

Smart Manufacturing

Leveraging embedded intelligence and new sources of information to connect and optimize the enterprise

Manufacturing leaders are living through a period of profound change, opportunity, confusion – and competitive pressures. The Internet of Things (IoT) is one of several technology disruptions creating opportunity for transformation into Smart Manufacturing environments. Early adopters have accepted the concept of Smart Manufacturing and are embracing technology to augment



their processes and their people for higher performance and efficiency. The IoT and other technology innovations, combined with government initiatives around the globe – the Advanced Manufacturing Partnership 2.0, Industrie 4.0, China Manufacturing 2025, Manufacturing Innovation 3.0, Usine du Futur to name a few – are fundamentally reshaping the industrial landscape.

Manufacturers must converge their Information Technology (IT) and Operations Technology (OT) systems into a single, unified network infrastructure and identify opportunities for using IoT technologies that enable seamless connectivity and information sharing across people, processes and things. They must be sure they can efficiently manage a greater abundance of data in ways that help them make better, faster business decisions. This includes using IoT device intelligence, cloud connectivity and data analytics together to help manage the large data sets required for balancing production activities based on upstream inventories and downstream demand.

LISTEN.
THINK.
SOLVE.

Smart Manufacturing

Smart Manufacturing offers nearly unlimited potential, and it all begins with establishing what Rockwell Automation calls The Connected Enterprise as the foundation for achieving greater connectivity and information sharing.



These and other programs frame the industrial evolution of Smart Manufacturing – knowledge-enabled enterprises in which devices and processes are optimized to enhance productivity, safety, security, sustainability and performance. Smart Manufacturing offers new ways to create value and requires action now.

Early adopters have embraced Smart Manufacturing by investing in technology that drives efficiency. Yet many leaders struggle to define exactly what Smart Manufacturing means and the benefit they can generate – for their organizations, their customers, and their suppliers. To get started, these executives need to review their operations objectives – and the advantages that Smart Manufacturing can offer for each.

Smart Manufacturing represents the integration of three key productivity factors: automation, operations information, and advanced analytics. These factors link machines and equipment through open platforms and enable them to “think” – creating systems that are able to interact with one another, analyze data to predict failure, configure themselves and adapt to changes within the manufacturing process itself. The goal is to improve productivity within an operation and ultimately across the entire value chain by increasing visibility and access to contextual information connected to processes and products, to get the right information to the right people at the right time.

Operations objective	Smart Manufacturing advantages	Benefits
Improve quality	Smart Manufacturing leverages embedded intelligence within machinery and equipment, automating operations such as quality inspection in real time, triggering immediate reactions to defective products/materials, and error-proofing processes in support of internal production and external supplier quality improvement.	<ul style="list-style-type: none"> • Decreased reject rate by 75%, yielding dramatic monthly savings
Increase productivity	Monitoring production in real time provides managers with insight into operations, including operators’ usage patterns, materials, and equipment, which allows them to streamline the workflow to reduce non-value added time and processes. Additionally, being able to predict and help prevent equipment failures allows the right resources to be deployed for predictive maintenance, which can minimize unscheduled downtime.	<ul style="list-style-type: none"> • Increased overall equipment effectiveness and productivity by 50% • Increased production capacity by 65%
Mitigate skilled labor shortages	Since Sakichi Toyoda invented a mechanism to detect broken threads in an automated loom in the early-1900s, equipment has been designed to enable quality and productivity yet minimize human intervention (“jidoka”). Embedded intelligence expands and digitizes jidoka by providing prescriptive work order instructions and increasing error-proofing capabilities to simplify the process. This requires less operator training, increasing the capacity of operators to both safely monitor and operate multiple machines simultaneously, enabling subject matter specialists the ability to remotely support the operation if needed.	<ul style="list-style-type: none"> • Improved production efficiency from 45% to 85%

