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Smart Manufacturing: The Supply Chain Challenges of Making Highly Engineered Products in a Dynamic Environment

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It's a big and transformative phenomenon worldwide, so of course it has a buzzy lexicon all its own. You can call it whatever you want - Digital Operations Technology, Industry 4.0, Industry of the Future, The Fourth Industrial Revolution, Smart Manufacturing - but you can't ignore it. MESA International offers a concise definition for this wave of change: "Smart manufacturing is the intelligent, real-time orchestration and optimization of business, physical, and digital processes within factories and across the entire value chain."

Powered by mobility, cloud, big data analytics, the IIOT, and many more emerging technologies, smart manufacturing is transforming the way things are made. From scissors to aircraft carriers, the digitizing of factories, supply chains and manufacturing operations end-to-end will impact business models, product design and customization, distribution and customer service.

On the other hand, revolutions are not known for unfolding in neat and tidy increments. The surge of changes, combined with market pressures, globalization and complex technology infrastructure and software implementation means many challenges lie ahead. Large manufacturers face issues with integrating myriad systems to create the sought after “digital thread” running end-to-end throughout the value chain, and especially with extending integration and visibility into the external supply chain. They are also under enormous pressure, especially in highly regulated industries, to closely manage quality and compliance, and to accommodate a constant flow of engineering changes to work already in process.

When it comes to the manufacture of highly engineered products, MES has already enabled larger manufacturing enterprises to improve productivity, create complex supply chains, and optimize quality and change management for efficiency and conformity. In complex discrete manufacturing enterprises (aerospace and defense, medical devices, nuclear, industrial equipment, etc.), the opportunities and challenges presented by smart manufacturing are intensified. Designing and building these products involves intricate and highly vetted global supply chains, complex diverse configurations, and long product life cycles, including maintenance, repair and overhaul (MRO) operations.

These manufacturers have requirements beyond core MES production and process execution functions. In these highly regulated industries, manufacturers also require: Vigilant Resources Certification Management, Complex Product/Process Configuration and Change Management, Detailed Integrated Quality Control Processes, and Detailed Product Unit History and Records Archival.

All of this has to be managed under intense market pressures and regulatory oversight. Finally, the emerging technologies that form the backbone of smart manufacturing have to be assessed, acquired, deployed, and integrated with existing machines and processes. Mobility, cloud, analytics, and the IIOT have already profoundly transformed manufacturing. Broader applications of 3D printing, robotics, cyber-physical systems, and augmented reality are on the horizon. PwC surveys indicate that adoption rates of these digital manufacturing technologies have already "crossed the threshold from early adoption to early main-streamed." And yet we've only begun to scratch the surface of the new capabilities that will soon become a reality—and a competitive necessity—for smart manufacturing enterprises.

Next Level Digital Integration

One of the central concepts guiding smart manufacturing operations is the "digital thread" defined simply as "a single, unbroken collection of data that is woven throughout the value chain." However, linking information technology to operational technology is harder than it sounds. MES is one such link, IIOT provides another layer of connectivity.

All this integration comes with obvious difficulties and cautions: legacy systems, cybersecurity, skills shortages, readiness of supply chain partners, and justifying the necessary investment in digital infrastructure—just for starters. One of the most significant impediments is interoperability. Government and industry will have to step up and lead the way to standards, alliances and open platforms. Standardization would make it more possible for smaller manufacturers to digitize their operations. This is important, in part because many SMEs are valuable supply chain partners for large, multinational organizations. Disconnects, lack of infrastructure, and lack of interoperability across systems leads to lack of integration in supply chains. The full benefits of smart manufacturing cannot be realized without deep supply chain integration and total visibility across the value chain.

Quality Management Throughout the Value Chain

In complex discrete manufacturing, the tolerance for faulty parts and products is near zero. For obvious reasons, the makers, distributors or end-users of medical devices, airplanes, and the like would prefer these products to be perfectly assembled and thoroughly tested for a wide range of scenarios.

Managing quality from the inside and throughout the entire manufacturing process using an MES that integrates inspection practices and verifies the certifications of personnel, tools and machines conveys an advantage to manufacturers. It's important to go beyond tracking defects, failures and corrections. It's much better, after all, to prevent errors entirely or catch them as early as possible. Repeat defects are much less likely when proofing activities are integrated into manufacturing processes, work instructions and throughout the shop floor. In other words, quality management is a key component of the digital thread.

