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WHITEPAPER

# Discrete manufacturing in a changing world

*Leaping hurdles and spotting  
opportunities*



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# Introduction

## *Discrete manufacturing in a changing world*

Discrete manufacturers around the world have undergone huge transformation in this fourth Industrial Revolution—and for a number of reasons. A combination of factors that include economic and market uncertainty, changing customer expectations around technology and a fast-moving green agenda are putting pressure on businesses to hone their supply chains and explore more sustainable and digital business models.

As well as the need to become more flexible and efficient, manufacturing change is increasingly aligned to the green agenda.

As a result, manufacturers need to change their business models and processes to keep their competitive edge. They need to drive efficiencies across the organization, introduce more personalized products and services faster, and become much more environmentally sustainable.

To help achieve these things, some manufacturers are trialing newer technologies that can deliver the speed, efficiencies and transformed processes that are required, with innovations like the Industrial Internet of Things (IIoT), Virtual Reality/Augmented Reality (VR/AR), Artificial Intelligence (AI) and data analytics high on the investment agenda. They are also exploring the same technologies to see where they can offer up additional insights and intelligence on how their business and supply chain is performing.

As well as the need to become more flexible and efficient, manufacturing change is increasingly aligned to the green agenda. In particular, the circular economy (a system designed to eliminate waste and the continual use of resources) and servitization (developing the capabilities to provide services and solutions that supplement product offerings) are having an impact on traditional manufacturing operations, alongside ongoing legislative change.





To keep up, manufacturers must evolve on all fronts—from innovating with the latest technology and making their business sustainable to adhering to geographical and industry-specific regulations. As part of this, they must look to migrate operations to the cloud to gain new cost and flexibility advantages, implement circular economy techniques and reinvent restrictive business models that hinder flexibility, scalability and growth. And they must also respond to legislative and economic change, initiated by the likes of USMCA and the Cloud Act in North America, and GDPR and Brexit in Europe.

New IDG-Sage research has found that these legislative changes are largely seen in a positive light, by manufacturers across the globe, as aiding quality standards, competitiveness, profitability and risk management, among other things. And they are willing to push through the pain barriers of IT investment, and technology, process and cultural inertia. This is because they recognize the cost, efficiency and growth benefits of:

- Circular economy practices
- Servitization
- Digital transformation and emerging technologies
- Regional legislation

These are the areas this whitepaper will examine, to see how manufacturers around the globe are faring. We will explore how, riding these seismic trends, manufacturers are chasing a vision where they are more green, sustainable and efficient. Where they are able to work across a connected

supply chain and thrive under newer business models. Where they can move away from big bang CAPEX (Capital Expenditure) products to services-led OPEX (Operational Expenditure) in a thriving digital economy.

Through this vision, they are also looking to: maintain performance and improve uptime; adapt to changes in customer demand; and, be able to better spot potential production problems before they manifest.

According to our resident expert for this report, Frank Piller, this represents a more modern understanding of the fourth Industrial Revolution, exploits advances in AI, robotics, the Internet of Things (IoT), 3D printing and other technologies.

This IDG-Sage whitepaper report draws on data gathered from manufacturing leaders across the world. It discusses how organizations can get ready for the future of manufacturing. And it offers executives and operational leaders, like you, insights into how they can make this vision a reality. Our research took place in October 2019 and surveyed 658 Director/C-Level business and IT leaders globally.

Of our respondents, 63% said their organization manufactures electronic and other non-computing electrical equipment and components, with 56% making computing-based equipment, appliances and components. Some 30% said their companies make industrial and commercial machinery, and computer equipment manufacturers. A fifth of respondents manufacture measuring, analyzing and controlling instruments, photographic and medical equipment, while 12% said they made food, beverage and tobacco products.

# Pursuing the circular economy

According to analysts, circular economy business models are the way forward. By 2029, the circular economy is predicted to be the only economy, replacing wasteful linear economies.

**97%** of companies who said they were impacted by green manufacturing trends (61%) said they have adopted a circular economy strategy

**24%** of North American firms said it was the factor that drove them to pursue a circular economy strategy, compared with manufacturers in EMEA (35%) and AUS (38%)

So what is the circular economy? In short, it is defined as a new economic model of production and consumption which encourages the continuous reuse of materials.

Through this model—which involves the sharing, leasing, reusing, repairing, refurbishing and recycling of existing products—and for as long as possible, organizations can extend the life cycle of products, minimize waste, and reduce the demand for additional natural resources. By taking this approach, organizations are able to move production from the more traditional model of “take, make, use and dispose” to the cyclical “make, use, reuse, remake, recycle”.

Approximately 97% of the companies who said they were impacted by green manufacturing trends (61%) said they have adopted a circular economy strategy.

Manufacturing expert Frank Piller says an increasing number of manufacturers are adopting a circular economic model into their digital strategies. This has been rising over the past year, starting with Daimler<sup>1</sup> around a year ago, and more lately, BMW<sup>2</sup> and several major pharmaceutical companies.

Industrial manufacturing is arguably one of the largest emitters of CO<sub>2</sub>, he comments, along with transport and energy sectors. It has an average operational equipment efficiency of roughly 60%.

