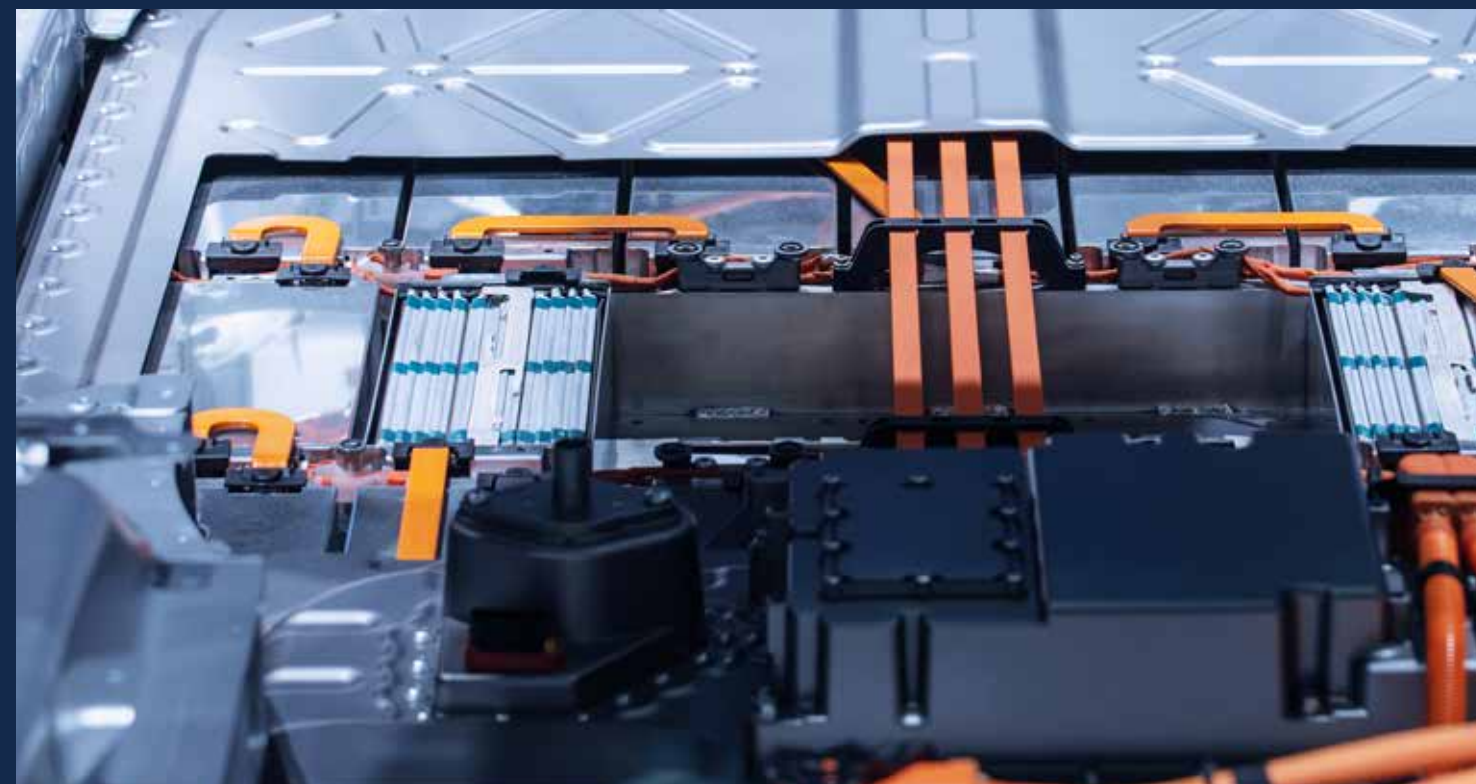# Automotive Manufacturing Guidebook

Increase production agility and improve operational performance with a modern Smart Factory

Automotive Manufacturing Guidebook

White Papers

Everything You Need to Know About Manufacturing Execution Systems

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MES Solutions from GE Digital

Proficy Smart Factory

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Everything You Need to Know About Manufacturing Execution Systems

Today, manufacturing equipment is connected online like never before. Every individual step in a manufacturing process generates gigabytes of valuable data each and every time it is run and a Manufacturing Execution System (MES) software can track, control, and document the data associated with these steps.

IIoT insights and intelligence:

What is MES? Drive results with one MES for Process, Discrete, and Mixed Manufacturing

MES enables Lean manufacturing through insights and intelligence powered by data integration, the Industrial Internet of Things, machine learning, and predictive analytics. By bringing the digital world together with the physical world of manufacturing, companies can transform their business and meet their critical key performance indicators (KPIs).

MES software is used to manage, monitor, and synchronize the execution of real-time physical processes and people involved in transforming raw materials into intermediate and/or finished goods. And, it supplies actionable information that helps manufacturing decision makers understand how the operating conditions on the plant floor can be optimized to further improve their production output.

Optimizing manufacturing operations

MES Functionality

MES works in real-time to enable the control of various parts of the manufacturing process in the space between automation systems and enterprise resource planning (ERP). It helps to unlock efficiencies and optimize operations to reduce costs, speed production, track genealogy and improve quality. It does this by integrating process control data from industrial automation systems on the plant floor with manufacturing operations management (MOM) systems such as quality, production, maintenance, and logistics systems.

The data collected by MES can be organized into three categories:

- Asset data: real-time sensor and measurement results

- Manufacturing data: real-time feed of manufacturing execution events

- Enterprise resources: financial impact

MES is especially good at collecting and analyzing data in highly automated fast-moving processes. It automates and integrates the information related to activities for managing production execution and optimize performance holistically, helping to balance the trade-offs between competing priorities of production operations.

One of the biggest benefits of MES is the increased visibility across the operation, which helps monitor production and catch deviations so companies can adjust processes and avoid waste. Visibility like this also enables a better understanding of operations and allows traceability across the entire scope of the production process.

MES in action

Real-world MES results

With the kind of results manufacturers are realizing with the use of MES, it's no surprise that analyst research indicates that MES technology use is increasing at a rate faster than automation in general. This is largely due to its ability to help optimize production for operational excellence.