Operations objective	Smart Manufacturing advantages	Benefits
Enhance customer satisfaction	Smart Manufacturing allows industrial customers to monitor and update operations in real time, track raw materials, work in progress and finished goods, and coordinate faster deliveries – getting higher quality products in the hands of your customers when they need it. It allows manufacturers to capture usage data that can enhance innovation and drive quality and performance improvements for all types of customers.	<ul style="list-style-type: none"> • Improved cycle times by 28%
Reduce business risks	Best-in-class safety strategies move operations beyond compliance to become part of a company's culture; production environments with embedded intelligence take environmental, health, and safety (EHS) compliance to levels of zero tolerance. As accidents are prevented and near-miss incidents investigated; energy and environmental concerns are tightly controlled; security vulnerabilities are addressed and track-and-traceability capabilities are deployed, strengthening the systems in place that can help mitigate issues.	<ul style="list-style-type: none"> • Immediate increase in detection and resolution of incidents • Reduced validation time from two weeks to two hours
Expand market opportunities	Smart Manufacturing is rapidly and efficiently creating entirely new markets, as manufacturers, industrial operators, and high-tech firms converge and innovate, resulting in new service opportunities and business models with enticing new margins. Some organizations now sell machine uptime instead of the machine itself, while others use embedded intelligence to create new value for customers.	<ul style="list-style-type: none"> • Reduced project development time by 50%

Is Your Company Ready for Smart Manufacturing?

According to many industry surveys, most organizations aren't yet ready for Smart Manufacturing. Even after years of improved automation via sensors and controls, companies are just getting started and are nowhere near being IoT-ready (i.e., having their manufacturing and industrial "things" communicate directly with each other and leveraging the data beyond real-time processing).

Why? Many simply don't know how to get there: Only 11 percent have implemented a strategy to apply IoT technologies to production processes, and just 12 percent have implemented a strategy to embed IoT technologies into their products. What's getting in the way? According to an IndustryWeek report, 76% of manufacturers are concerned about network security and 74% with data privacy.¹

Half of manufacturers are still struggling with the basics of defining and implementing IoT and Smart Manufacturing strategies (Figure 1).²

An IoT strategy – where and how to apply and leverage information from embedded intelligence for optimal gains – requires increased connectivity and is foundational for Smart Manufacturing strategies. Companies can get started and reap returns on even rudimentary IoT implementations that can fund the



	Applying IoT technologies to processes	Embedding IoT technologies in products
Strategy in place – implemented	10.9%	12.0%
Strategy in place – not yet implemented	22.7%	20.3%
Plan to develop strategy	32.5%	30.4%
No plans to develop strategy	33.9%	37.3%

Figure 1. Internet of Things Strategy Implementation (% of manufacturers)

next IoT step. Yet other obstacles loom and need to be considered to drive success with IoT and Smart Manufacturing initiatives:

- **Antiquated technology:** Older, fragmented automation and IT systems can prevent the implementation of a Smart Manufacturing strategy. Many plants use automation equipment purchased more than 20 years ago. Few manufacturers can replace all of their equipment sensors or controls at the same time; managers must prioritize their investments over a certain period. Unfortunately, many companies also face massive information-technology gaps now; half of manufacturers will have to upgrade network and security infrastructures or overhaul their networks to accommodate machine-to-machine, and machine-to-business communications.³

Smart Manufacturing requires convergence between IT and OT, leveraging scalable computing options to deliver value in different stages of operations and drive increased visibility, collaboration, and efficiency within plants and facilities, across operations, and through the value chains. Value can be gained from increasing information sharing between the business systems and the plant floor automation and information systems. However, many firms encounter a roadblock here due to homegrown, proprietary, and legacy systems that lack standardization and open protocols, preventing the adoption of common metrics among multiple facilities. Even worse, the industry is facing a skilled workforce challenge as those who understand these proprietary systems retire. The World Bank study highlights the need for 220,000 new engineers every year until 2022 to connect the unconnected.⁴



- **Corporate misalignment:** Even where technologies have been applied, company objectives, practices, and roles are frequently misaligned — especially in the case of IT and OT staff. Barely half of manufacturing executives believe that their IT and OT departments collaborate to resolve technical operations issues.⁵

The gap between IT and OT visions and objectives can cripple IoT initiatives before they start. Who manages a connected IT/OT network infrastructure? Who defines working data capital (i.e., new information that can be leveraged for the good of the organization)? Who applies and maintains smart devices?

Achieving organizational alignment and setting the right priority is critical to the success of a Smart Manufacturing implementation. Such a wide-reaching and culture changing program must be sponsored from the top of the organization and driven by a cross



functional collection of change agents. In the words of Peter Drucker, "Culture eats strategy for breakfast."⁶ A brittle culture can easily doom even the best, most flexible, analytic-based architectures.

