GE
Intelligent Platforms

Digitizing Complex Discrete Manufacturing Processes

Driving lower costs, higher quality and faster production to stay competitive today and ensure success tomorrow

Introduction

Complex discrete manufacturers today are part of multi-faceted, fast-moving supply chains, with the production of distinct items in an increasingly global and competitive environment. Orchestrating the movement of parts and components around the world is an intricate process, especially as constant change becomes the norm.

Whether in aerospace, defense, energy, heavy equipment, or other complex discrete manufacturing industry, the need for comprehensive visibility into production performance has become increasingly imperative to stay competitive. Fast, reliable and accurate information is the name of the game, and manufacturers need to rely on more digitized processes and less manual interaction as they seek to effectively manage their operations and work toward optimizing their supply chains.

According to ARC Advisory Group, the next decade will be about empowering value networks, whereby manufacturers will transform from a plant-centric integrated model to a more advanced model that focuses on value network collaboration. This network includes the companies that work together to deliver goods and services to end customers—creating an inter-related supply chain ecosystem that manufacturers need to succeed in for a competitive edge.

The key toward this transition for empowering a value network begins at the line and plant level with classic Manufacturing Execution System (MES) capabilities such as Quality, Resource Allocation (Operators, Workstations, Tooling, etc.) Work In Process (WIP) Tracking, Traceability, and Work Instructions. Only when manufacturers can leverage critical insight within their own operations can they reap the benefits of tightly integrating their suppliers, supported by more advanced MES capabilities.

This paper discusses the critical role MES digitization plays in complex discrete manufacturing at the plant level, the value it adds for increased competitiveness, and how to achieve full digitization. Readers will understand the value that digitization affords through the latest software capabilities, driving optimized performance today and a forward-looking foundational path for success tomorrow.

To stay competitive, manufacturers need to rely on more digitized processes and less manual interaction—a critical enabler to effectively managing their operations and optimizing their supply chains.

Industry Trends and Challenges

Complex discrete manufacturers and their suppliers face multiple industry challenges, including:

Shorter development times: The demand for new products and engineering changes are ongoing and can shift rapidly, whereby the window of time to develop and introduce new products is increasingly tighter. Manufacturers must produce products faster and often have limited timeframes to recoup their investment for a new offering.

Increasing price pressures: Many discrete manufacturers face competitive global price pressures as well as rising manufacturing costs for raw materials, labor, and energy. They must do more with less and protect their profitability margins without raising prices.

Greater demand for customization and quality: Driven by the need to balance customer expectations for more flexibility and minimize the high costs associated with a pure engineer-to-order (ETO) model, manufacturers are increasingly seeking to adopt a build-to-order (BTO) business model. The need for agility and responsiveness without compromising quality to meet demands has become more important than ever.

Extreme pressure to manage costs: From costs for labor and warranties to operational overhead, discrete manufacturers must minimize these costs while increasing productivity to stay ahead. Competition from emerging economies in countries such as China and India places even greater urgency to keep costs in check.

A key obstacle to addressing these challenges

Despite these trends and challenges, complex discrete manufacturers and their suppliers have the opportunity to drive growth but are held back by paper-based processes and legacy systems built on aging technology used to manage their plant floor production. This is especially true of many manufacturers and suppliers of large, complex products in industries such as aerospace, defense, energy and heavy equipment.

Processes are manual, and manufacturers lack the infrastructure to access pertinent quality information to make the best informed decisions. Challenged by too much WIP and a lack of visibility into where that WIP exists, they are burdened by hidden manufacturing costs and the inability to track and trace products. It becomes difficult to deliver quality information demanded by customers, or for example, to find relevant data to address a warranty claim.

Furthermore, the use of paper-based production trails hinders optimized operational and financial results. It slows down production, leads to greater potential for errors that affect quality, and generates higher costs.

The power of MES digitization for increased competitiveness

As complex discrete manufacturers continue to lean out their operations, they need modern MES software systems to leverage the benefits of digitized processes such as reducing waste, increasing flexibility and decreasing lead times. Today's technologies make it possible to capitalize on the value of fast, reliable and accurate information to maximize production performance.