To help manufacturers leverage all this data available to them, GE Digital developed a Manufacturing Execution System (MES) software solution that helps to drive higher efficiency, improve quality, and reduce costs associated with manufacturing by understanding conditions on the plant floor.

GE Digital's MES software brings together the digital world with the physical world of manufacturing, delivering holistic performance management for today's connected enterprise.

Recently, industry analyst Gartner, identified four critical capabilities for manufacturers to consider as they choose a MES solution:

- process quality management,

- data management/data collection,

- production equipment integration,

- and enterprise integration architecture.

GE Digital's Proficy MES software, called Proficy Plant Applications, scored as #1 in Continuous Process Manufacturing, #2 in Batch/ Repetitive Flow Manufacturing, #2 in Highly Regulated Industries, and #4 in Complex Discrete Manufacturing.

Lean manufacturing in the age of the Industrial Internet

Connect machines and devices with people to access operational insight

From Henry Ford's moving assembly line to Taiichi Ohno's Toyota production system, now known as lean production, manufacturers globally have constantly strived to make their operations better. The concept of lean, widely known for its tools to eliminate non-value added processes, has been at the forefront of management for the last five decades.

Lean production has enabled manufacturers to transform their operations to be more efficient, more productive and their businesses to be more profitable. Whether it's frontline workers solving knotty problems, improved scheduling with just-in-time production, or stopping a production line as soon as there's an issue, lean has been about making physical changes to improve operations.
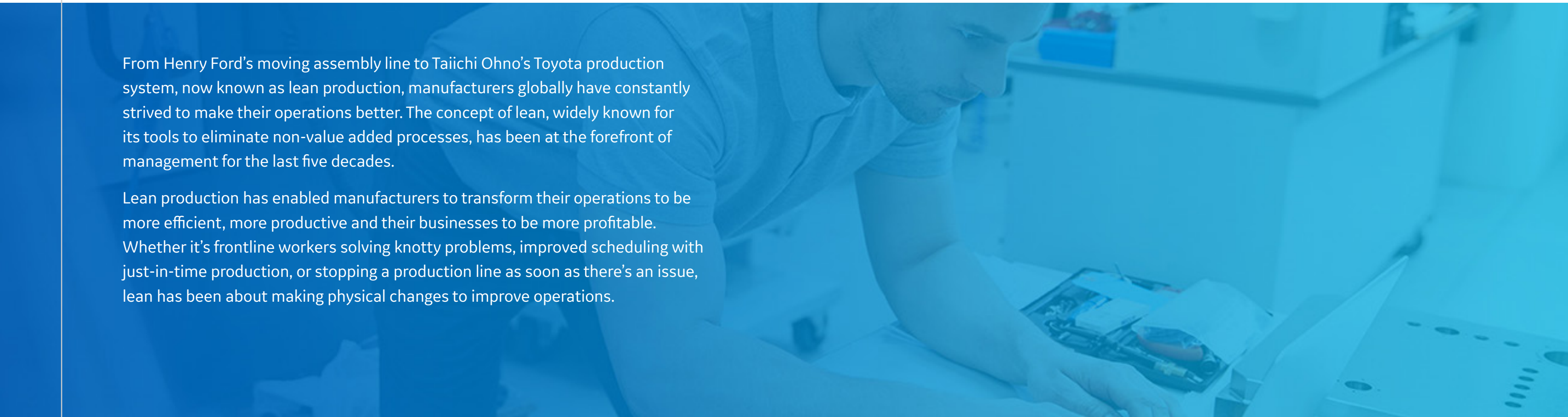
That was then, this is now...

Imagine a manufacturing environment where your machines and devices are connected, and people have access to operational insight wherever they are with business intelligence at their fingertips. Envision a production floor where operational data transforms into intelligent foresight to tell workers, for instance, where to find additional efficiencies in production, what steps to take to drive higher yield, and how and when processes can be improved to drive faster cycles.

Advances in technology make this a reality today—enabling lean to take on a deeper meaning beyond improving just processes. Now manufacturers can leverage data intelligence to revolutionize their operations for significant improvements, including greater productivity, less waste, and lower costs.

The benefits of lean have yet to reach their full potential. Today's technology, powered by the Industrial Internet, allows enterprises to drive even more value and reach new levels of performance to accelerate their competitiveness.
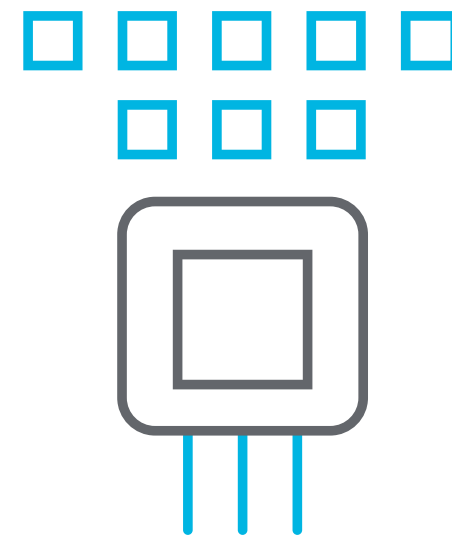
The challenges in manufacturing

Manufacturers face increasing costs, global competition, and growing consumer demands. They must move faster, better, and leaner every day just to keep up, let alone stay ahead of competitors. They're up against extreme pressure to produce more for less and to quickly respond to changing market demands while lowering costs. In short, manufacturers have to capture every operational efficiency possible. Hence, lean manufacturing remains ever more critical than it has in the past. And more often than not, manufacturers have done everything they can to lean their processes to the maximum.

So now what?
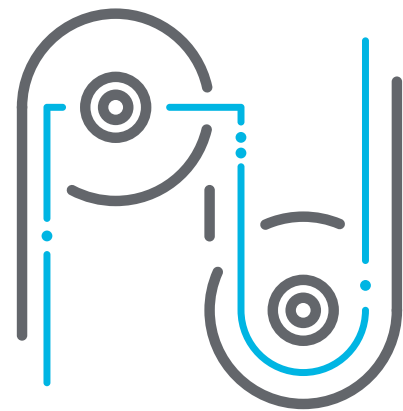
Taking lean to the next level

Complementing lean are the principles of Six Sigma, which also seeks to eliminate waste by streamlining and improving all business processes and removing variation within the process. The two disciplines, lean and Six Sigma, can be especially successful when working in tandem.