- Talent shortages:** The adoption of Smart Manufacturing often outpaces the ability of many companies to embrace, apply, and leverage scalable computing (i.e., mobile, edge, cloud, wireless, cellular, remote access, security) and analytics technologies. Nearly a third of manufacturers cite lack of talent as their biggest challenge related to IoT capabilities. It doesn't help that many manufacturers don't yet have a solid understanding of the IoT; 42% have only a limited understanding, and 24% have no understanding.⁷
- Perceived lack of ROI:** Many companies are still trying to understand the business value to be realized from investing in IoT and Smart Manufacturing initiatives. They stall IoT initiatives because of concerns about data security, paralyzed by fear of the unknown. They should worry more about unauthorized access to old equipment, PLCs, and controllers, as well as a lack of security standards and programs.

Both the fearful and frugal should focus instead on a vision of their own Smart Manufacturing (and their potential returns on investment), build a roadmap to the vision and identify areas to get started. For example, by leveraging sensor data to predict when equipment is wearing down, manufacturers can reduce maintenance costs, in some cases achieving as much as 40% improvement. Unplanned downtime can also be decreased with predictive and preventative maintenance plans. Companies are enjoying major productivity improvements and reductions in operating costs with early IoT investments.

Improve product quality	57.9%
Increase speed of operations	57.3%
Decrease manufacturing costs	57.0%
Improve maintenance/uptime	46.5%
Improve information for business analytics	41.6%
Improve agility and responsiveness	41.0%
Improve information for production decisions	40.7%
Improve coordination with customers	39.5%
Improve coordination with suppliers	34.9%
Develop remote monitoring capabilities	33.7%
Lower energy costs	29.1%
Improve safety	27.9%
Improve compliance (customer specifications or regulatory)	24.7%
Develop visualization capabilities	18.9%
Other	1.2%
None of the above	5.5%

Figure 2. Smart Manufacturing objectives (% of manufacturers)

Establish operations stability

A Connected Enterprise helps manufacturers to more reliably create high-quality products, better, faster, and more economically than ever before. Start by identifying requirements and top areas of focus based on past performance (e.g., customer rejects, production yields, injuries, downtime, and work stoppages). Assess where obsolete, unreliable, and hard-to-connect equipment and automation systems are out of date, and where IT systems are hindering productivity, agility, and innovation.



Second, prioritize processes and equipment for redesign (e.g., reduce idle time, build in error-proofing, improve worker safety and ergonomics, and implement automated alerts and tasks). Ask your line workers about idle time, how they would make the process easier to understand, where they spend non-value-added time looking for things like drawings, work-order instructions, etc. Ask your production managers where smarter machine assets can provide more visibility and control of complex production processes. Take advantage of embedded intelligence to gather data – equipment status, exception-based reporting – and offer real-time insights into quality, safety, compliance, energy usage, and downtime issues.

Third, make it happen. Do something Smart, even if it is applied to just one part of your operation (a single line or a cell). Implement the production systems you've designed; use the projected return on these investments (e.g., improved product yields, lowered warranty costs, decreased insurance premiums, increased plant capacity) to budget for the capital spending, or, consider projects that can initially be managed through operating expense.

Secure your infrastructure

Businesses can barely stay ahead of the myriad security threats to their networks and information. It is true that risks from both internal and external sources expand with each new connection of smart things, creating threats capable of disrupting control-system operation, safety, productivity, and the ability to help protect assets, machinery and information. These threats have the potential to strike at the heart of a company's reputation and its long-term viability. Unless companies make ongoing investments in secure industrial control systems, they are likely to expose themselves to unnecessary risks as they capitalize on the opportunities presented by The Connected Enterprise.

Your company's networking specialists need to be looking for threats while updating automation technologies to current industry standards for interoperability and commonality. A robust and secure network infrastructure will allow technicians to securely manage software installations, patches, and upgrades for years to come. Strengthen security procedures for other technologies, too, including machine operations and BYOD (bring your own device) policies. This approach helps companies establish a sustainable security culture, conduct comprehensive security assessments, and deploy a robust security infrastructure across both automation and industrial IT assets.

Improve production

Equipment that delivers the highest standards in quality, safety and security is merely the foundation for a Connected Enterprise. It's what you do with the equipment that grows sales and profits. State-of-the-art technologies and smart devices can monitor every product specification — customer or regulatory — in real time. Use that information to rapidly address defects and variations, speed the flow of goods and material, enhance on-time performance, and delight customers. For example, if you deliver to customers

in two weeks with 100% on-time status, why not achieve the same benchmark in half the time – and free up a week of production capacity?