“Manufacturers can achieve significant climate change impact by making their industrial systems a little more efficient. It would be much faster than changing consumer behavior, which is much more difficult to do,” says Piller.

Key factors driving the adoption of circular economy practices include the ability to increase revenues and reduce costs. Other drivers are more energy efficient practices, and advances in productivity, efficiency and resilience. Manufacturers also feel that being greener enhances their brand image.

Interestingly, improving the carbon footprint was less of a focus for North American firms taking part in our survey. Only 24% said it was the factor that drove them to pursue a circular economy strategy, compared with manufacturers in EMEA (35%) and AUS (38%). These variations are likely to be down to political uncertainty and change across different regions, and are in line with respective governments’ interests in improving the carbon footprint.

<sup>1</sup> [www.globalcompact.de/en/themen/Good-Practices/Umweltschutz/Best-Practice-Kreislaufwirtschaft-bei-Daimler-Kopie.php](http://www.globalcompact.de/en/themen/Good-Practices/Umweltschutz/Best-Practice-Kreislaufwirtschaft-bei-Daimler-Kopie.php)

<sup>2</sup> [www.bmwgroup.com/en/responsibility/sustainable-stories/popup-folder/circular-economy.html](http://www.bmwgroup.com/en/responsibility/sustainable-stories/popup-folder/circular-economy.html)

“Manufacturers can achieve significant climate change impact by making their industrial systems a little more efficient. It would be much faster than changing consumer behavior, which is much more difficult to do.”

— Professor Frank Piller

#### **Circular economy challenges and opportunities**

The vast majority see the circular economy as a net benefit to their organizations, and they see it as having a positive impact on their business over the next two years. Very few see a downside, even though most (77%) said they face undertaking substantial transformation to take advantage of it. “Often people might see it as more of an obstacle, as they have to build more resilience into their supply chain,” says Piller. But our respondents seem willing to pay the price.

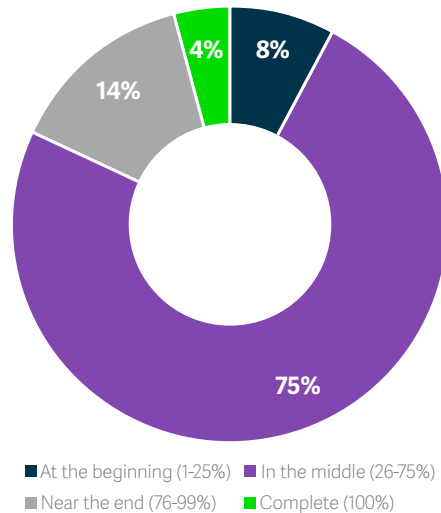
Almost every manufacturer we surveyed across the globe has begun transforming its operations to ensure it is fit for the circular economy. Of these, three-quarters said they are in the middle of transforming, while a reasonable 14% said they are almost done or completely transformed (4%).

In reality, transforming manufacturing operations for the circular economy is challenging for three in four companies—especially when it comes to adapting supply chain practices (83%) and balancing sustainability with the bottom line (79%). Many manufacturing leaders also feel there is a lack of customer or market understanding of the value the circular economy provides.

Piller says manufacturers still produce too many unwanted goods and lack the ability to predict what the market wants. If companies could understand customer demand by better analyzing data, they could better predict demand. That would help them drive down product wastage, he says.



How complete is your circular economy transformation? Globally, three-quarters of companies are in the middle of transforming and just 4% are completely transformed.



**76%**

**Transforming manufacturing operations for the circular economy is challenging for three in four companies**

He also mentions an emerging buzzword, the “biologization” of industrial manufacturing, which could be the next big wave of Industry 4.0. “This is where you use biocomposable products and materials that go into the products. But for this, you need new kinds of manufacturing,” says Piller.

The second generation of Industry 4.0 will feature much closer collaboration between the way products are designed and how manufacturing systems are developed, he says.

Additionally, connected, smart products will yield data that will impact product recycling and reuse. For example, data from a product’s digital twin can communicate whether an item or component needs to be refurbished, replaced or recycled.

It is here that Piller already sees certain companies leading the way. For example, he recalls the CTO of SKF, a Swedish manufacturer of bearing systems, telling him in the past that the company once had the mantra: “designed for quality.” A bearing is a cheap product, but if it fails, an entire wind turbine, for example, experiences significant downtime. In the past, the company would over-engineer the product with additional safety layers, disposing of it on failure.

After introducing predictive manufacturing and maintenance, however, the company changed its mantra from “design for quality” to “design for prediction.” Predictive technology now means the company doesn’t have to over-engineer the product. It knows how customers are using its products and has the data it needs to be able to reduce wastage and downtime.

“I see a very strong link with this type of thing and the circular economy,” says Piller. “It’s not just about using less water or energy for manufacturing.”

Manufacturers are facing market, social and economic pressures to adopt circular economy techniques. But these can also be a force for good.

Businesses stand to improve their customer offerings and relationships. They can gain new efficiencies by driving down waste in the manufacturing supply chain and customer sites. And there are significant cost savings to be made from adopting more environmentally friendly practices, which is why global manufacturers are willing to pay the price for change.