But that's not all. The opportunity for manufacturers to get more from lean Six Sigma is powered by the explosion of data from today's connected machines, enabled by the Industrial Internet. With advanced MES (manufacturing execution system) solutions, this data can provide timely and relevant insight to help improve both the top and bottom lines of a business—improving customer service, shortening lead times, improving production performance and operations efficiency, all while avoiding costly mistakes.

Digitization of manufacturing processes and data with MES helps uncover interrelationships and deep insights across the enterprise to drive better, leaner ways of doing business. It provides the underpinning from which big data analytics can inform strategic planning, guide real-time operations, and uncover root causes of issues before they become problems.

The two disciplines, lean and Six Sigma, can be especially successful when working in tandem.

Building the foundation

From a lean Six Sigma perspective, let's explore how leveraging MES software technologies are best suited to support these initiatives. To begin, there are some fundamental questions that need to be answered in order to effectively lay the foundation.
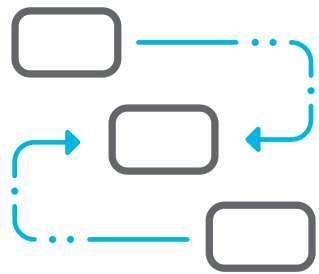
Am I collecting the right data?
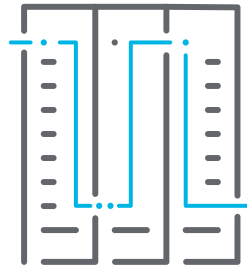
Do I have an effective and efficient way to store and access it?

Do I have a way to visualize it in context?

Do I have a way to get it to the right people?

How can I integrate analytics into my production plan?

Define the roadmap to value

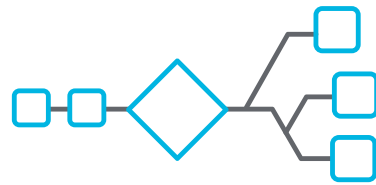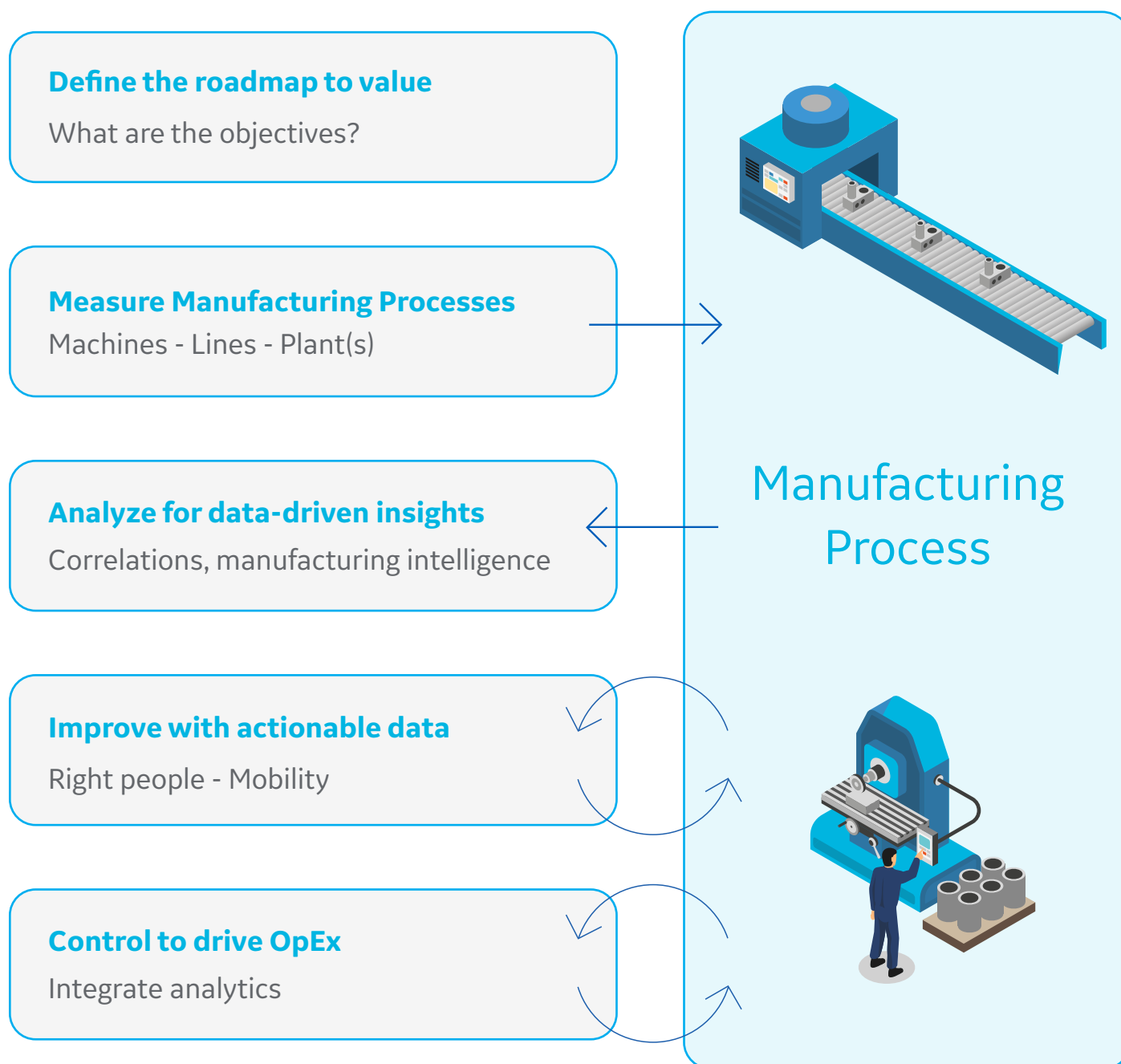You need to identify the outcomes you desire and prioritize your goals. For example, your goals may include one or more of the following: produce products faster, reduce work in progress, tighten control on quality, streamline the supply chain and reduce warranty costs. Addressing these areas at once can be overwhelming, so instead of trying to solve everything, determine which one or two areas are the most impactful for your business and then optimize around those.