Better control and transparency of manufacturing processes offers opportunities for improved productivity and profitability, too. Identify where real-time information and analytics can help to reduce costs (e.g., lower inventories, better labor and asset utilization). Extend intelligence to all functions in the enterprise – finance, human resources, R&D – and out to the supply chain as well, delivering critical information to suppliers (e.g., end-customer demand, forecasts, schedules) and customers (e.g., order status, product prototype data) while monitoring inbound quality and delivery performances.

Make better decisions

Information moving within The Connected Enterprise – within supplier plants, internal operations, and at customer sites – provides strategic insights to:

- Identify operational strengths and weaknesses
- Analyze processes and plan improvement initiatives
- Design and implement better production systems
- Develop targeted training programs
- Establish performance management systems.

New working data capital and scalable analytics allow you to optimize assets within plants and across your entire business enterprise. For example, improved productivity creates extra capacity, which in turn leads to capital avoidance. You'll also allocate capex spending within a context of plant performance data (which processes and facilities deliver the highest returns on new assets?) and core competencies (should this be produced internally or outsourced?), enabling the transition from a capex constraint climate to an opex flexible environment. Don't forget to involve your customers: business intelligence shared with them increases the value of the services and products they buy – and builds stronger relationships.

Get Started with Rockwell Automation

Business intelligence can improve processes, products, and business performances now – and your competitors are already on the move. Three-quarters of manufacturing executives say their company’s application of smart devices and/or embedded intelligence will increase in the next two years (Figure 3), and more than half expect that their efforts will improve quality, increase operations speed, and lower costs.

	Application of smart devices and/or embedded intelligence in production equipment and processes	Application of smart devices/ embedded intelligence to non-production equipment and processes
Increase significantly	13.5%	9.8%
Increase somewhat	62.5%	56.2%
No change	23.2%	33.7%
Decrease somewhat	0.3%	0.0%
Decrease significantly	0.6%	0.3%

Rockwell Automation has successfully operated its own Connected Enterprise to support Smart Manufacturing strategies for years. Through first-hand experience and close collaboration with other companies, we are actively engaged with industry consortia and standards groups and continue to demonstrate the true value of interoperability. We’ve supported Connected Enterprise initiatives around the globe, helping companies to systematically and successfully move into the Smart Manufacturing era by asking four key questions:

1. How smart are your operations today? Conducting a baseline assessment is a critical first step. The journey toward a Connected Enterprise starts by evaluating all facets of an organization’s IT/OT capabilities – information infrastructure (hardware and software), controls and devices that process data, networks that transmit information – as well as security policies and procedures. Be mindful of your operations’ current and future states. Consider your goals regarding quality, downtime, productivity, and overall equipment effectiveness (OEE), among other things. Identify key objectives, problems, and metrics you’re trying to impact, and consider where you’re seeking greater efficiencies. We can help guide you through this assessment and help you to identify and catalog issues.
2. Where should your operations be smarter today? A challenge for many organizations is the sheer volume and variety of outdated controls and networks in place that need upgraded or replaced. We help you:
 - Identify areas of first priority (operations safety, data security).
 - Develop a roadmap focused on replacements and upgrades, highlighting how the evolution can positively affect people, processes, and technology and enhance IT/OT convergence.
 - Build cross-functional teams that include representation by location, function, etc., to establish priorities and build consensus throughout the organization.

3. How much smarter should your operations be tomorrow? An effective IoT strategy incorporates data from devices, assets, and applications and turns that data into information to enable improved decision-making, improved performance, and more productive operations. We help you understand the new, accessible data and identify actions to take to generate new working data capital. With an effective plan that takes advantage of data from devices across the enterprise, performance-critical information is used for real-time, critical decision-making.



4. How can you optimize returns on Connected Enterprise capabilities? We help you transform data into strategic decisions that grow sales and boost the bottom line. We also extend The Connected Enterprise to your suppliers and customers, creating an environment that anticipates activities, enabling responsiveness to not only existing operations but to external events, supplier and customer activities, business trends, and changing market conditions. Within the enterprise emerge predictive capabilities that make for more efficient production planning and asset management; timely and leveled order execution; improved quality; and streamlined site-to-site performances.

We've helped others along their journeys and we're ready to help you get started, as well. What are you waiting for?

Visit www.rockwellautomation.com/connectedenterprise to learn more.

¹ IndustryWeek Manufacturing Connectivity and Data Integration report (2015)

² MPI Internet of Things Study, The MPI Group, December 2015.

³ Ibid.

⁴ "ICT For Greater Development Impact," World Bank (June 2012); European Commission Global Economic Outlook

⁵ Ibid.

⁶ Peter Drucker

⁷ Ibid.

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