# The servitization of manufacturing

As well as adopting green initiatives, discrete manufacturers around the world are also driving forward with a servitization agenda.

The vast majority of manufacturers (93%) see servitization as having a positive impact on their business.

So, what exactly is servitization? Closely linked with digitization, it gives businesses new opportunities to expand their product lines with services and solutions. These include attractive add-ons, such as implementation, maintenance, upgrades and product life cycle.

Some 52% of our global respondents said this is a trend that is impacting them. Of these, 91% said they are pursuing a servitization strategy.

However, that level of impact differs across regions. Approximately 28% of North American respondents said servitization is impactful for them, but this percentage was much higher in EMEA (62%) and Australia (71%).

Frank Piller comments, "I was surprised to see that, in people's perception, North America is behind. I would have thought they would at least be at the same level as Europe or even higher, given that American companies are better in business model innovation.

"My intuition would have said that North America is driving servitization. The US is, by far, leading digital services around products in consumer goods. Most of the connected product ecosystems and platforms are from big American companies."

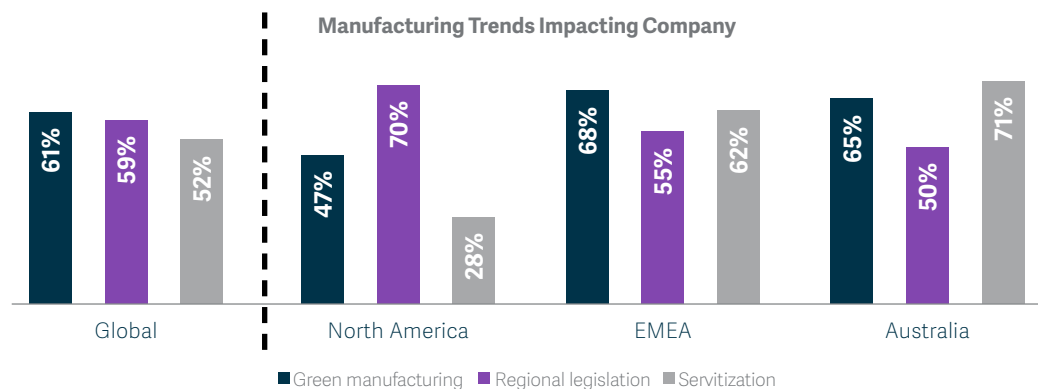
Servitization also creates new billing and financing options for customers. These help service users to shift their CAPEX to OPEX, and it enables smaller firms to compete with larger ones by not having to invest massively up front to compete.

For the manufacturers themselves, servitization offers a range of financial benefits. According to the global leaders we surveyed, this includes increasing share of wallet (72%), obtaining long-term contracts (58%) and steady cash flow forecasting (57%).

Most of them currently offer intermediate-level services, such as product repair, condition monitoring, field service and customer help desk. Just under half say they are also offering advanced servitization, add-ons such as pay-per-use, fleet management, availability contracts and integrated solutions. In particular, Australian and EMEA manufacturing leaders saw themselves as leading with these more advanced services (57% and 49% respectively).

Overall, the vast majority (93%) see servitization as having a positive impact on their business, with 59% of those seeing a strong net positive for them.





The major global manufacturing trends tend to have similar impacts globally. Green manufacturing and servitization seem to be less impactful in North America.

Piller comments that servitization covers a very broad spectrum. It starts with machine tool manufacturers selling machinery along with a service contract. This has happened in Europe for many years, he says.

However, manufacturers may benefit from considering the broader business implications of servitization, along with product and pricing implications. For example, would servitization be a good approach for both premium and high volume/low-cost services?

Indeed, servitization is growing far more sophisticated thanks to new data-centric capabilities. "In agricultural machinery manufacturing, I would say the American company John Deere is really leading digital services around agricultural equipment. You can create competitive advantage from traditional differentiators like quality, or functional differentiation on a hardware level. But real differentiation comes from features that are on the service layer," says Piller.

So, if manufacturers can offer digitally-oriented predictive maintenance, for example, servitization can make a lot of sense to users, from an investment perspective. That said, three-quarters of the global manufacturers who are pursuing a servitization strategy find it challenging to implement from a people and resource perspective.

The key challenges are around adopting servitization-centered supply chain practices. Aligning the goals of customer service and profitability is also an issue. Companies also find it hard to transform existing business practices across the organization.

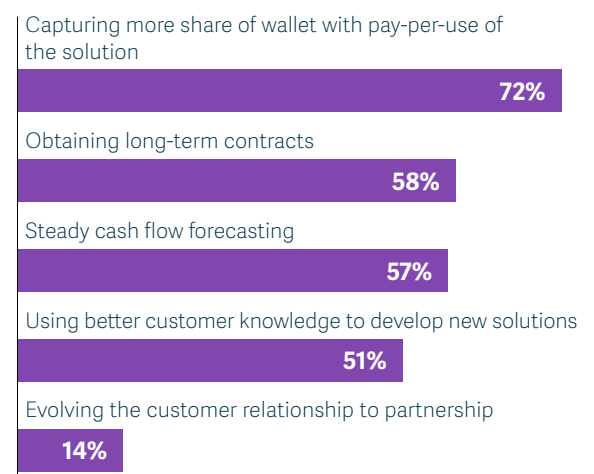
In addition, the primary factor hindering servitization for many is leadership, or technical or business cultural inertia (47%). An outdated business model (also 47%) and a lack of IT infrastructure (40%) are also holding back many from progressing with a service-oriented strategy.