To effectively impact those desired outcomes, collecting the right data is imperative. Consider what meaningful data you need from your manufacturing process, critical assets and people, and determine the key sources of that data—whether it's product data, execution data, work instructions, quality metrics, supply chain metrics or genealogy/traceability data.

It's worth noting that the Industrial Internet enables the manufacturing environment to comprise data not only inside building walls, but also the sources and activities that feed the facility (like suppliers) and the customers who are served after products leave the factory.

Ideally, the data created from suppliers (or before) gets built into the manufacturing and assembly activities, enabling both real-time analysis and a holistic view of critical activities.

Maximize Lean Six Sigma with MES Digitization

Define the roadmap to value
What are the objectives?

Measure Manufacturing Processes
Machines - Lines - Plant(s)

Analyze for data-driven insights
Correlations, manufacturing intelligence

Improve with actionable data
Right people - Mobility

Control to drive OpEx
Integrate analytics

Manufacturing Process

The level of data you need will drive what technology is required to collect that data.

Measure your manufacturing processes

The next step is to measure your manufacturing processes with capabilities that enable you to collect, store, and manage your data. The level of data you need will drive what technology is required to collect that data. For example, if you need plant-level data that scales with related production assets, a plant-wide historian with data modeling and central administration capabilities is ideal.

If you need to get closer to a machine or production asset such as a sensor or control system that requires even higher speed collection rates, you may take advantage of a technology such as Proficy Historian Edge. This may be technology that allows you to create a network of intelligent machines connected to the Industrial Internet to achieve the desired collection rates.

You also need to consider data collection at the enterprise level, which may require the consolidation of multiple plant historians into a single historian with common configuration to enable analytics and visualization in a more expedited fashion.

Finally, there's more to it than the amount or size of the data; it's also about the type of data. You need the ability to handle a number of different types of data and correlate them together within a common context. For example, this could include product data, event data, and quality data that takes the format of time series data, metadata, pictures, videos, etc.—all of which must be managed in a consistent and coherent way in order to realize value from it.

The right MES solution enables you to collect, store, and manage your industrial big data—the foundation from which you can leverage higher-level analytics. This is where lean Six Sigma delivers valuable business insight, and powerful performance improvements start to take shape.

Analyze for data-driven insights

With the foundation in place, manufacturers can leverage MES to build varying degrees of analytics that get at very specific problems for their business. For example, such solutions can analyze historical and real-time datasets for trends and patterns, and then alert the appropriate personnel of a problem that requires immediate attention in order to maintain and optimize production.

MES solutions play a critical role in helping operators visualize data and deliver data-driven root cause analysis to determine what the problem was, what happened, how often it happened, where it happened, and what the final disposition should be. This manufacturing intelligence can drive significant and game-changing productivity and efficiency for manufacturing operations.

Data-driven insights through advanced analytics help enhance asset performance by detecting and predicting the why, when, where and how of future potential production anomalies. Perhaps more important is the ability for manufacturers to assess through simulation what a potential change in the manufacturing process may have before it is actually implemented.

Case Study

For example, a large-scale manufacturer leveraged the data collected from its plant floor in several different ways. Historical process metrics were used to pinpoint the cause of a quality defect found during final product test. Analytics applied to the data revealed a difference in operating procedures between first and second shifts due to an operator removing the product too early from a critical operation. This data-driven insight enabled corrective action to improve product quality.

This same manufacturer was also able to perform production simulations based on the performance metrics collected over time. It wanted to understand the implications of a machine going down and what levers it could pull and still produce product and meet production schedules. Having these scenarios identified beforehand helped it determine where potential single points of failure were in its production process and have a contingency plan to keep production running in the event a failure occurred.
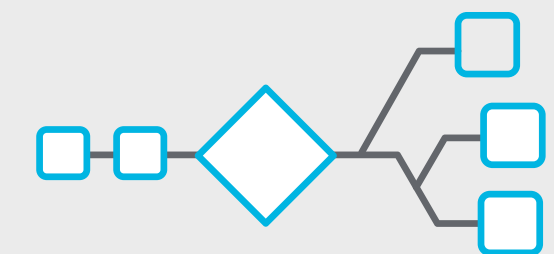
Turn Data into Actionable Knowledge
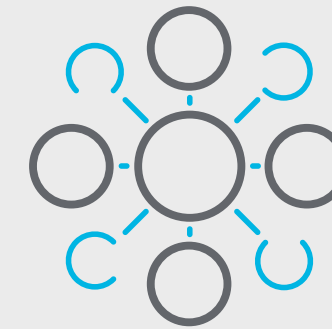
01 Collect data from your systems
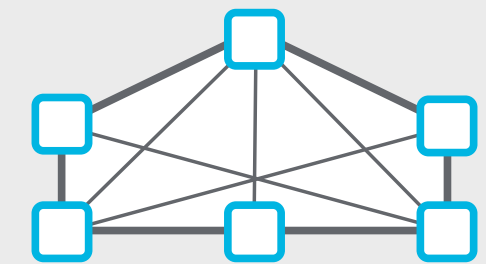
02 Transform the data into intelligent insights

