

Smart connected manufacturing

New models for a digital world



Advanced digital technology is transforming manufacturing in profound ways. Smart sensors, digital twins, the industrial internet of things (IIoT) and other technologies are swiftly changing the way products can be designed, manufactured, delivered and maintained. Increased digitalization is leading to improved customization. Cloud technology is allowing companies to instantly shift resources to meet changing demands and enable seamless integration of new technologies into the existing systems environment. And analytics is taking a wider role in the manufacturing life cycle, as companies leverage data to reduce downtime through predictive maintenance and gain other efficiencies.

Despite these advances, however, the traditional technology paradigm at manufacturing companies has largely remained the same: The IT side of the business focuses on networks and core back-office functions while the operational technology (OT) side keeps the production lines going. Business units operate in silos, and customers may or may not have similar experiences when dealing with engineering, sales and services teams in the same company.

Many manufacturers are discovering that this traditional way of doing business no longer supports success. To keep their leading positions, companies are looking to build new organizations and new value chains through smart manufacturing. They want to drive innovation and multiply knowledge sharing through improved partnerships and collaboration. They want to shift their focus from simply selling and producing products to also delivering a full array of connected after-sales services throughout the product life cycle. They may even seriously consider transforming to a “platform organization” that owns a digital infrastructure and generates more value by acting as a multiplier at a lower cost.

But implementing these changes won't come easy. In addition to technical know-how, change requires a cultural shift that includes being receptive to collaboration and possibly attracting new people with new skills.

Business drivers for industrial digitalization

Creating value through smart connected manufacturing involves establishing ecosystems of connected products and services to transform operations, value chains and customer experiences. This typically means modernizing and extending the digital core to facilitate collaboration with internal and external partners, suppliers, customers and other entities in the ecosystem.

Smart factories that successfully leverage automation, integration and business insights enable smart collaboration, which eventually leads to a series of value networks. These value networks can facilitate collaboration everywhere, between functions, divisions or even multiple enterprises and institutions.

Industrial digitalization produces numerous benefits that help manufacturing companies remain competitive, including the following:

Reduced costs. By optimizing the utilization of physical and financial assets, companies can reduce costs across the manufacturing process. Greater automation increases efficiency, and digital business platforms can boost scale and speed. This can be accomplished by deploying modernized infrastructure and operational platforms as well as by gaining better insights through analytics.

New revenue streams. Advanced, customized products combined with connected after-sales services — such as predictive maintenance and the deployment of digital marketplaces — drive new sources of revenue. Companies can also differentiate goods and services and produce customized products at the cost of mass-produced products.

New value via ecosystems. Qualitative collaboration and approaches such as joint ventures and joint go-to-market efforts transform industry engagement models. Established players may need to rethink their strategies, either by joining existing ecosystems or by forging their own. Ideally, the results of such efforts will include enhanced customer experiences and access to new markets.

Smart manufacturing requires new business models

While the potential benefits of smart manufacturing are clear, the path is filled with challenges, both technical and cultural. New business models need new mental models to take on these challenges — models crafted to achieve a fully integrated environment that enables dynamic value networks, better collaboration and analytics-driven cognitive capabilities. To start down the path, we recommend focusing on the following priorities:

Break down the silos. Smart manufacturing goes well beyond the factory floor to include digitalizing design, engineering, marketing, sales and service, finance and other important cogs in the manufacturing machine, as well as production. Traditionally, barriers exist between the various functions, and companies need to break down the silos in the manufacturing process to foster improved internal and external collaboration. Today's manufacturing companies must stand up value networks that include suppliers, partners and providers. It's all about sharing, cooperating and, most importantly, breaking down the barriers to allow interconnectivity.

Fully digitalized production allows companies to engage differently with the outside world. Traditional supply chains become value networks that enable ecosystem participants such as customers, manufacturers, suppliers and independent software providers to interact in more collaborative, agile and ad hoc interaction models.

The introduction of value networks can result in the disintermediation of certain supply chain activities, leading to more direct collaboration with customers and suppliers. For example, a raw material supplier can provide information directly to a customer's product development department.

Emerging manufacturing-focused digital platforms can provide a central point to consume services, connect manufacturing capabilities and manage a collection of factories. The future of manufacturing lies in distributed, automated and trusted platforms — driven by cloud/edge architectures as well as blockchain technology — that allow flexible and platform-independent manufacturing.

The transformation to the digital factory is not just about a business or technological transformation; it's also about a cultural change in the way organizations are set up and led. Functional thinking centered on specific areas such as production, engineering and sales doesn't work anymore. The new digital world of smart manufacturing breaks down those borders and integrates the various aspects of the industrial life cycle for a seamless experience.

