Microsoft

Agile Manufacturing: Redefining the Smart Factory

After years of "just around the corner" predictions, the smart factory has arrived and is operating at scale in a growing number of global companies

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Introduction

Industry 4.0. Industrial IoT. Edge computing. IT/OT convergence. These interlocking smart factory concepts are rooted in the belief that computing technologies have the potential to revolutionize manufacturing. Now, global manufacturers are starting to see actual results.

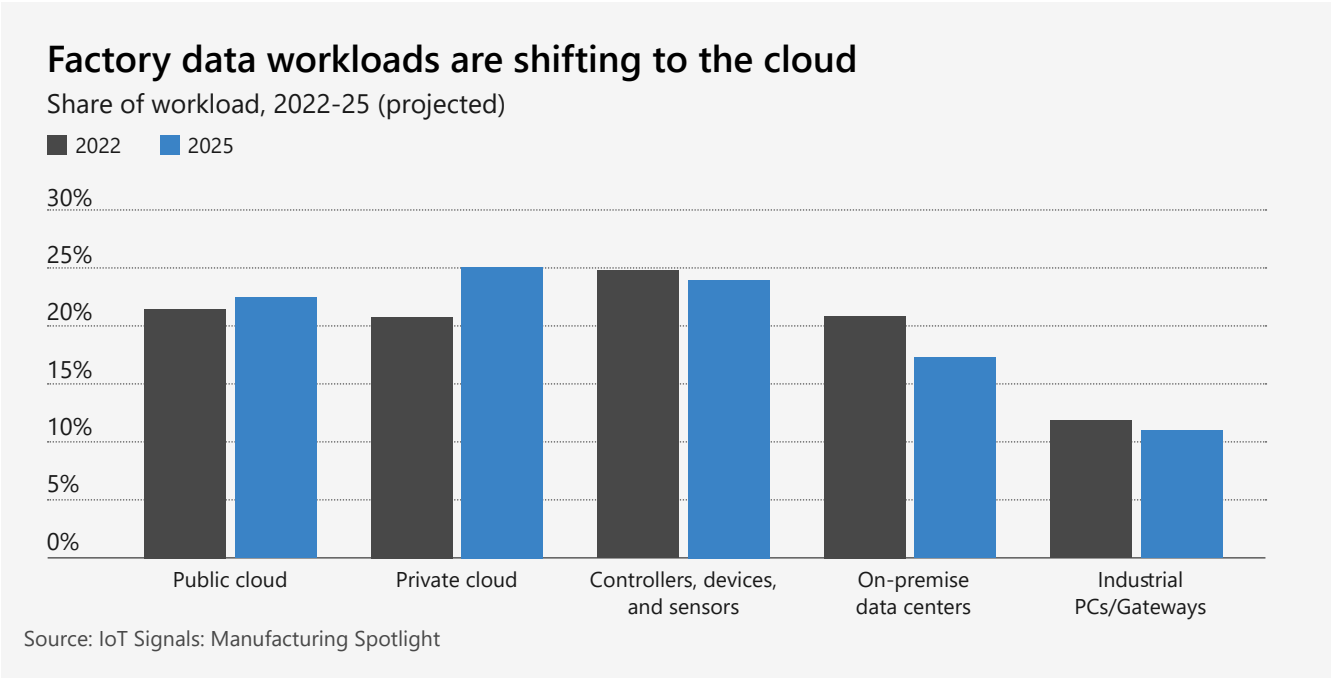
In less than a decade, businesses have gone from cautious pilot projects to a strategic approach that delivers real business value. Manufacturers not only seek to understand what new efficiencies are available to them, but also build a foundation for digital transformation of production lines, supply chains, and workforce development.

In a recent survey of 500 senior managers and executives published in the 2022 "IoT Signals: Manufacturing Spotlight" report, 72% of them said their firms have already implemented a smart factory strategy. And nearly four out of five assets are now connected[1] – an astounding figure considering the depth and breadth of legacy controllers and specialized hardware present in most industrial environments.

Amol Adgaonkar, Senior Director of the Microsoft Manufacturing and Supply Chain Industry strategy team, works closely with manufacturers and Microsoft's extensive partner ecosystem. He says the businesses he works with do not want "science projects" that take a lot of time to plan and execute and are more suited to experiments or proofs of concept. Rather, they are looking for real results on working production lines in a much shorter time frame.

"We set out to look at one problem in a single factory, and in 12 weeks deliver real tangible value," Adgaonkar adds. "We refer to this as a minimum viable product (MVP), and it is delivering real measurable value. There's no two ways about it."