03 Deliver relevant information to the right people

04 Drive operational excellence with lean production

Advanced MES capabilities helped an industrial mixed-manufacturing company drive lean operation by providing better visibility into plant-floor operations. Providing real-time information and analysis about inefficiencies, the solution identified that set-up time was far too long, and it pinpointed the root cause, enabling the manufacturer to address the issue. The solution also spotted pick-up time; one item was produced in another building, and it could take two hours to get it to the next operation. Leveraging MES, the manufacturer could dispatch out the request to the material movers to pick up the WIP and minimize waiting time at the next operation.
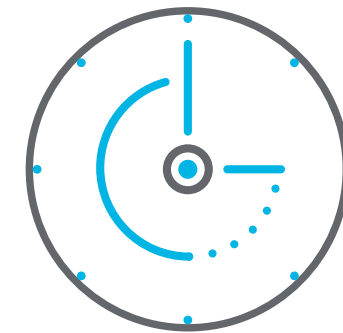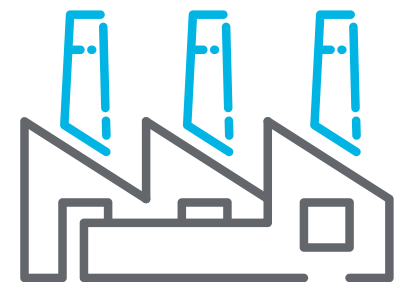
Case Study

15% improved labor utilization

15% reduced WIP and raw material inventory

Faster set-up time and pick-up time

Production optimization based on availability and materials to maintain on-time orders

Improve with actionable data

With the ability to measure and analyze in place, connecting the right people to the data is key. MES visualization technologies provide real-time operational intelligence so that the operator, control room personnel, plant manager, engineer or maintenance staff can separate the signal from the noise. Thus, he or she can prioritize the right actions at the right time.

Relevant information in context readily available at their fingertips, workers can identify critical parts of the process and drill down further if needed. Connecting intelligent insights to the right people will enable manufacturers to drive the best actions every time—driving significant operational improvements. Furthermore, much like in the consumer world, the industrial world is becoming increasingly mobile, so steps must be taken to make data accessible.

MES industrial mobility, powered by the Industrial Internet, enables today's manufacturers to connect to their production processes from anywhere at any time on mobile devices—a powerful business enabler. Mobility also provides executives with access to real-time information, fostering a "walk-the-plant-floor" management approach as opposed to a "spreadsheet management" approach.

This hands-on culture aligns with the philosophy of lean Six Sigma, whereby real-time information and action accelerates process improvement initiatives.

Relevant information in context readily available at their fingertips, workers can identify critical parts of the process and drill down further if needed.

Control to drive operational excellence

Ultimately, you want to continually drive Operational Excellence across your manufacturing enterprise. As the Industrial Internet enables connectivity between your machines, data and insights, and people, you have the infrastructure to leverage business and operational insights into the future, transforming your operations to be leaner than ever.

To sustain these new levels of lean performance, MES enables you to integrate analytics as part of your production plan, so you can continually drive better outcomes such as:

- Schedule production in plants or on lines or machines to produce within the defined targets

- Reduce work in process with real-time visibility

- Produce products faster by closing the loop between manufacturing and engineering to deliver products to customers faster

- Increase quality through real-time data collection and conformance metrics to verify as-built equals as-designed management and consumption metrics

- Leverage full product genealogy for fast traceability and exposure containment

- Optimize production based on energy constraints

- Integrate energy and water consumption into material

Case Study

A global manufacturer was bringing 10 new ground-up products into production in parallel on a very tight schedule. Its existing systems were disparate and non-connected, lacking visibility and a much-needed end-to-end system. To lean its operations and drive continuous improvements, it leveraged a powerful MES solution that delivered an integrated ERP to manufacturing system, accurate and timely business metrics, complete product genealogy, real-time visualization and control, and scheduling optimization.

The results:

- **30–40%** raw and WIP reduction

- **24%** estimated reduction in warranty cost through end-to-end genealogy

- **20%** greater uptime

- Double digit **improvement** in deployment cost and speed

- Improved **quality** and less rework

Conclusion

The explosion of data from today's connected machines, enabled by the Industrial Internet, brings forth the critical opportunity for manufacturers to leverage MES solutions to drive better, leaner ways of doing business. Industry is rapidly moving towards having analytics that are connected at the point control and the process, so that manufacturing businesses will ultimately be self-learning, self-improving, and self-"leaning" for accelerated competitiveness.

It's the world we live in, where technology enables the convergence of machine and intelligent data, and everything is connected. The sooner manufacturers embrace digitization, the more quickly they can leverage what today's technologies can do for them. And that's when the power of the Industrial Internet becomes real for manufacturing operations.

FIND OUT MORE

Implementing Lean Manufacturing Principles

Use Modern Technology to Level-Up Your Game

Key Takeaways

- Lean principles focus on eliminating waste throughout the manufacturing process.

- Visual management gives employees the right information at the right time.

- An MES can help manufacturers improve product quality.

- Poka-yoke, digitized work procedures, and analytics can reduce errors.

- Digital Kaizen supports continuous improvement.

- A digital Lean process motivates employees and drives a culture of growth.

Overview

In this period of uncertainty, organizations are looking for ways to increase productivity and reduce cost without affecting quality. This is driving a renewed interest in implementing Lean principles, which focus on eliminating waste so that every step of the process adds value.

While the principles of Lean haven't changed since the concept was introduced, the technology surrounding Lean has. Today's technology, including anytime, anywhere mobile offerings, is positively impacting how and when plant managers, engineers, quality, maintenance, and operators are accessing information and making improvements.

Key takeaways

Lean principles focus on eliminating waste throughout the manufacturing process.

Lean manufacturing is a systematic approach to eliminating waste in the manufacturing process, so that each step adds value. The five principles of Lean (shown to the right) help businesses identify those activities that consume time, resources, or space but do not add value. Through a process of continuous improvement, organizations seek to remove these wasteful activities.

Lean is about making sure that every step is a value-added step and is not something that's just taking up time and not providing additional value to the process or procedure.

Principle	Actions
Define value	Identify the problems that need to be solved and the end goals.
Map value stream	Identify wasteful steps and tasks in the process by mapping out (in detail) how the process works now.
Create flow	Refine the existing process to improve the flow, leading to benefits in productivity and efficiency.
Establish pull	Determine what steps can be shifted to a just-in-time approach, minimizing the amount and cost of additional stock or extraneous processes.
Seek perfection	Continuously improve the process; revisit the "define value" step and start the cycle again.