A more effective flow of information can be established by assessing the existing state of systems and processes that enable cross-functional efficiencies and repurposing them to be more fluid. An example is to deploy more focused services or applications with dedicated functions that can communicate effectively to add value. This requires a more finely grained service architecture that allows collaboration both within the enterprise and with outside companies.

Provide a seamless customer experience. Today's customer expects a seamless experience when engaging with a manufacturing company. If a customer wants to make a purchase, customize a product or explore after-sales services to enhance a product's functionality, that customer wants the same or a similar experience no matter what part of the company is being dealt with.

To provide this consistency and ease, the entire manufacturing life cycle — from the initial sale to after-sales services — needs to be managed on an integrated and orchestrated platform. Business processes and the systems supporting a company need to be seamless and fully integrated instead of separate and disparate for production, engineering and so on.

Manufacturers can look to lean companies and startups as models for providing seamless customer experiences. A prime example is Amazon, which makes transactions easy for customers while collecting purchasing data to inform continuous experience improvements. Outsourcing certain function becomes more crucial because traditional corporate functions rarely have high levels of scalability in digital business models. Some key examples are payment services, cloud provisioning, OT/IT integration and agile development and operations.

Providing a seamless customer experience goes together with transforming silos into a business model that enables consistency through the full manufacturing life cycle and after-sales services.

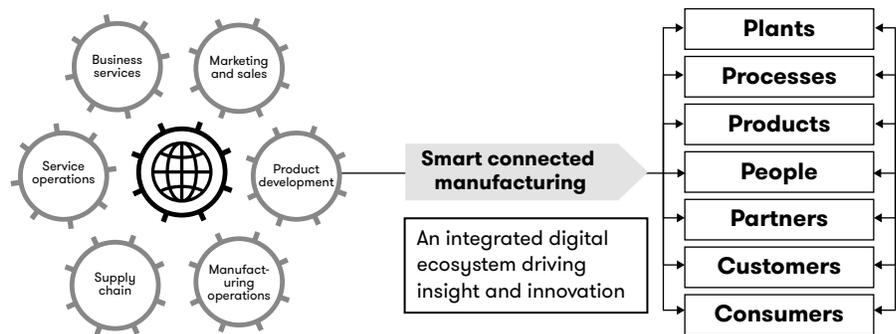
Orchestrate the full life cycle. Building new organizations and value chains in smart manufacturing means taking a deeper look at the full life cycle — most notably what happens after the initial product sale. Improved collaboration is an important part of orchestrating the full product life cycle.

As business models are shifting from pure “product sale” to “as a service,” manufacturers need to prepare to deliver in line with their demanding customer needs. This requires basic capabilities such as predictive maintenance but can also mean implementing a more advanced pricing platform that enables “consumption-by-the-hour” billing. It can also mean increasing agile software development capacity to deliver new, incremental product functionality via regular software updates. Those who succeed will benefit from better, stronger relationships with their customers.

Learning by fast iterations and improving collaboration as a company is also important for trying new processes and technologies that can benefit the life cycle. An organization can encourage deploying agile projects with short-term initial outcomes that can be learned from and used to inform and feed next steps. This gets a company from the initial exploration stage with a dedicated team to rapid scaling and deployment of a solution that spans suppliers and customers.

Integrate into a cohesive ecosystem. For smart manufacturing to become a reality, manufacturers need to integrate the various systems and processes into a single cohesive ecosystem that encompasses all aspects of the business. Business units such as supply chain, product development, sales and services can be combined into an integrated digital ecosystem that drives insight and innovation (**Figure 1**). Combining isolated networks via IIoT and the cloud into a common infrastructure will allow people, machines and components to constantly communicate with each other.

Figure 1. Smart connected manufacturing



Life-cycle integration addresses gaining control and transparency of the entire in-house production process. This requires complete data integration from the machinery on the production floor through all production-relevant systems, up to the management decision level and any relevant, external data sources.

Building on IIoT concepts, smart manufacturing production systems can take advantage of the massive amounts of data being produced by network-connected devices. Successful integration of the data supports fact-based decision making and forward-looking predictions.

Part of building a cohesive ecosystem is bridging the gap between the IT and OT factions of a manufacturing company. IT needs to push into the domains of OT to form an IT/OT convergence that operates the digital factory.

In this area, however, one aspect of IT/OT convergence that needs to be addressed is the lack of standards on the OT side. While the IT side has detailed practices in place such as ITIL, this sort of framework largely does not exist on the OT side. Once a framework of standardized processes is introduced into the OT environment, the OT business can be run like the IT business, and it will be easier to merge the two worlds.