Through the power of MES digitization, complex discrete manufacturers can leverage real-time information and automate their processes—saving time and money while still providing a consistent high quality product. For instance, they can easily monitor production, record production data, analyze quality and yield issues, and uncover the root causes behind performance requirements misses, as well as the drivers behind waste and inefficiencies. With deep visibility across their operations, complex discrete manufacturers can drive robust strategies for growth and competitiveness.

Digitization also affords the realization of comprehensive product records. No longer do shop floor personnel need to physically include quality certificates from suppliers with paper-based product records—a manual process prone to errors. It further reduces errors by eliminating the manual tracking and updating of non-conformances, quality data measurements, quality approvals, etc., which are inherent in a paper-based system. Digitized product records not only include the manufacturing instructions and the routes used to manufacture the product but also the approvals that were obtained before release to manufacturing—providing a comprehensive view.

Aligning to tomorrow's manufacturing needs

MES digitization sets the path for manufacturers to evolve with the trends of the future such as a virtualized enterprise. It enables the transition toward more advanced MES capabilities that will become critical as manufacturers' needs continue to grow with rising expectations from customers, increasing competition, and powerful new IT capabilities.

MES digitization allows complex discrete manufacturers to harness the benefits of an increasingly connected world, providing deep visibility across their operations and setting the path to drive growth and competitiveness.

For example, using cloud-based technologies and mobile capabilities, real-time collaboration enables an expert sitting in one location to view a manufacturing site in another part of the world and troubleshoot a problem. It enables an executive anywhere in the world to access the real-time information needed to maximize supply chain operations and efficiencies.

The possibilities are many, and it begins with the deployment of a modern IT infrastructure that allows for digitization at the plant level.

The journey toward full MES digitization

Digitization, enabled by the latest MES software capabilities, provides the foundation that allows manufacturers to achieve lean manufacturing and increased competitiveness.

MES Digitization: Enabling targeted results

- **70%** reduced order-to-delivery time for a major lighting manufacturer
- **15%** reduced WIP for a major electrical equipment manufacturer
- **15%** reduced rework for a major aerospace manufacturer
- **24%** reduction in warranty costs for a major appliance manufacturer

A step-by-step methodology to help complex discrete manufacturers achieve full digitization is outlined in the following journey. It starts with defining how the product is going to be manufactured, providing digitized information to enable the workforce, digitizing all the quality data, extending the capabilities to the supply chain, and building and maintaining complete digitized product records.

Digitized Process

The first step of the journey is to eliminate the paper-based traveler that is released with the production order to the floor. Based on the complexity of the final product, there can be tens of thousands of these orders and travelers released every year. Digitized systems are provided for the industrial engineer to define and manage the routes, and instructions are associated with each one of these orders, which can result in more than 100,000 documents that are digitally managed.

As part of the definition, it is important to identify what certifications are required for resources (i.e., people and equipment) in order to perform the different manufacturing operations defined within the route. Quite often in this complex manufacturing environment, the routes and instructions need to be approved by others from Quality, Product Engineering, and Manufacturing Supervision. Digitized workflows can help make the accomplishment of this task easier.

Enabled Plant Personnel

The next step in the journey is to provide this digitized information to the operators on the floor as the orders are released and executed. A fully digitized system provides a list of jobs for the operator to select to execute. Once selected, the instructions are digitally provided, which helps eliminate many errors that can occur associated with using the wrong paper-based instructions. Once jobs are completed, the order is digitally routed to the next operation.

This digitized information also enables managing and having true real-time digitized visibility to the WIP. Manufacturing supervisors no longer need to manually run around the floor to identify locations and statuses of the orders within the plant. Flexible WIP displays are used to identify all in-process material across the entire manufacturing facility or just in one area. Views should also be provided for a collection of orders.

Tighter Quality Control

The next and very important step is to gain better control of quality through full digitization of the quality process. All key quality variables are defined and digitized within the MES system. Digitized forms replace the quality forms that were included in the paper traveler. Quality is automatically collected and stored from the associated equipment such as torque tools, gauges, etc., or plant-floor personnel may manually enter quality data.