Although manual processes can be used in Lean environments, today's technology, including manufacturing execution systems (MES) and enterprise resource planning (ERP) solutions, improve the availability and visibility of Lean across the business, from the factory floor to the business office.
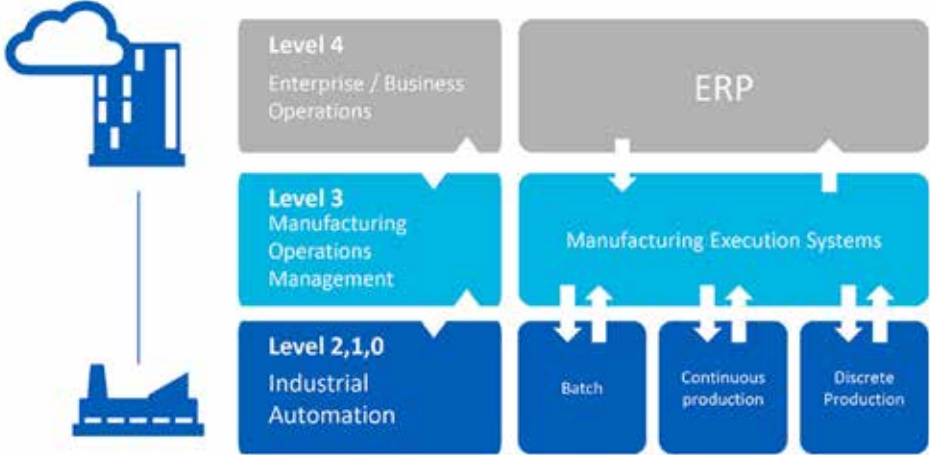
Figure 1: Leveraging technology to enable Lean across the business

Visual management gives employees the right information at the right time.

Visual management is a key component of the Lean manufacturing process: dashboards, huddle boards, story boards, and Andon boards provide employees and managers with the right information at the right time. Today's mobile technologies allow users to receive this information on their phones, tablets, and even smart watches regardless of where they are, enabling individuals and organizations to react quickly as issues arise.

Using mobile technologies to deliver visual management information drives mobility across teams and increases efficiency. Mobile access to this data empowers all members of the operating team, giving them easy, flexible access to their manufacturing data for decision making and enabling real-time interactions.

An MES can help manufacturers improve product quality.

An MES provides condition-based quality management, giving manufacturers real-time information they need to produce a high-quality product the first time.

Real-time product and process quality analysis and control, alarms based on conformance limits, and ad hoc key performance indicators and dashboards are among the MES tools that help manufacturers lower production waste, scrap, and recall cost.

Poka-yoke, digitized work procedures, and analytics can reduce errors.

Work process management, like poka-yoke and digitizing work procedures, as well as machine learning and analytics, can help manufacturers reduce and even prevent costly errors.

Poka-yoke is any mechanism in any process that helps avoid mistakes. It helps eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. For example, a digital solution that prevents a user from entering invalid data is a form of poka-yoke.

Digitized work procedures allow businesses to capture knowledge that often resides in employees' heads and create guided work instructions, structure documents, and standard operating procedures that are reusable and repeatable. These procedures can also be applied to machine learning to help enforce the proper work processes and procedures.

Machine learning and analytics enable businesses to use all of their collected information and, ultimately, take action to avoid issues. With these digital tools, manufacturers can move along the spectrum from responding to an error that has occurred to preventing errors before they happen.

| Dashboards	Ad hoc metric, such as trend charts and graphics. Example: Shows metrics by department and by team, with targets and goals.
Huddle Boards (Agile Kanban Boards)	Visually communicate the tasks to be completed during the sprint. Often the focus of daily standup meetings to play the day's activities and escalate concerns.
Story Boards (A-3)	Combine trend charts of performance metrics with further analysis to convey the actions taken by a team to solve a problem or improve a process.
Andon Boards	Display current production information, such as actual production vs. target, on a daily or per-shift basis. Can also be applied to service operations, such as call centers or retail environments.
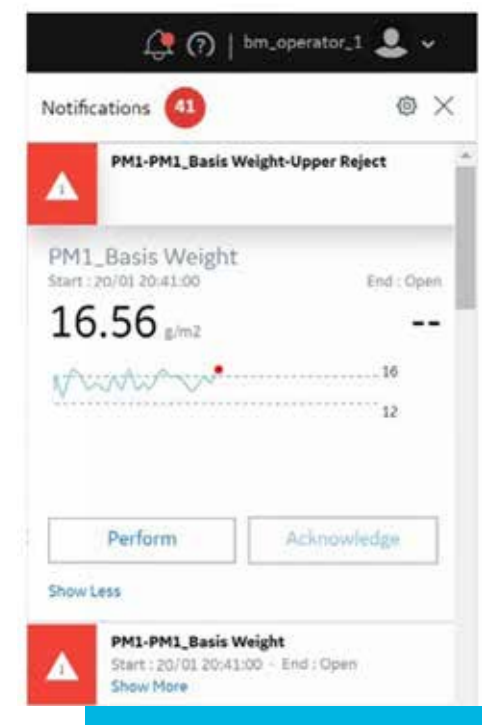
Figure 2: An MES provides real-time information that improves product quality

Digital Kaizen supports continuous improvement

Kaizen empowers people to continuously make small changes, monitor the results, and quickly adjust. This method supports a key element of Lean: Plan Do Check Act (PDCA).

Digital Kaizen further enables collaboration and continuous improvements through digitized processes and tools that users can build on their own, without needing to know any programming.

Digital Kaizen accelerates the continuous improvement process, providing users a single version of the truth. Information is accessible from anywhere, on any device, and cross-team communication is increased. Digital Kaizen solutions are easy to maintain and deploy, and can be configured so that alerts can trigger action.

A digital Lean process motivates employees and drives a culture of growth.

A systemic digital Lean process goes beyond reducing the total cost of ownership and improving productivity; it motivates employees and makes them more accepting of change, and it drives a culture of growth.

Employees feel a sense of ownership when they realize that they are part of the change process, and that their ideas are being incorporated. They are more willing to contribute more, and more open to change, especially the continuous, incremental change that comes with Lean processes.