Industry leaders that effectively implement OT service management can apply global governance to manage each plant while allowing for local flexibility. Digital cooperation is blended across business units as machines, systems, humans and

robots are synchronized across the enterprise. Benefits include the ability to align skills and technology with customer experiences and to bring real-time insights into the physical world of manufacturing. Through it all, the key to success is effective integration.

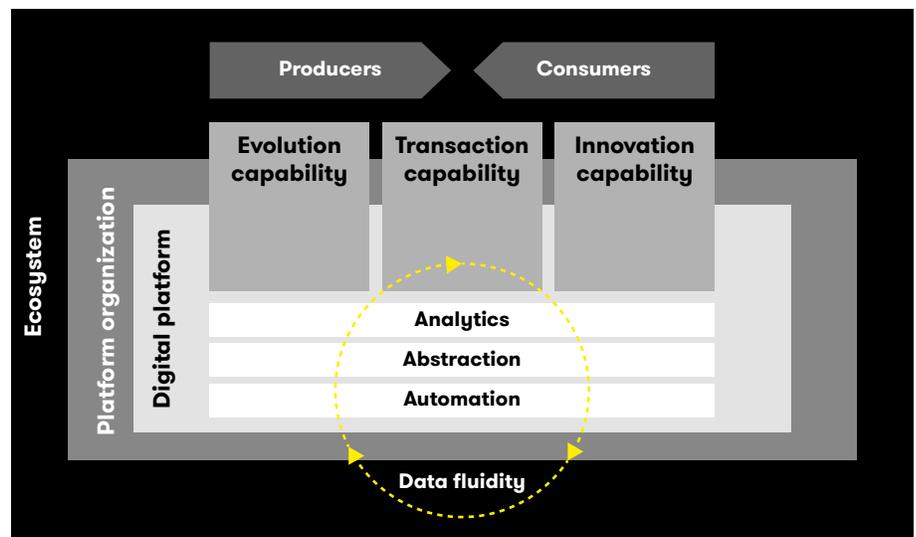
Deploy digital platforms to power up ecosystems. Every ecosystem needs a digital platform to enable and integrate its transactions, innovation and evolution capabilities — and smart connected manufacturing follows the same principle.

Traditional companies are often hampered by dense complexity, with many overlapping systems and applications processes. They need to define a digital platform roadmap that includes legacy systems and any modern, third-generation digital platform, as integration of both worlds is key when developing the future architecture.

Modern digital platforms are based on cloud-based, open APIs that orchestrate the exchange of data across the ecosystem (abstraction). These platforms follow agile application architectures on platform as a service (PaaS) using microservices or containers. They need to embody a foundation for “digital trust” through identity, vulnerability and threat management across all services. Digital platforms are centered on an intelligent core to analyze and generate actionable insights from the data flowing through the platform and its participants (analytics). Over time, they become increasingly automated and autonomous, often powered by machine learning and artificial intelligence (automation).

Together, they help to build data fluidity — the lifeblood of platforms and ecosystems — ensuring that data is accurate, accessible and actionable (**Figure 2**). Improving data fluidity is a key purpose for the digital platform’s owner. (See the LEF report, “**Liberating Platform Organizations, Part 2: The Machinery of Platform Organizations.**”)

Figure 2. Capabilities required by the platform organization to power digital platforms



Find the right security balance. As smart manufacturing companies travel the road to improved integration, sharing information places a sharper focus on security. From manufacturing processes to design secrets, IP assets are the crown jewels of manufacturing, and they need to be protected. Companies need to find a balance between sharing information with partners, suppliers and other third parties and protecting their IP assets.

For security considerations, a company's IP can be protected by intelligent ways of sharing just parts of the data while retaining the full functionality of services. For example, a company can create metamodels and share only key parts of its IP instead of everything it has.

Stand out from the competition

Most manufacturers hope to stand out from the competition through faster response times, higher-quality products and excellent customer service. To do this in a digital world, companies need the flexibility to innovate and the ability to compete with manufacturers that are already taking advantage of technology — and are consequently lowering their cost of entry, increasing their speed to market and generating more and different forms of value.

It is important for traditional manufacturing companies to embrace new technologies and learn from the lean and agile approaches taken by more nimble startups. To continue to succeed, companies need to implement and integrate modern systems and processes so that they can realize the promise of improved automation, machine-to-machine and human-to-machine communication, AI, continued technology improvements and digitalization.

The fully integrated smart manufacturing enterprise focuses on the horizontal flow between vertical functions — with an emphasis on collaboration — and implements inline systems to improve communication and support a more efficient flow of information.

Smart connected manufacturing relies on innovation, wise choices and well-planned integration. As the competition for experienced talent rages on, companies can greatly benefit from an independent services provider that can tap into experience, expertise and partnerships to deliver the optimal solutions to meet specific needs.



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