This data is now validated instantly against the expected spec limits. The entered data may also be digitally routed to Quality personnel to digitally stamp and validate the entered information. Non-conformances can be digitally created for out-of-tolerance material and routed to the right personnel for corrective action.

The journey toward full MES digitization provides the foundation that allows manufacturers to achieve lean manufacturing and increased competitiveness.

Expanded Supplier Collaboration
The fourth step in the journey is to expand the digitized MES ecosystem beyond the plant to the suppliers. Outsourced operations can now be digitally routed to suppliers, providing them with a digitized display containing a queue of their orders to work from. In addition, Certificates of Analysis can be digitally delivered from the supplier to the main manufacturer, whereby hundreds of suppliers can be included with the WIP being managed from the central MES system.

Comprehensive Product Records
All these prior steps of the journey enable the final step: producing a complete, comprehensive, digitized product record of the end product, including all associated components and sub-assemblies. No longer do paper-based product records need to be managed and retained in boxes at secure storage facilities; no longer do personnel need to manually retrieve and peruse stacks of paper to find the appropriate information if a warranty issue occurs. An online digitized product record database enables quick retrieval of any information that may be required.

Delivering benefits that drive manufacturing performance

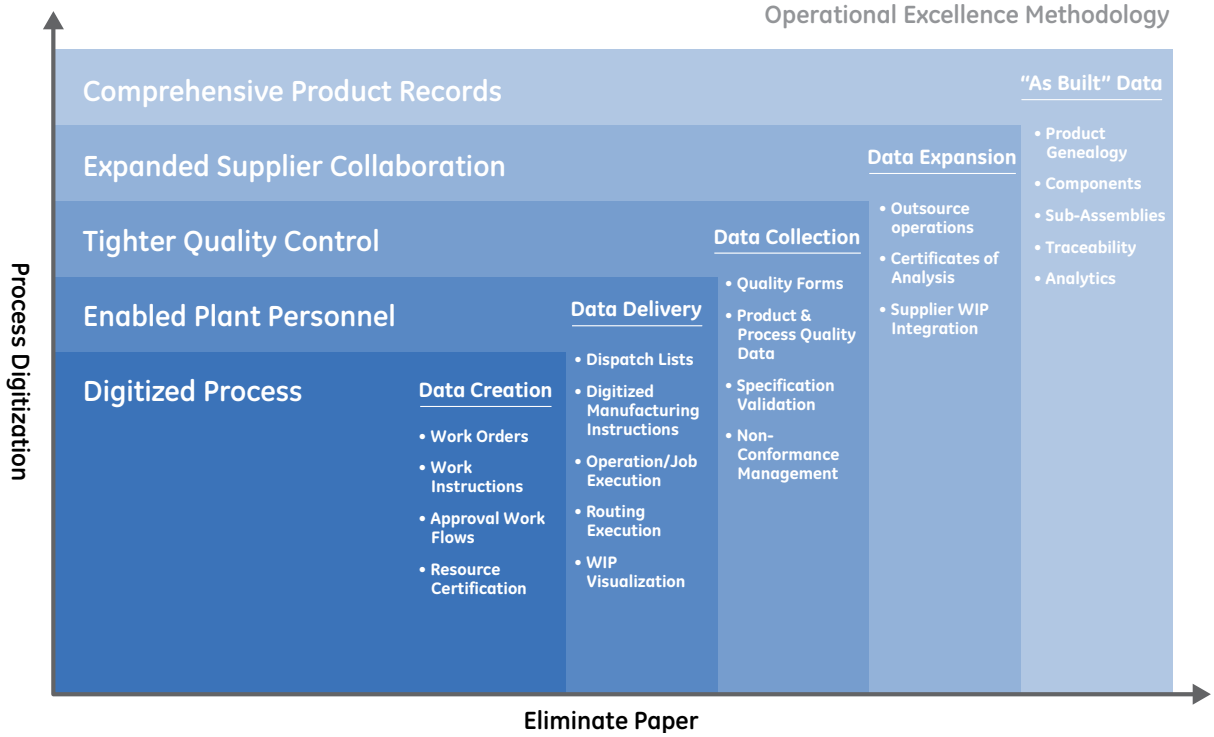
The benefits for digitizing complex discrete manufacturing processes are significant. Manufacturers can produce products faster through reduced cycle times, reduced lead time from order placement, and first time production of a new product. In general, digitization helps eliminate non-value added production time, which directly impacts cycle times.