> **"The smart factory is all about applying advanced digital technologies such as IoT, AI, analytics, augmented reality, robotics to really drive a step-change level of improvement in production as measured by throughput, cost, safety, environmental sustainability, and workforce collaboration."**
>
> — Howard Heppelmann, Divisional Vice President and General Manager, ThingWorx IoT Solutions at PTC



Adgaonkar describes one such project at a global candy manufacturer. "Their packing machines were drifting over time, and packing too much," he says. "We came in, we built a closed feedback loop, and applied machine learning." The end result: projected savings of some $50 million.

Importantly, the work on this MVP provided a template for future expansion. Can other types of products or different packaging scenarios benefit from a similar treatment?

"When you build a digital foundation to do something, the same digital foundation becomes the platform to do additional use cases," Adgaonkar says, adding that scaling should take place both horizontally and vertically to capture the full potential and realize the greatest business impact. Horizontal scale involves extending the infrastructure to other facilities to address the same need. Vertical scale brings different use cases into the system.

Infrastructure shifts

A manufacturer's smart factory foundation requires that assets – whether located on the plant floor, out in the field, or extending to supply-chain partners – be connected. Moreover, this foundation needs to be optimized for speed, scalability, and security.

Industrial enterprises have learned that developing a custom smart factory infrastructure with internal resources is a nearly impossible task. There is a fundamental shift taking place, as manufacturers move away from on-premise data centers and custom implementations to applications that use cloud-based services.

The shift to public and – in particular – private clouds should come as no surprise. The costs of building and staffing in-house data centers are significant. Enterprise-grade software is increasingly cloud-based. And no one likes to deal with the headaches associated with securing on-site data centers.

A refinery for data

Imagine a smart factory with thousands of pieces of specialized machinery such as compressors, cutting machines, computer numerical control (CNC) devices, and autonomous electric vehicles (EVs). Add to that a multitude of sensors arrayed around the assembly line, to ascertain the state of assets, the safety and location of plant employees, and key indicators that measure defect rates and plant output.

The amount of data generated by this factory in a single day is incredible. Extended across multiple facilities, up and down the supply chain, over many weeks or months, the tsunami of data created by a single enterprise is staggering.

What is Microsoft Cloud for Manufacturing?

Agile factories enable manufacturers to gain insights and make data-driven decisions to improve quality, productivity, and efficiency within their plants – driving digital, agile manufacturing.

Some may wonder how this much data can be effectively used. According to Howard Heppelmann, Divisional Vice President and General Manager of ThingWorx IoT Solutions at PTC, 90% of the raw data coming off connected assets is in many cases not useful – it's how you take that raw data and turn it into actionable insights that makes a difference.

PTC, based in Boston, is a computer software and services company with more than 6,000 employees. It produces computer-aided design (CAD), product lifecycle management (PLM), Internet of Things (IoT) and augmented reality (AR) solutions that together can enable better data continuity and collaboration for businesses. PTC helps global manufacturers realize impact with software solutions that enable them to accelerate product and service innovation, improve operational efficiency, and increase workforce productivity. In combination with its partner network, PTC provides customers flexibility in how its technology can be deployed to drive digital transformation – on premise, in the cloud, or via its pure SaaS platform. For instance, its ThingWorx IoT platform helps companies develop more connected products and services.

"Data is the new oil," Heppelmann says. "And just as none of us can put crude oil into our vehicle or home furnace, raw data is of little use to any manufacturer. Raw machine data even less so."

For companies seeking to improve efficiency metrics, only a small number of connected assets – 5% or less, according to Heppelmann – constrain throughput. "Those 5% are going to determine whether or not you're operating at 50%, 60%, or 70% efficiency," he says.

To tame the deluge of data, manufacturers need to incorporate "data refineries." These are capable of leveraging disparate sources of business data and machine data, applying meaningful context to support specific use cases and business outcomes, and then processing the data to deliver desired results to the appropriate person, machine or process.

"Some of that will happen at the edge, so that they immediately reduce that overwhelming sea of data to something that can be used for the business cases that they're pursuing," Heppelmann says.

Many traditional manufacturers still operate with rigid systems that can't evolve to meet today's business needs. Digital industrial transformation involving disruptive technologies, such as edge computing, IoT and machine learning on the cloud can help transform what's possible in manufacturing and bring value to unused data. The combination of the PTC and Microsoft partnership enables companies to grow top-line revenue, improve the bottom line, and gain a competitive advantage with scalable, secure digital transformation solutions.