Nevertheless, 70% of global manufacturers said they are "ongoing" with servitization transformation, recognizing the revenue and customer-centric benefits it brings. Three-quarters of our respondents know they must transform their operations substantially to offer services in addition to products.

But regardless of the challenges and the investment time horizon, most say it's worth it for the business.

Servitization's key benefits are typically financial. Approximately 93% of firms see servitization as having a positive impact on their business and 59% of those seeing a strong net positive.

#### Trends that Drove Adoption of Servitization Strategy



### **In pursuit of a value-based pricing model**

Piller observes that real servitization comes down to the operating model and concepts like value-based pricing. This is where you don't buy the machine itself, but pay for each produced item based on an agreed perceived value of what a product is worth. Manufacturers would determine that value in partnership with the customer.

He points to one such example: "General Electric was the one that really pioneered this with their digital manufacturing platform, and also proposed this model of value-based pricing for manufacturing."

However, he adds, "Value-based pricing was the big hope for Industry 4.0, but it seems there's an unwillingness to adopt it."

Conversely, volume-based pricing is easier to manage because you just count physical pieces. For example, automobile paint shops are moving to this system, where automotive manufacturers pay-per-car for new equipment. This is rather than paying for the cost of the paint shop itself.

Another barrier to adopting value-based pricing is that the customer is required to share vital cost and

value data with the manufacturing supplier for it to function. Using this information, they can work out the value-based pricing together. But manufacturers are not generally willing to share this information.

So, when it comes to both the circular economy and servitization, both business culture and business models within manufacturing organizations need to change for these to be successful.

The vast majority of manufacturers feel positively about servitization. They can see it offers them financial benefits, such as greater share of wallet and an improved cash flow. And it can generate new revenue streams and enhance relationships with customers, among other things.

To make the most of servitization, manufacturers need to support their new services and solutions through IT modernization. This is what we will look at in the next section.



# Digital transformation and the impact of emerging technologies

At the core of the change manufacturers are currently undergoing is a need to update manufacturing operations. This is what will enable them to transform the way they offer new services in the future. It's also what will help them improve profitability, shift from CAPEX to OPEX business models and expand the business.

**60%** | of discrete manufacturers globally are already in the cloud, with at least one workload or application currently hosted

**75%** | of global manufacturing businesses admitted it is challenging, or extremely challenging, to introduce cloud computing infrastructure or applications into their operations

Often underpinning this transformation is cloud migration: moving essential applications, processes and data from on-premise systems to more flexible, scalable and utility-priced cloud infrastructure.

Manufacturers are looking to shift to cloud for a whole host of reasons. For example, they might expect to improve process efficiencies or customer service. Alternatively, they may move to cloud to take advantage of newer technologies, such as IIoT, automation, AI and data analytics.

The advantages of cloud SaaS (Software as a Service) and PaaS (Platform as a Service) platforms are also attractive to smaller manufacturers, says Piller. It can give them a huge range of new capabilities, access to processing power and advanced technologies like AI and analytics, and help expand their geographic reach. This all enables them to compete with larger competitors with

more resources. The cloud can enable all of this for SMBs, without them having to invest in the technology infrastructure, R&D and IT expertise.

A hybrid approach to ERP also has advantages for SMBs, offering the benefits of cloud while giving them the option to keep certain processes in-house. That way, they can configure, manage and secure them to their satisfaction, and ensure their customers enjoy smooth and reliable services.

Nevertheless, Piller comments, "With cloud-based solutions, the costs of digital innovation are much lower than the traditional costs from investing in manufacturing, if you can get things as-a-service. And if you connect to a manufacturing platform, suddenly, as a smaller player, you can get benefits that were previously only exclusive to larger players."



Piller cites an award-winning factory in Belgium, a small-sized furniture manufacturer with approximately 100-150 employees. He says it has become a best-in-class digital manufacturer with a unique business model, offering its customers full customization of the furniture products they can buy. "They are an owner-based company with big ambitions and are probably more advanced than any other furniture maker in the world. There are a lot of these examples," says Piller.

However, he adds, while smaller manufacturers can take advantage of cloud to punch above their weight, they may lack sufficient time or skills compared with their larger rivals. Piller says, "These companies often don't have the cognitive capacity. It's because they are so busy with daily business, and the two people who are qualified have so much to do.

"And in markets like the UK and Germany, where there is a shortage of qualified labor, these businesses don't attract the talent they need. They would be the last to get a data scientist, or to be an educated buyer of analytics services. It's an interesting trade-off. On one side, the technological advantages can really empower this mid-market. The organizational realities, however, are a big hurdle."