Digital Kaizen democratizes the digital world and the data users can get to, and allows for easy collaboration and continuous improvement.
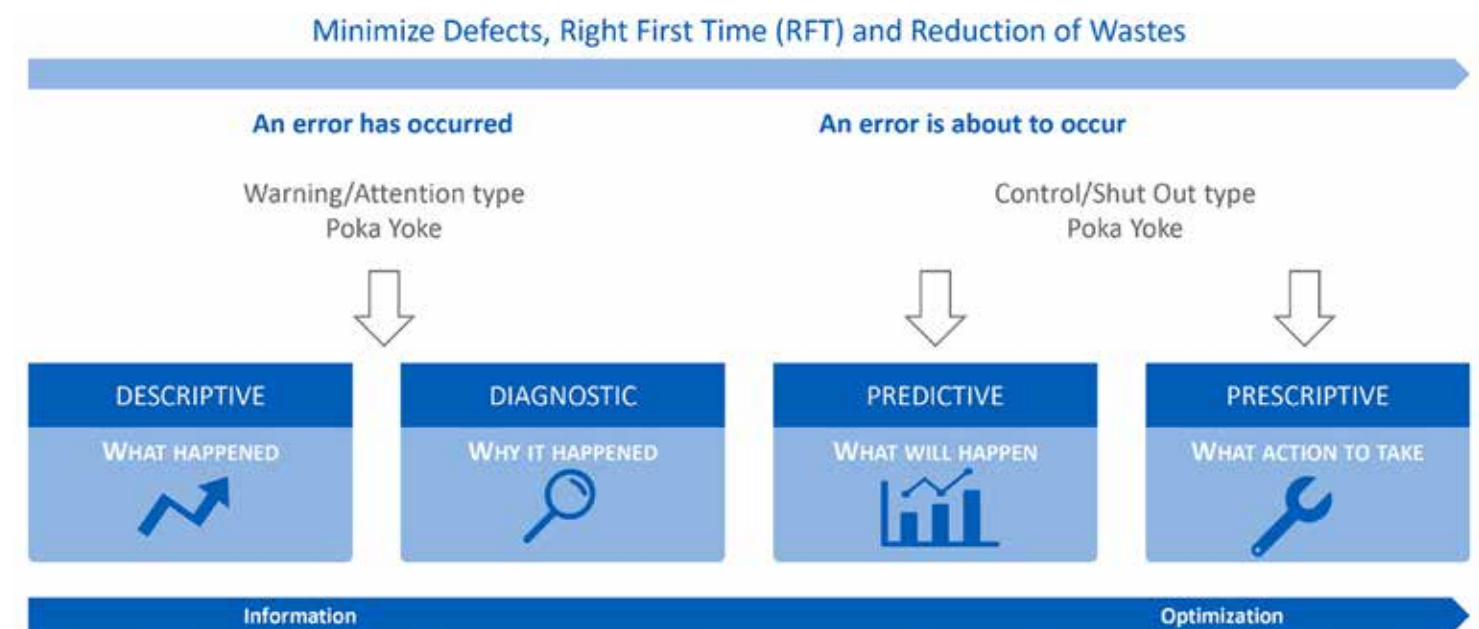
Figure 3: Machine learning and analytics will shift businesses along the spectrum from responding to errors to predicting them

How technology is changing the game

The sense of ownership and the willingness to accept change inspires a culture of work and improvement, and ultimately, growth, which is key to the success of the business.

Ready to learn more about digital solutions that enhance your Lean programs?

EXPLORE MES

Adjust or tweak your changes

Plan your improvements, including setting goals
Analysis tools give hypothesis for small changes

Measure your success relative to your baseline
Dashboards & analysis tools as ways to measure success

Put in place the actions required for improvement
Implement using Rapid Application Development tools

Figure 4: A key element of Lean, Plan Do Check Act (PDCA), supports continuous improvements

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 co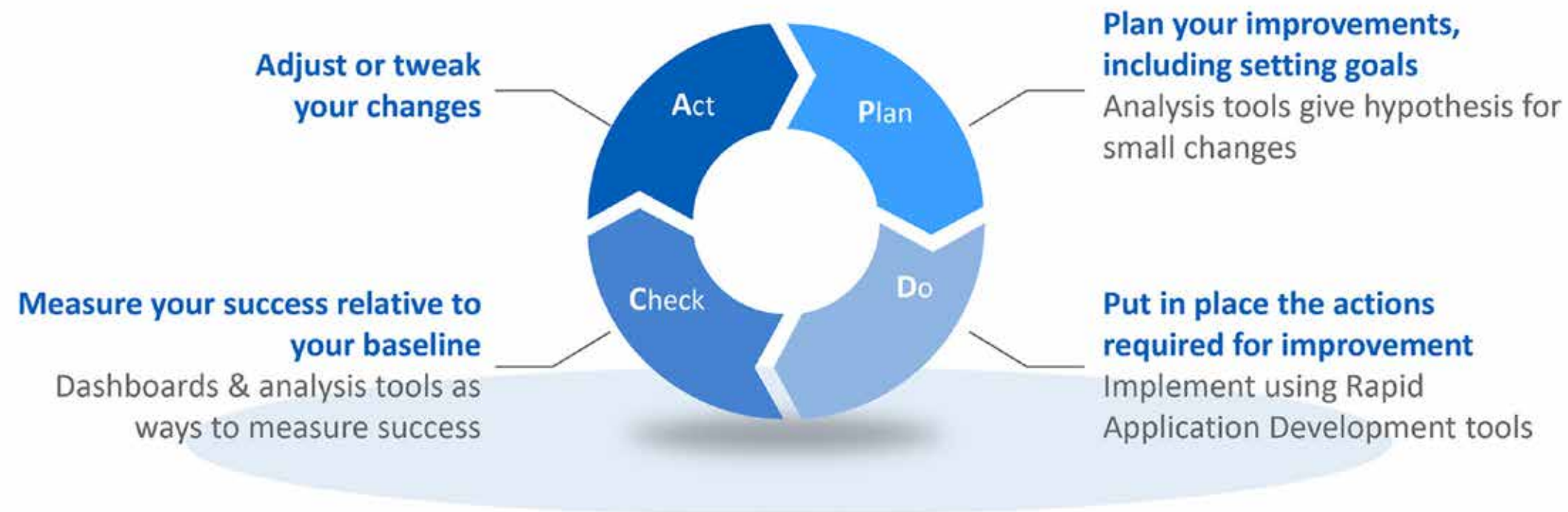mprehensive visibility into production performance has become increasingly imperative to stay competitive. Fast, reliable and accurate information is the name of the game, and manufacturers need to rely on more digitized processes and less manual interaction as they seek to effectively manage their operations and work toward optimizing their supply chains.

