

To enable the smart manufacturing vision and realize the true potential of the factory floor to drive business success, manufacturers need information integration. This IDC Technology Spotlight highlights how manufacturers can support their business processes through an integrated approach to information management on the factory floor.

Toward Smart Manufacturing: Information Integration to Fulfill the Factory's True Potential

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Introduction

The convergence of physical and virtual technologies today means that the very core of a manufacturing business — the production process — is being completely revolutionized. These key transformations happening within the factory floor are often referred to as Industry 4.0, digital factory, or simply smart manufacturing.

What Is Smart Manufacturing?

Two of the recurring questions many manufacturers ask themselves are:

- » What can digital technology do for the shop floor?
- » How can the principles elaborated under the many Industry 4.0 initiatives promoted by governments, industrial automation providers, and ICT vendors be deployed to generate business advantage?

Answering these questions becomes particularly tough when accounting for the complex scenarios that can arise from shop floor digitization. IDC defines smart manufacturing as the movement of digital initiatives onto the factory floor.

IDC has defined three factors that companies will need to carry out factory digitization:

1. **Factories have to be "data hungry."** A factory will have to become more and more "hungry" for data. Ultimately, data will be at the center of and permeate every key process step as follows.
 - In the input phase, raw material and components enter the factory with embedded information about their genealogy and suppliers as well as assembly instructions.
 - The production process itself will be increasingly defined and supported by a continuous interplay and information handover among workers, machines, and business applications. Every step in a modern manufacturing plant can potentially be digitized and made visible in real time.
 - Notably, in the output phase, the final product is also data centric. Many factories will be dedicated to producing connected and smart products that will be able to provide feedback and report their status to the plant while in operation, request production of a spare part for a maintenance job, or report a quality issue that can be potentially addressed on the actual product via a rework in the factory or — on the product line — via a process fine-tuning.

AT A GLANCE

KEY TAKEAWAY

Integrating information across the factory floor will likely require a fresh look at the existing technologies and working with a partner to help navigate the options. In this context, the role of manufacturing execution systems (MES) is key.

- 2. Workers have to be augmented.** The human brain provides the flexibility and decision-making capabilities required to deal with increasing business and operational complexity. In smart manufacturing, people will be freed from repetitive tasks and empowered by technology to focus on value-added activities such as production optimization and business reinvention. This principle applies strongly to low-volume, high-variability productions such as aerospace, industrial machines, and heavily engineered products.
- 3. Production has to be distributed.** Faced with today's business complexity and the need to balance factory capability with volatile demand across elongated and complex supply chains, manufacturers need to enable a "global plant floor" consisting of a network of factories managed as a unique virtual factory that consolidates different manufacturing plants in terms of resources, processes, and products. This calls for the ability to harmonize, supervise, and coordinate execution activities across the manufacturing operations of the company and its suppliers with a greater level of real-time visibility.

Benefits

Why Is Smart Manufacturing Mission Critical Today?

For the first time in history, manufacturers realize that their plants are capable of generating much more data than they can currently process and benefit from. Mastering factory floor processes will enable manufacturers to become proactively disruptive in their market segments, not only by delivering fantastic products but also by leveraging transformative business models that entail demand-driven manufacturing, agile production processes, lot size one, and mass customization.

Technologies such as the Internet of Things (IoT), cloud, pervasive mobility, augmented reality (AR) tools, and blockchain are contributing or will contribute to this vision. Most importantly, the ability to see the plant as a technology-driven enabler of business success promises to be a real game changer for companies.

Putting people at the center provides the opportunity to significantly transform existing processes. IDC has monitored several companies that understood their greatest opportunity in digital transformation was to evolve the way people managed processes and interacted with IT tools. Some of these companies worked on IT refreshes (e.g., by standardizing the enterprise resource planning [ERP] footprint or implementing a new manufacturing execution system [MES]), but most understood that the key areas to tackle were the existing business rules and tools, which are often not integrated or online. These organizations understood the need to empower decision makers to run self-managed, decentralized processes based on real-time notification and information scripted at the lowest possible hierarchical step, right down to the operator/mechanic level. For example, they enabled operators to run root cause analysis focused on key metrics such as energy management, uptime, mean time between failure (MTBF), and run to target.

Transformation opportunities span improving product quality, optimizing cost structure, innovating the process, supporting new business models/business reinvention, increasing speed, achieving better customer fulfillment, augmenting visibility, and improving workers' experience.