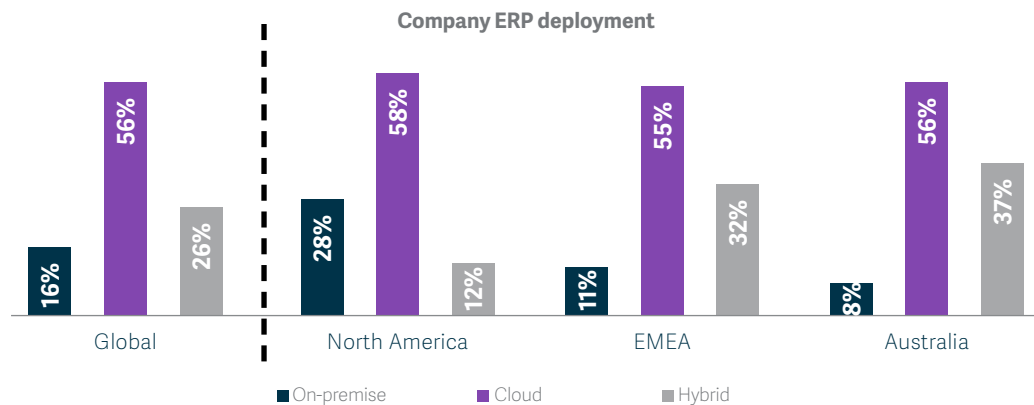
Nevertheless, most discrete manufacturers across the world say they have begun their cloud journey in earnest. Approximately 60% globally are already in the cloud, with at least one workload or application currently hosted.

Over a third said they planned to use cloud-based applications, or computing infrastructure via the cloud, within the next 12 months. And the remainder, a slimline 6%, planned to be in the cloud within three years.

In terms of describing the degree to which cloud is a good fit for their organization, there was a high degree of variation among business leaders we surveyed. For example, just over a third of global discrete manufacturers said they are not significant cloud users, while 18% admitted they are at the very start of a cloud journey.

The level of cloud usage also varies across regions. Two-thirds (66%) of Australian firms said they operate cloud-based manufacturing systems. This figure was 30% in North America and 55% for EMEA.





ERPs are rarely still completely on-premise, though more commonly in North America. Some 26% of respondents said they are running a hybrid infrastructure, with their ERP partly on-premise and partly in the cloud.

Just 6% of Australian firms said they are starting to investigate cloud technologies—compared with 34% in North America and 11% in EMEA.

Regardless of where businesses are in their cloud adoption, many are experiencing challenges in moving to cloud environments.

Three-quarters (75%) of global manufacturing businesses admitted it is challenging, or extremely challenging, to introduce cloud computing infrastructure or applications into their manufacturing operations.

A good indicator of where businesses are in terms of Industry 4.0 sophistication is how advanced they are in shifting their legacy IT systems to the cloud, Piller says. “If you utilize cloud services, it means you are starting to aggregate data and move into prescription and prediction. That’s the second wave of Industry 4.0.”

#### How far do manufacturers trust the cloud?

There is a notable appetite among manufacturers globally to move Enterprise Resource Planning (ERP) applications to the cloud. Approximately 56% of companies in our survey reported they already use cloud-based ERP.

About a quarter of respondents (26%) said they are running a hybrid infrastructure, with their ERP partly on-premise and partly in the cloud. As for on-premise only, North American manufacturers are more likely to keep things in-house (28%). This is versus 11% of EMEA manufacturers, and a slim 8% of Australian firms. Most companies (87%) are also using industry-specific ERP solutions.

Piller says that, in his experience, manufacturing organizations across the globe still have reservations about trusting cloud infrastructure with critical system workloads.

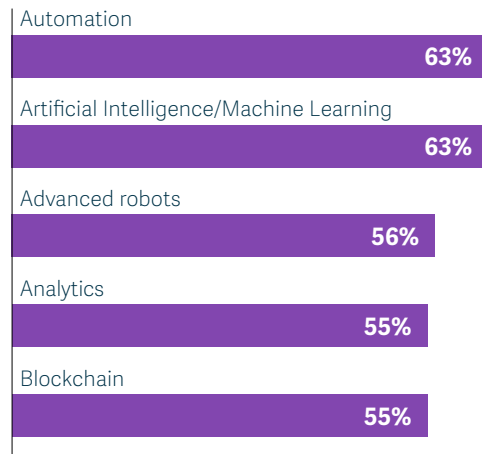
“A lot of technical experts will say workloads are much safer in the cloud if they are professionally managed. But the cognitive barriers of really moving something to the cloud are preventing businesses from migrating their manufacturing systems,” he says.

On one hand, employees and customers are becoming open to the idea of downloading an application from a manufacturing platform. But on the other, there is still very strong resistance to sharing data externally—especially manufacturing data, says Piller.

“It seems to me it’s easier for businesses to put their Customer Relationship Management (CRM) data into the cloud with someone like Salesforce. And that’s really valuable company data: your customer data. But when it comes to manufacturing data, they’re not willing to. There’s a lot of human resistance.”

Many large manufacturers even find it hard to share data internally, Piller has found. “Manufacturing plants in the same company often compete with each other. So, there is, surprisingly, less willingness to share data even within the same enterprise, as they are competing with each other and don’t want to share their tricks.”

#### Top 5 Manufacturing Technologies Currently Adopted or Planned



The same top five technologies currently implemented are also those most planned for. Global manufacturers plan to take advantage of a diverse set of cutting-edge technologies.