Bringing quality management closer to the supply chain reduces waste, saves time, protects reputation, enriches brand value and even saves lives. Over half of the high-profile quality failures in recent years have originated somewhere in the value chain; it's no wonder that Gartner, ISO and other entities have called for an urgent focus on improving supply chain visibility. The cautionary tale at hand, the Takata airbag recall, has thus far impacted over 100 million vehicles from 14 different automakers. The costs

associated with the recall could potentially reach $24bn, a heavy burden that will be shouldered by both Takata and the automakers.

Regulatory compliance is an ongoing headache for complex discrete manufacturers, as it is in many industries. Compliance activities go hand-in-hand with quality management activities. When these activities are integrated, digitized and automated throughout the manufacturing process, the data collected and analyzed at key points can be used to predict, prevent and detect errors. Corrective actions can be automated, documented and propagated throughout the manufacturing process to avoid repetitive or cascading errors. Traceability and tracking of inspection and remediation processes improves audit readiness and streamlines callbacks when needed.

Constant Change in Dynamic Environments

Engineering change orders are frequent in complex product manufacturing, and require a higher order of change management capabilities. Building an aircraft, for example, involves a continuous stream of complex engineering changes directed at work that is in process over extended periods of time, involving myriad sub-assemblies manufactured in various locales. Integrating the engineering system with MES is key to creating a seamless link between product development, manufacturing planning, and execution. Closing the loop on engineering changes promotes conformance to customer specifications and regulatory compliance, assuring that as-built configurations match as-designed. It also ensures that knowledge and documentation of changes is communicated upstream and downstream throughout the digital thread, preserving product and process integrity with optimal efficiency.

Advanced manufacturing enterprises, in general, are dynamic environments characterized by continuing change. Meeting market and customer demands for productivity, cost-cutting, speed, innovation, and customization requires shop floors to achieve ever higher levels of flexibility and agility. There is an ongoing effort to upgrade existing machines and add new ones, evolving processes, tooling, and materials in tandem. Digitization helps to automate and streamline change management processes through better tracking, documentation, and collaboration.

Opportunity and Challenge on the Road Ahead

As digital operations technology systems are implemented and integrated with existing infrastructure, many challenges and opportunities will arise. First things first, it's important to determine how to get started, and where to make initial investments. An organization's approach will depend on their current status, their strategic goals, the nature of their products, the readiness of their supply chain and knowledge workers, and much more. Likewise, calculating "digital ROI" will be a unique exercise for each enterprise. A recent PwC report identified concerns about financial, cultural, and skills readiness as the top five inhibitors to developing digital operations capabilities.

There isn't much room for hesitation: PwC reports that U.S. manufacturers and venture capitalists alike are ramping up investments in digital operations technologies, and a significant portion of manufacturers plan to increase adoption of IoT strategies, embedded sensors, robotics, 3D printing, augmented reality, and smart machine data analytics over the next few years.

Organizational change management, retraining and support for smaller suppliers will be paramount to successful implementations. There are so many technology-driven upheavals on the horizon, these

efforts will pay dividends for years to come. Being ready for a future we can barely envision has to become a new core competency.

To lay the foundation for smart manufacturing improvements consider the following:

• Take the time to evaluate current assets and weak points

• Set new strategies and milestones

• Foster a new culture and new partnerships

• Address any skills gaps, and

• Evolve infrastructure throughout the value chain

It's often wise to start with low-hanging fruit, building pilot programs around obvious opportunities for improvement where success is readily attainable and visible; this helps cement buy-in from the shop floor all the way to the C-suite.

Promote and support industry and government initiatives (e.g., DMDII, OAGi, and MESA) to create meaningful standards and alliances. With more plug-and-play standards to work from, more suppliers and SMEs can be integrated into digital manufacturing ecosystems that are currently evolving out of large manufacturing enterprises. This will pay dividends as regulatory and standards bodies continue to focus on risk management in the supply chain.

The principal promise and challenge of smart manufacturing is the creation of a homogenous, harmonious, and totally interconnected entity. An organization undertaking this journey will find many challenges and opportunities along the way—it can be a steep hill to climb, but the view from the top is limitless.

Source: iBASEt