348

PHILIP MOINE

Associate

philip.moine@oliverwyman.com
+33 1 4502 3397

WOLFGANG KRENZ

Partner

wolfgang.krenz@oliverwyman.com
+49 89 939 49 403

DANIEL KRONENWETT

Principal

daniel.kronenwett@oliverwyman.com
+49 89 939 49 591

HANNES ENGELSTÄDTER

Senior Manager

hannes.engelstaedter@oliverwyman.com
+49 89 939 49 431

ROMED KELP

Partner

romed.kelp@oliverwyman.com
+49 89 939 49 485

WOLFGANG WEGER

Partner

wolfgang.weger@oliverwyman.com
+49 89 939 49 430