There are exceptions, of course. Industry leaders such as Volkswagen are leading the charge into the industrial cloud with its March 2019 announcement<sup>3</sup> that it is working with Amazon Web Services to build a significant cloud operation.

The plan is for Volkswagen Industrial Cloud to combine data from all its machines, plants and systems across all the facilities of the Volkswagen Group. That's more than 30,000 locations of over 1,500 suppliers and partners throughout the world.

The company expects to make significant productivity improvements at the plants. And it also plans to integrate the global Volkswagen supply chain into its cloud infrastructure in the long term. Andy Jassy, CEO of AWS, commented at the time, "Volkswagen's and AWS's collaboration will have a profound impact on efficiency and quality in production throughout Volkswagen's global supply chain."

#### Cutting-edge technologies poised to transform discrete manufacturing

Alongside cloud, global manufacturers plan to take advantage of a diverse set of cutting-edge technologies. Their aim is to meet the changing needs and expectations of customers and deliver IT transformation.

Among these technologies, according to our survey respondents, are automation (63%), AI/Machine Learning (ML) (63%), advanced robots such as co-bots—collaborative robots—(56%), data analytics (55%), and Blockchain for sourcing and tracking sustainable materials or components (55%).

There is a natural crossover between several of these technology categories, according to a McKinsey analysis on automation in manufacturing<sup>4</sup>. Specifically, there's an overlap between automation, AI, robotics and analytics.

The consultancy firm says manufacturing companies and sites can capture value at each stage of their automation maturity. This could start with a basic sensing infrastructure for temperature, pressure and flow, for example. Or simple task execution automation, such as for actuators.

Mid-level automation might include advanced sensing equipment, such as vision and in-line sampling analysis. Alternatively, it could include automated process control, or machine learning-based optimization routines that can create machine or supply chain efficiencies.

McKinsey says advanced automation is where manufacturers are using collaborative robotics and automated guided vehicles, or are operating optimized automated programming facilities based on AI and neural networks.

Automation is on track to be a hugely impactful technology for manufacturers going forward, as they enjoy the benefits of mid-level and advanced automation in transforming their operations.

<sup>3</sup> [www.volkswagenag.com/en/news/2019/03/volkswagen-and-amazon-web-services-to-develop-industrial-cloud.html](http://www.volkswagenag.com/en/news/2019/03/volkswagen-and-amazon-web-services-to-develop-industrial-cloud.html)

<sup>4</sup> [webcache.googleusercontent.com/search?q=cache:LB\\_tegtogmUJ:https://www.mckinsey.com/business-functions/operations/our-insights/human-plus-machine-a-new-era-of-automation-in-manufacturing+&cd=12&hl=en&ct=clnk&gl=uk](https://www.mckinsey.com/business-functions/operations/our-insights/human-plus-machine-a-new-era-of-automation-in-manufacturing+&cd=12&hl=en&ct=clnk&gl=uk)



As an aside, one upcoming trend in the industrial field is AI-enabled, consumer electronics-style user interfaces, says Piller. Several machinery companies he has spoken to are investing in User Experience (UX) designers. These manufacturers anticipate they can competitively differentiate their products and digital services based on the dashboard they provide, and ease of use they can offer customers.

### **The rise of the Industrial Internet of Things**

Another technology that can be integrated with a number of these cutting-edge innovations, and which is seeing widespread adoption among manufacturers worldwide, is the Industrial Internet of Things (IIoT).

This is where individual computer devices and mechanical equipment are networked together. They can then send sensor-based and operational data back to the organization, which can analyze and act on it.

The biggest driver for pursuing an IIoT strategy is increasing customer satisfaction by improving products or services. Three-quarters of global organizations considered this a top priority, followed by enhancing operations and cost optimization (65%). Next was generating new revenues with new products and services (59%), with respondents also citing enhancing worker satisfaction by improving conditions (45%).

However, the actual usage picture for IIoT differs a little from the reasons people plan to adopt it. Discrete manufacturers are currently applying IIoT in their business predominantly for quality control (50%) and safety (45%). They are also using it for data analysis (39%), to create a connected supply chain (36%) and to improve the customer experience (35%).

So, IIoT is clearly finding practical uses that advance organizations' digital transformation agenda.

### **The second wave of Industry 4.0**

The adoption of cutting-edge technologies is a sign of the second wave of Industry 4.0, says Piller. He explains that Industry 4.0 emerged around 2012 and 2013, as manufacturers continued to modernize their operations through digital technologies. It was popularized, to a great extent, by IT systems and machinery vendors and suppliers, who were pushing the ideas along with their products, services and solutions.

"There was a lot of talk about digital manufacturing technology like additive manufacturing, horizontal corporation and new machinery. That was the first wave of Industry 4.0, and it was very much focused on the plant level and single factories. In the early years, it was about creating the technical infrastructure. How we save our data, and which standards we will utilize," says Piller.

“The cognitive barriers of really moving something to the cloud are preventing businesses from migrating their manufacturing systems.”