Adgaonkar from Microsoft finds that most manufacturers will take a hybrid approach that incorporates both edge and cloud infrastructure. "If you're building a closed-loop system, you might want to stop the machine very quickly, meaning in a few milliseconds, based on certain data coming in," he says. "You want to do this on the edge."

On the other hand, when a company is training an AI algorithm or a machine learning model, in which

thousands or even millions of data points are processed, a lot of computer power is required. This, according to Adgaonkar, calls for a cloud-based solution.

Becoming a digital company

Bringing manufacturing into the smart factory paradigm entails a range of challenges. Technical hurdles include connecting legacy assets on the plant floor, setting up secure cloud interfaces, and incorporating applications and tools. There are equally formidable cultural issues, as companies' IT departments may suddenly find themselves working side by side with more traditional operations technology (OT) personnel — machine operators, plant engineers, maintenance technicians, and other specialists.

According to Gabriel González-Alonso, Senior Vice President of Corporate Production Management at ZF Group, tackling the "mindset" issue is a prerequisite for a successful smart factory rollout.

"You can introduce edge computing, IoT, artificial intelligence, whatever," González-Alonso says. "But the change will not take place without the heart, without the will to change things."

ZF Group, based in Friedrichshafen, Germany, is a Tier 1 original equipment manufacturer (OEM) supplier for the auto industry. The company produces transmissions, power steering assemblies, braking systems, and components for passenger and commercial vehicles, as well as specialized industrial equipment, such as wind turbines. It employs 165,000 people worldwide and booked $48.6 billion in sales in 2022.[3]

A key effort for the manufacturer is implementing a smart factory strategy to not only realize new efficiencies, but also create a foundation for future expansion as the global auto industry shifts from vehicles that burn fossil fuels to more sustainable EVs. Central to ZF's transition to becoming a software- and cloud-based company is its Digital Manufacturing Platform (DMP), a cloud-based infrastructure that lets plant managers integrate and scale up advanced manufacturing technologies at its 168 production locations and 19 main development locations.[3]

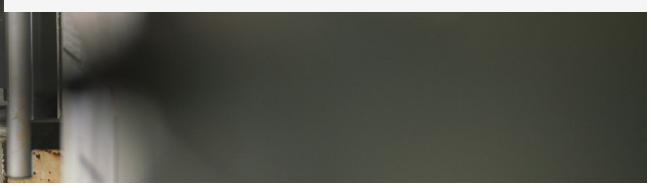
"We had a big technical debt," González-Alonso says. "We needed to homogenize it, we needed to standardize it, and we needed a lot of investment and resources."

ZF's Digital Manufacturing Platform (DMP)

With Microsoft and PwC, ZF built a two-tier DMP infrastructure:

Cloud + Edge: plants that need to integrate advanced systems and cutting-edge algorithms.

Cloud Reporting: applications do not require cloud connections but enable basic dashboards and condition monitoring.



Labor shortage

422,000	415,000	7,000	694,000
New hires	Separations	Net hiring	Job openings

Source: National Association of Manufacturers, February 2023 data

Working with Microsoft and PwC, one of the top global professional services firms, the ZF team responsible for developing the DMP catalogued 81 different manufacturing execution systems (MES) across the enterprise, as well as legacy IT and OT dating back decades. Integrating, upgrading and securing these assets within the new cloud-based platform was only part of the challenge.

The mindset issue loomed large. According to González-Alonso, it was not just a matter of convincing skeptical employees of the benefits of the new DMP and bringing the associated technologies into their processes and workflows. ZF also has to encourage management, operators, and other staff at far-flung locations to embrace the flexibility of the DMP while avoiding reinventing the proverbial wheel at each new facility – or sliding back into old ways of working.

"How do we get a common infrastructure?" González-Alonso asks. "How do we reduce the different systems that we already have running? And how do we put everyone into communication with each other, so they are aware of existing products and applications?"

Smart factories and recruiting

A long-standing issue for manufacturers is a shortage of qualified workers. In the United States, the National Association of Manufacturers reported nearly 700,000 unfilled job openings earlier this year, as well as high turnover.[2]

"Yes, there is a shortage of people," Adgaonkar agrees. "Yes, we need more people who are excited about the manufacturing domain in general. And yes, we need more tech on the factory floor to empower these employees to do more."

Both Adgaonkar and González-Alonso believe that smart factory technologies hold real promise for recruiting. This is because the younger millennial and Gen Z adults who have grown up with digital technology are very receptive to working with cutting-edge technologies. When given the right tools, they are also primed to collaborate with others – whether colleagues, supply-chain partners or customers.