For example, manufacturing businesses within GE have reduced cycle times in the range of 20% through digitization—enabling a significant competitive edge, especially as complex discrete manufacturing cycles are typically long.

> Manufacturing businesses have reduced cycle times in the range of 20% through MES digitization—directly reducing labor costs and driving faster production of products.

Furthermore, the simple capability of providing real-time WIP visibility can reduce WIP inventory levels by at least 10% and as much as 30%. By understanding where WIP exists, manufacturers can respond to changes in demand and eliminate bottlenecks to quickly bring products to completion.

MES Digitization – Complex Discrete Manufacturing



Digitizing Complex Discrete Manufacturing Processes

Using the right digitized instructions helps tighten control on quality by monitoring and validating quality data against the expected spec limits. This enables products to be built right the first time, avoiding rework and scrap by as much as 25%. Manufacturers can also streamline the supply chain with more efficient supplier collaboration through outsource operations management and certificates of analysis for components received. Digitized product record retrieval reduces warranty investigation time by as much as 70% and contains warranty exposure information to reduce warranty costs.

Additionally, there are other cost benefits associated with implementing a fully digitized system, including labor and paper savings. Long cycle, complex manufacturing requires significant labor to manufacture all the components and assemble the final product. Therefore, any reduction in cycle time directly impacts the labor costs associated with the product.

Finally, eliminating the costs of paper and related items such as printers, ink, etc.—along with the hidden costs associated with the process, including handling, storage and retrieval of paper—enables further cost savings.

Complex discrete manufacturer on track to save millions annually

A major locomotive manufacturer with many service shops globally had a remanufacturing plant that needed a flexible solution to support conditional routing of assets. It sought to address variable processes based on additional inspections as assets were being disassembled. The operations applied to any given part number were variable, depending on the condition of the part received from the field.

This site performs teardown, service, and remanufacturing of wheels and motors for the locomotive engine cab. In this application, the elimination of paper travelers and use of digitized standard operating procedures have resulted in tighter control on quality. In addition, the manufacturer has the ability to proactively identify trends to limit the more costly repairs/replacements—savings that directly impact the bottom line.

Key benefits include:

- Improved quality due to process consistency and fewer errors
- Higher profitability margins on Contract Services Agreements (CSAs)
- Reduced remanufacturing cycle times and associated WIP costs
- Improved service shop capacity with reduced frequency of remanufacturing
- Greater efficiency of locomotives running on the rails

The success of the digitized MES system at this site has resulted in a plan to roll it out to the manufacturer's other service shops.

Conclusion

As complex discrete manufacturers find themselves having to compete in an increasingly global and competitive business environment, the need for digitized processes cannot be overlooked. Defining how a product will be manufactured and managing all the associated components to produce the end product requires precise, accurate and timely orchestration and complete production visibility.

To that end, digitizing MES processes at the line and plant level is a critical enabler to achieving effective operations and supply chain optimization. The journey toward full digitization enables manufacturers to reap significant rewards that can help them leapfrog their competition with the value of real-time information and the elimination of non-value added production time.

Greater production accuracy, faster approval routing, reduced WIP, tighter quality, and better integration with suppliers are among the cumulative benefits of MES digitization. The culmination is the ability to produce a complete digitized product record of the end product—providing the infrastructure to make the best informed decisions, which in turn, helps optimize operational and financial results.

Lastly, digitization enables manufacturers to leverage more advanced MES capabilities as their needs extend into the future. It is the backbone to drive results quickly and reliably, without compromising product quality—allowing manufacturers to stay competitive by successfully transforming from a plant-centric model to one that can capitalize on the advantages of a collaborative value network.

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