— Professor Frank Piller

Initially in Europe, but mainly in the US, Industry 4.0 digital transformation was about creating operational efficiencies. Manufacturers saw it as a new means to improve on traditional KPIs, like unplanned downtime. This was one of the big pressure points for companies, along with quality control and energy costs. They were the key factors driving change, says Piller.

But it was only in 2016 and 2017 that companies started to strategize effectively about digital Industry 4.0. They started to appoint digital directors and give them a broad overview and remit across the organization. They were also given the freedom to shape and create new business models for the company.

Manufacturers shifted their focus towards achieving greater customer-centricity through customized manufacturing and mass customization. Then, more recently, they turned to sustainability and the circular economy.

Piller says the emerging technologies mentioned, particularly automation and data analytics, are now driving Industry 4.0 maturity. These are what will enable manufacturers to get to the next level.

He describes an Industry 4.0 model that has four stages of maturity, with the latter stages representing the second wave of Industry 4.0.

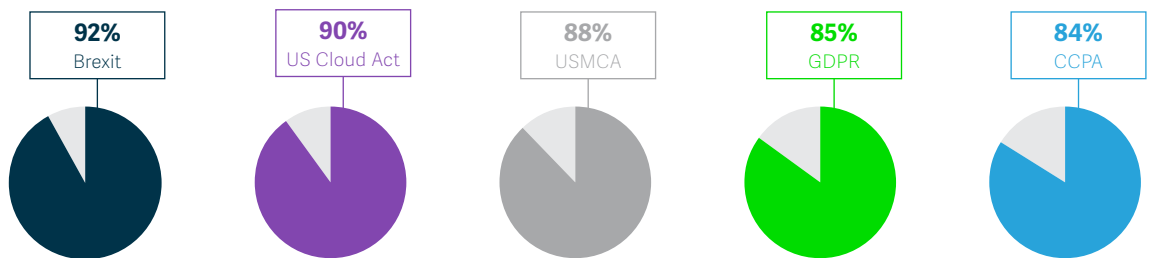
The first, he says, is to have to have data-centric visibility across processes and systems to see what's happening across the organization. The second is to understand the data and recognize patterns. The third is to have the ability to predict what might happen from the data. And the final stage is to be able to prescribe and give recommendations on what to do, and to be automated and proactive.

But Piller notes, “There are also steps minus one and minus two. Before I have visibility, I have to be able to capture, store and transport data. If I don't have a clear 'digital twin' or 'digital shadow' of my operations, and a unified data storage model, it's very difficult to get visibility, which is the starting point for everything else.”



# The impact of changing regional legislation

The final trend impacting manufacturers across the world is to do with regional legislation. Almost all manufacturers say they are currently grappling, or expect to be engaging with, the following developments:



In terms of impact, Brexit will have the greatest impact on investment strategy (86%), mergers and acquisitions (76%), supplier contract fulfillment and cost and the availability and cost of labor (both 71%), according to the surveyed global IT and business leaders.

In a political and economic climate marked by uncertainty, European manufacturers specifically, seem to have little option but to take a “wait and see” approach when it comes to business investment and expansion. They also feel Brexit will impact their market access, foreign currency exposure, and manufacturing operations and systems.

As for North American manufacturers, they also see both the Cloud Act, USMCA and the CCPA as being broadly disruptive to investment, mergers and acquisitions, the availability and cost of labor, and the supply chain—in terms of supplier contract fulfillment and cost.

The indication is that enterprises across the globe are having to be cautious in acquiring companies and making significant investments, wary of market uncertainty, shifting legislative requirements and painful tariffs. And, judging by the constantly changing geopolitical and economic scene, there is no clear sign of when this uncertainty will end.

Piller comments that the effect of changing US tariffs abroad can make it difficult for manufacturers to define their supply-chain strategies.

“We have to be much more flexible in how we balance our product assortment across different factories, mainly to prevent tariffs. One manufacturer told me it built this wonderful new factory in Mexico, but should they use it or build it again in the US?”

Fluctuating tariffs can affect product mix across geographies, adds Piller. “For many years, one of the KPIs of more advanced digital manufacturing was assortment flexibility. So, if you want to have a higher product mix in one factory, you deploy flexible automation. But over the last year, I hear that manufacturers are seeking volume flexibility. They want to go up or down by 30% in volume in each factory. And that’s a huge challenge technically: much more challenging than assortment flexibility. This is entirely driven by the fear of tariffs, as companies don’t know which factory they should use to ship volume products.”

“We have to be much more flexible in how we balance our product assortment across different factories, mainly to prevent tariffs.”

— Professor Frank Piller

#### **A positive long-term outlook on legislation**

Surprisingly, most of the people we surveyed view legislation positively. They feel it is good for their business overall.

Over 80% of respondents believed the impact of the legislative and political changes on manufacturers will be positive in the next 24 months. This was across all five regulatory/legislative frameworks we queried them on: Cloud Act, GDPR, USMCA, CCPA and Brexit.

In fact, most of the business and IT leaders felt there is a positive global impact from transforming manufacturing operations to meet the requirements of regional legislation.

Over the coming two years, they saw a net positive coming from global expansion, greater profitability, moving from CAPEX to OPEX, and benefiting from improved quality standards.