"Nobody wants to do what their parents or grandparents did on the factory floor, like operating a stamping press for 30 years," Adgaonkar says. "But they are definitely open to doing something a little more creative, work that's a little more complex, tasks that demand more, challenge them, and stimulate their mind."

He points to training using the HoloLens mixed-reality headset. "We take a new employee, and have them try it on, and work on a complex assembly task," Adgaonkar says. "On day one, they're able to use the guided workflow, they're able to do the job, and they feel really good about it."

As for the highly specialized IT skills required for smart factory implementations, such as application development, data science, and cybersecurity, this is where the Microsoft Cloud for Manufacturing and its leading partners play an important role, providing advanced capabilities and integration expertise, while removing many support and staffing burdens. The inherent scalability of the infrastructure and applications means manufacturers do not have to rewrite software from scratch at every factory.

For ZF, González-Alonso believes smaller factories can be clustered geographically to share access to in-demand skill sets, whether these are internal IT services

or maintenance of mission-critical OT systems. But in the end, getting the right mindset in place – and helping their workforce feel pride in what they do – is key.

"They feel proud working for a digital company, or a company that is sufficiently digitalized," González-Alonso says. "This is what we provide."

Success metrics

Which KPIs are most important for a smart factory's success? (survey sample: 500)

Source: "IoT Signals: Manufacturing Spotlight," 2022, and associated survey data

Partnering for success

The manufacturing sector collects the largest volume of data of any global industry each year,[4] but only a tiny fraction of data collected in factories is evaluated and used. This is because the data is often siloed or fragmented, or has no context, so it cannot be used for analysis.

This is where Sight Machine comes in. Sight Machine, a Microsoft partner based in San Francisco and Ann Arbor, Michigan, is a manufacturing data platform that helps companies use their plant data to improve profitability, productivity, and sustainability. It streams and contextualizes plant data from all sources to create a unified data foundation and a real-time, system-wide digital twin for comprehensive analysis and visibility.

"That's what Sight Machine does. We make all this data usable," says Sudhir Arni, Senior Vice President of Business Outcomes.

Better utilization of this data and real-time visibility can help target one of the biggest concerns for manufacturers: unplanned downtime. Arni says visibility used to mean that when a machine broke down for 15-30 minutes or an hour, you could

"Data must be contextualized to be useful."

— Sudhir Arni, Senior Vice President of Business Outcomes, Sight Machine

record the downtime and act on it. But in reality, machines sometimes stop for two seconds and start again, which is still a downtime event. Historically, you couldn't even measure that. But dozens or even hundreds of micro-stops can add up. It's not unusual for a production line to experience three hours of combined downtime in a single shift.

"You start with real-time visibility into every possible downtime event, and even if it happened for three seconds, you can measure it and do root-cause analysis," Arni reports. "You're able to predict when they happen, and you're able to prescribe recommendations to your operators to take action before the event happens. These things were not possible before the world of smart manufacturing."

Sight Machine's manufacturing data platform is optimized on Microsoft cloud, edge, and AI technologies. Sight Machine uses IoT Edge to seamlessly and securely transfer plant data to Azure via IoT Hub, where it transforms streaming data for use in both front-end tools and by Power BI, Azure Digital Twins, and other cloud apps, providing system-wide analysis and visibility. Sight Machine also uses the Microsoft Azure OpenAI Service to harness generative AI technology, making manufacturing data and analytics even more accessible and impactful for everyone – from executives to shop floor operators.

Sight Machine has also partnered with Microsoft on an initiative for energy cost optimization.

"The whole idea is how do we get manufacturers to not look at energy data and manufacturing data in isolation from each other? You've got to be thinking about energy data combined with manufacturing because many greenhouse gas emissions come from industry," Arni says. "We can start measuring how much emissions are actually coming from manufacturing processes, and not just how much energy was consumed. We can also determine how energy use and emissions are influenced by production settings and use this knowledge to reduce energy use and emissions for each unit of output. That's not going to happen unless you combine these data sets."

Conclusion

Bringing the manufacturing industry into the smart factory paradigm is not without challenges, including technical hurdles, cultural issues and a shortage of workers. Despite these hurdles, manufacturers have already implemented a smart factory strategy and are motivated to drive major results. This is where the Microsoft Cloud for Manufacturing and its partners come in, helping manufacturers to gain key insights and to drive more digital, agile operations.

References:

1. Microsoft, "IoT Signals: Manufacturing Spotlight," 2022.
2. National Association of Manufacturers, "Facts About Manufacturing," 2023.
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