For successful manufacturers, achieving these ambitious targets will mean reconsidering their factory vision and turning it upside down as part of a data-centric revolution.

Trends

In a modern enterprise, information must flow through three main layers:

- » **People intensive (level 4).** This layer distributes information through enterprise business applications (ERP, product lifecycle management [PLM], and supply chain management [SCM]). This is where enterprise processes link with the factory. Examples include SCM/manufacturing integration or PLM/manufacturing integration. In this layer, information coming from the factory is instrumental to the improvement of level 4 processes such as reducing delivery lead times or improving time to market.
- » **Process intensive (level 3).** This layer is centered around covering the factory floor needs and handles information between IT and operation technology (OT). This is the core of smart manufacturing, where information is a key ingredient to the execution and optimization of the process itself. In this layer, information is a production asset, and this is where MES plays a key role.
- » **Automation intensive (level 2).** In this layer, data and information are instrumental to the operation of machine tools, automation, and control devices. Here, information is mostly confined within the OT domain. This means that to empower a factory with greater flexibility and cost efficiency and to achieve greater visibility and coordination, manufacturers must open it up to the corporate IT systems, transforming the way information flows from machines to enterprise applications.

The goal is to hand over greater decision-making power to the people in charge while retaining the efficiency provided by automation through a manufacturing operations platform that offers the following capabilities:

- » **Harmonization of global manufacturing operations** to provide a uniform environment for all plants globally to automate decision making
- » **Manufacturing intelligence** to enable higher visibility into manufacturing operations as a way to gain more control over manufacturing capabilities
- » **Seamless integration with corporate business applications** to enable bidirectional integration of manufacturing operations processes and data with corporatewide ERP systems and other applications
- » **Connecting design and manufacturing operations** to link as-designed bills of materials (BOMs) and routings to improve the new product introduction and engineering change processes
- » **Improvement of fixed assets utilization** using maintenance management to increase plant availability, reduce operational costs, and minimize capex
- » **Compliance and environmental footprint reduction** to reinforce regulatory compliance and lessen the environmental footprint of the manufacturing operations

To achieve all this requires reconciling the real-time data coming from machines and processes with the information coming from the enterprise.

Bringing Information Together in the Context of Emerging Technologies

A key challenge manufacturers face is the lack of a single integrated system to manage each operational process. Instead, they often rely on disparate systems connected only by manual processes or shallow integration. This lack of integration may be the result of growing through mergers and acquisitions or pursuing factory IT and automation investments in total isolation with respect to other corporate initiatives. As a consequence, processes such as manufacturing execution, maintenance/repair/overhaul, lean management, planning and scheduling, quality, environmental health and safety (EH&S), and design and engineering are often managed inconsistently.

The challenge of integration is becoming more important as we see an escalation in data availability in the factory driven by the following trends:

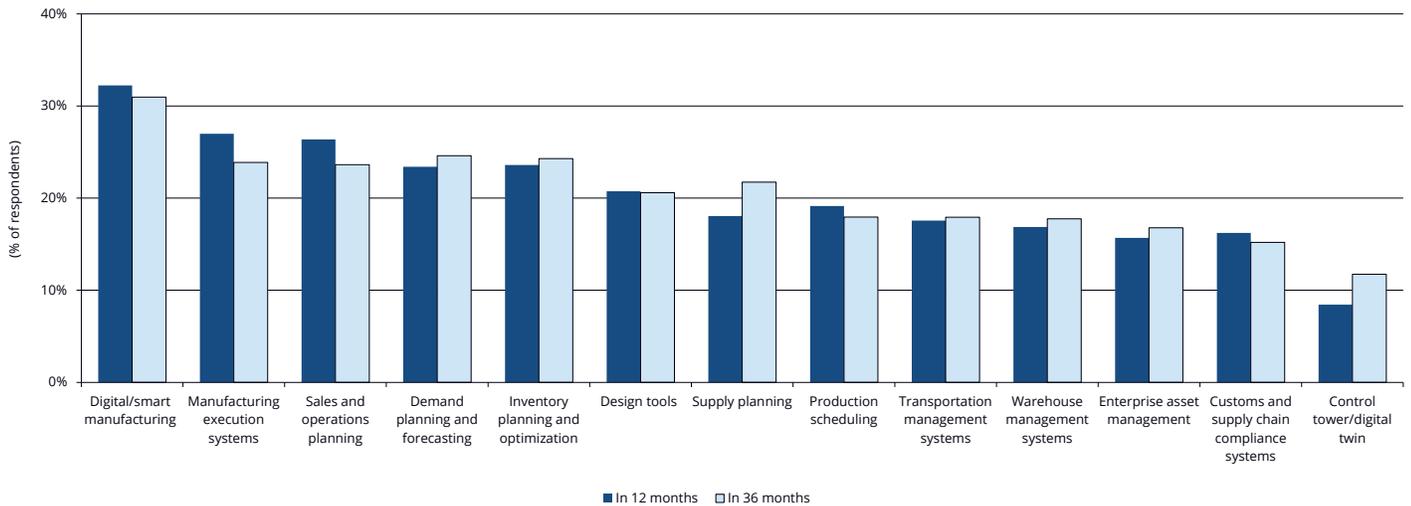
- » **The proliferation of the industrial Internet of Things (IIoT).** The amount of operational equipment instrumentation has increased in the past few years. For example, IDC research shows that among production systems, the share of the operational equipment that is instrumented (i.e., has programmable logic controllers [PLCs], distributed control systems [DCS], sensors, meters) has grown significantly. Nearly half of global companies report that the vast majority of their operational equipment is connected.
- » **The impact of cloud.** Until recently, cloud has been often considered a "taboo" word for too many companies, especially around mission-critical processes such as the shop floor. However, we are now witnessing a big transformation. Investments are focusing on enabling cloud to support operational processes and analytics. Manufacturers are starting to deploy cloud-based execution models that depend on edge analytics to enable the seamless handover of data to enterprise applications to achieve real-time visibility, supply chain integration, and increased operational flexibility.
- » **The rise of smart equipment.** Industrial machinery companies are creating a revolution as they are delivering intelligent, connected products, becoming de facto IT suppliers. This proliferation of smart machines is also amplifying the complexity and leading to an inflation of options in the environment manufacturers need to deal with.

It is not a surprise that according to the most recent IDC research, smart manufacturing ranks as the top area of focus for manufacturers when it comes to investment aimed at improving supply chain and operational processes. In fact, as plants are now seen as supply chain bottlenecks, they are becoming the primary targets for new investments. Companies realize that business process reinvention and business model transformation must be enabled by solid factory capabilities and a "back to basics" attitude that sees the factory as a key contributor to companies' value proposition. It is also very telling that manufacturing execution systems rank just after smart manufacturing. While not new technology, these systems are now evidently seen as the key enabler for business process improvement and one of the key factory investments (see Figure 1).

FIGURE 1: Smart Manufacturing and MES Are at the Center

Investments are focusing on enabling cloud to support operational processes and analytics

Q What will be the key focus areas for improvement for your supply chain over the next 12–36 months?



n = 816

Source: IDC's Supply Chain Survey, April 2020

Considering Aegis Software

Aegis Software is a global software provider that offers an adaptive manufacturing execution and operations solution, driving enterprisewide compliance, quality, and efficiency improvements. Aegis' MES solution, FactoryLogix, is designed for today's manufacturing reality, connecting business-critical systems, processes, and people to enable transformative benefits of Industry 4.0. Since 1997, Aegis has helped more than 2,100 factories across the military, aerospace, electronics, medical, and automotive industries drive rapid, high-quality, and continuous innovation while reducing operational costs.

FactoryLogix aims to support and improve discrete manufacturing from piece parts and electronics assemblies to subassembly manufacturing and full large-scale system integration. The solution even extends beyond shipment, enabling the return of products to be repaired or overhauled in return material authorization (RMA) and maintenance, repair, and overhaul (MRO) environments. Aegis began with an initial focus on electronics manufacturing. As a result, FactoryLogix stores a product's mechanical and electronic computer-aided design (CAD) data. All manufacturing information is mapped to this intelligent design data, providing shop floor visual aids, quality data collection, analytics, and traceability. FactoryLogix provides easy-to-use, end user-configurable dashboards, reports, and analytics without requiring IT resources. The entire manufacturing life cycle is supported from a large vehicle/system down to a single pin on a single part on a circuit card in a single platform.