Many were looking forward to greater competitiveness, and the ability to produce more personalized, customized products. Others expected productivity improvements and better operational risk management.

They recognize they must transform their IT operations to comply with current or future legislation. Especially legislation pertaining to the cloud. Businesses envisage that they needed to undergo a substantial or major transformation to their cybersecurity, hosting and cloud operations, and business analytics.

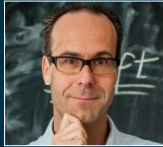
Consequently, respondents feel that the need to transform their IT in response to legislation will largely lead to good things. Among these are greater profitability, global expansion, customer experience, data security and innovation.

In fact, most see few negatives to modernizing their IT. Only approximately a fifth to a quarter of companies felt the legislation would have no impact, while just a slim minority said it would have a net negative effect on their business. Most said that the global impact of transforming their manufacturing operations due to regional legislation would be an improvement in quality standards, competitiveness, profitability and risk management, among other things.

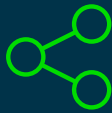
Evidently, regulation can be a force for good.

# Frank's four takeaway tips

How discrete manufacturing operations must change, culturally and economically



Professor Frank Piller is Professor at RWTH Aachen University in Germany and cofounder of MIT's (Massachusetts Institute of Technology) Smart Customization Group. He is an acclaimed expert in the areas of mass customization, open innovation and personalization. He's also frequently quoted by leading media publications, such as the *New York Times*, *Business Week* and *The Economist*.



## 1. Sharing

Businesses need to embrace more openness in their innovation systems. They should think about getting value from sharing their data both internally and externally. The adoption of cloud-based systems is a big driver for this type of transformation.



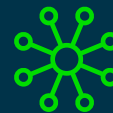
## 2. Vision

Manufacturers must develop a vision that incorporates new capabilities, such as manufacturing resilience and flexibility. These can enable a different type of business model, or a different value proposition in terms of the circular economy. In other words, they should not just look for operational efficiencies but also the strategic value and cultural change that they can enable.



## 3. Agile thinking

When companies adopt agile development thinking, this can bring about further cultural change. Companies could give their manufacturing people a whole new set of tools and train people on the shop floor in design thinking, so they can redesign processes and design their future workplace, for example. It's more about process development and innovation, and how processes are managed, and much less about product development.



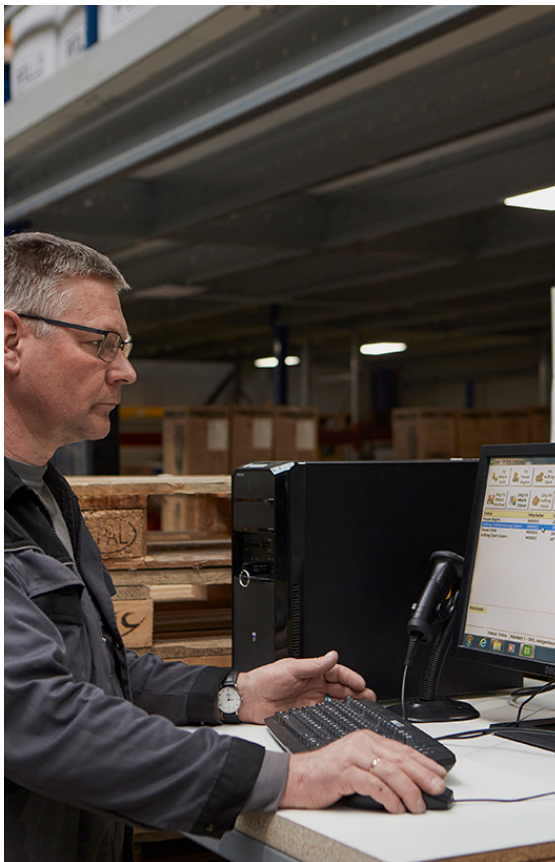
## 4. Optimization

In the future, manufacturing leaders will move more of their critical systems to the cloud and become more open. They will further optimize processes, but not just on the level of one factory or plant. They will go beyond thinking about the plans of one company. Instead, they will view optimization more holistically, in terms of the supply chain and partner infrastructure, user consumption and the life cycle of their products.

As everything becomes more interconnected, there will be a much larger chain from which to glean competitive and relevant data on which to base future decisions. Successful leaders will thereby make smarter decisions by connecting what they do in manufacturing with what happens in the broader supply chain, and how users consume their products. That's where emerging technologies, such as AI, automation, IIoT and analytics, will really come into their own.

# Resilient manufacturers see the upside of change

Discrete manufacturers are a resilient industrial group. They are willing to weather economic, market and legislative uncertainties.



They are clearly being impacted by pressures to green up, offer more and better services to customers, digitally transform and cope with shifting regional legislation. And there are signs they are holding back investment and expansion in response to economic and legislative uncertainties.

But, ultimately, they are willing to put in the work to transform to meet the needs of a changing market. There is a desire among global manufacturers to modernize and invest in—and pursue—the benefits of circular economy practices, servitization, and digital transformation and cloud.

They understand the advantages that IT and process modernization can give them in terms of cost, efficiency and insight—and rightly so. As Frank Piller indicates, there's a new wave of Industry 4.0 coming fast, and businesses need to be ready.

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