The solution's scope of capability includes the following:

- » **Digital manufacturing engineering.** This feature enables the transformation of CAD and BOM data into the entire digital work package, route, quality plan, and work instructions, among other things.
- » **Execution.** This manages how process routing and control, route logic control, process interlocking, flow, and quarantine enforcement are handled.
- » **RMA/MRO.** The control of field repair activities, as well as MRO teardown and rebuild to a new configuration, is managed via an MES and process control system route.
- » **Lean materials.** The traditional push-based materials model on the shop floor is transformed to the more efficient pull-based model to keep lines running while maintaining minimum materials on hand.
- » **Adaptive planning.** A near-term tactical planning engine with materials and real-time machine awareness factorywide enables floor planners and expeditors to better manage the variability of the near-term production plan.
- » **Quality.** The three primary aspects of quality are controlled in the following ways:
 - Firewalls prevent incoming materials issues from reaching the manufacturing process by digitizing incoming materials sampling, supplier score carding, and quality control.
 - Defects are detected, identified, and repaired.
 - The corporate/admin reaction to any quality problem is managed by digitized MRB, FRACAS, and/or CAPA processes.
- » **Analytics.** The solution provides integrated and natively developed real-time dashboards, reporting, data mining and collaborative analytics, mobile interfaces for iOS and Android, and business intelligence (BI) connectors at both the site level and the enterprise warehouse level for reporting via third-party platforms.
- » **IIoT engine.** A highly evolved and well-proven IIoT engine with the largest library of existing machine adapters is part of the solution.
- » **IIoT ontological schema and contextualization engine.** A true ontology model for manufacturing is offered, intrinsic within the data structure to provide the basis of a true IIoT solution.
- » **Regulatory compliance.** Comprehensive capabilities exist for manufacturers in all industries, especially regulated industries such as electronics, medical device, aerospace, and defense. Automated completion of factory audits is available via FDA CFR Part 11 compliance, GMP 5, ITAR compliance, CAPA/FRACAS and MRB records, AS 9100, and more.
- » **Augmented reality.** FactoryOptix is designed to double the productivity of human operators by enabling the use of both hands at all times; not having to pick up barcode readers, use keyboards, or a mouse; and not having to look away to read work instructions from a screen.

Challenges

The MES market is diversified. In particular, the MES vendor landscape is evolving as players from the industrial and machinery world release solutions that complement their products, either via internal developments or by acquiring software solutions. Aegis Software, other MES vendors, and the MES market itself are moving at speed toward the implementation of smart manufacturing principles. Transformation is essential in this situation. However, the company's strategy must be picked carefully because there is no standard, industry-proofed, "one size fits all" approach to the problem.

Conclusion

For companies willing to go "back to basics" and inject new life into their factory floors via digital technologies, the vast size and complexity of the smart manufacturing opportunity are quite remarkable. However, integrating information across the factory floor will likely require a fresh look at the existing technologies and working with a partner to help navigate the options. IDC believes the market for smart manufacturing solutions will continue to be relevant, and to the extent that Aegis can address the challenges described in this paper, the company has a significant opportunity for success.

In this context, IDC offers the following guidance to manufacturers willing to embark on this journey:

- » **Realize that connectivity is not the target.** It is easy to connect disparate data sources but difficult to provide the context for decision making to happen.
- » **Understand that information is not a capability.** Sometimes companies focus on creating information without placing enough focus on making sure it is translated into enabling decision makers with new capabilities. In other words, the capability of a solution to support business needs is linked to how quickly and easily relevant functionalities can be deployed.
- » **Think big, start small, scale fast.** Investments have to be planned with the big picture in mind. Companies should keep track of early wins to promote the digital journey internally.

About the Analyst



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Lorenzo Veronesi is a Research Manager for IDC Manufacturing Insights EMEA. In this role, Veronesi leads the Worldwide Smart Manufacturing research program and supports all the IDC Manufacturing Insights research services for EMEA by looking at digital transformation drivers in multiple manufacturing industry subverticals. He is also often involved in consulting projects across the world for end users, IT vendors, and the European Commission. During the past decade, his research has focused across key processes such as manufacturing operations management, supply chain management, and product life-cycle management in multiple manufacturing verticals, including — among others — automotive, aerospace, machinery, high tech, chemicals, CPG, and fashion.

MESSAGE FROM THE SPONSOR

Our view of Industry 4.0 is a factory that has auto-adapting processes capable of producing fully customized, unique products one after another, but able to do so at high volume production rates with minimal levels of human intervention. It is automatically controlling materials flow to eliminate downtime and operate at the lowest level of inventory possible. The ultimate goal is to transform manufacturing into an environment that is adaptive and customer-centric, capable of generating new business models and revenue sources. But without needing the army of engineers to make it happen. To learn more about Industry 4.0 and the best practices to consider on your journey, visit: www.aiscorp.com.



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