According to ARC Advisory Group, this decade is about empowering value networks, whereby manufacturers 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

- Work Instructions

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.

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 including faster cloud deployments, driving optimized performance today and a forward-looking foundational path for success tomorrow.

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 in a global economy creates 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.

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.

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.

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.

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.

Enable the Connected Worker

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.

MES Digitization: Enabling 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

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.
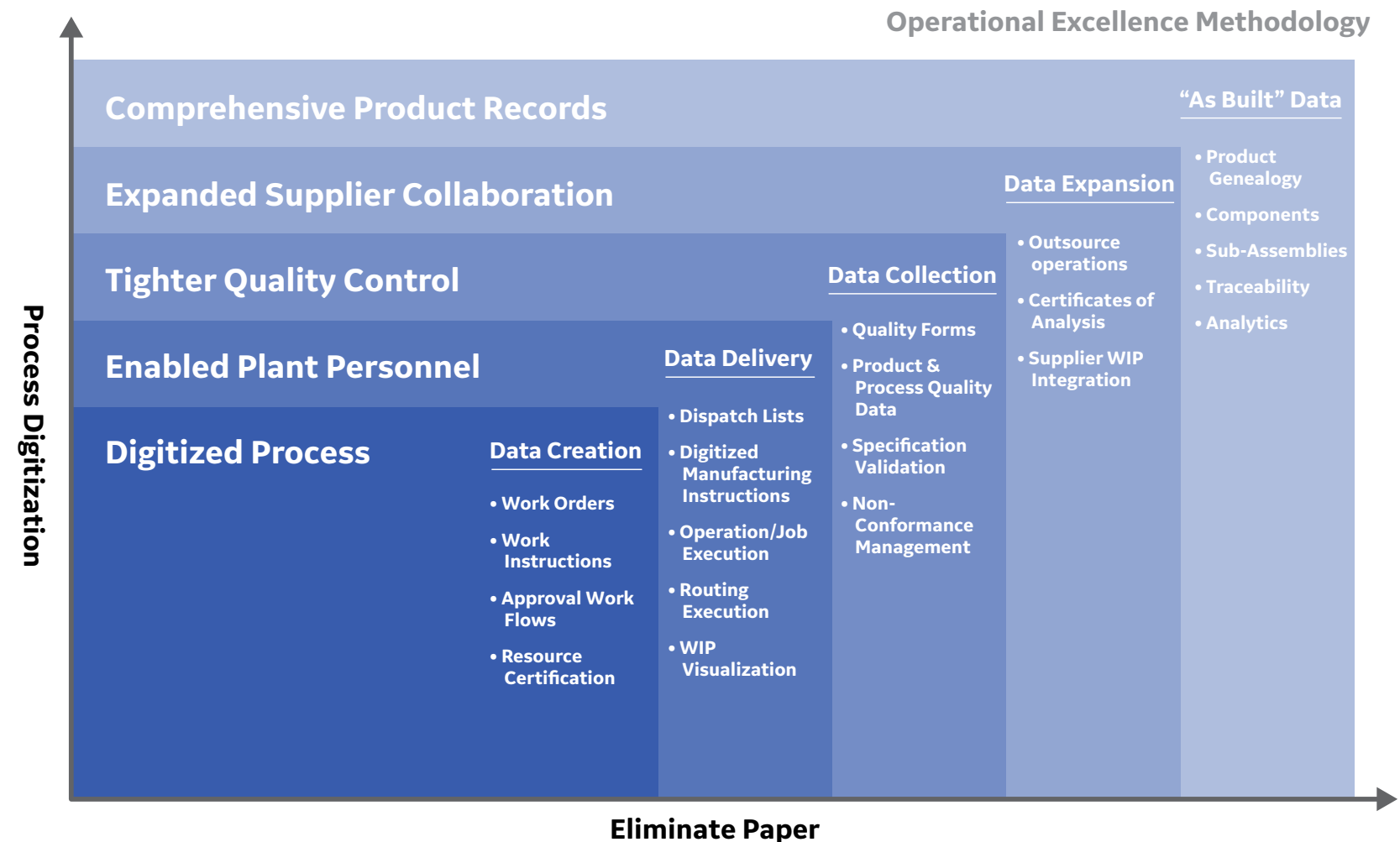
Comprehensive Product Records

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.

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.

**MES Digitization –
Complex Discrete Manufacturing**

Operational Excellence Methodology

Process Digitization ↑					
Comprehensive Product Records					**"As Built" Data**
Expanded Supplier Collaboration				**Data Expansion**	• Product Genealogy
Tighter Quality Control			**Data Collection**	• Outsource operations	• Components
			• Quality Forms	• Certificates of Analysis	• Sub-Assemblies
Enabled Plant Personnel		**Data Delivery**	• Product & Process Quality Data	• Supplier WIP Integration	• Traceability
		• Dispatch Lists			• Analytics
Digitized Process	**Data Creation**	• Digitized Manufacturing Instructions	• Specification Validation		
	• Work Orders	• Operation/Job Execution	• Non-Conformance Management		
	• Work Instructions	• Routing Execution			
	• Approval Work Flows	• WIP Visualization			
	• Resource Certification				

Eliminate Paper →

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.

Furthermore, the simple capability of providing real-time WIP visibility can reduce WIP inventory levels by approximately 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.

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

Produce Products Faster | Reduce WIP | Tighten Control on Quality | Streamline your Supply Chain | Reduce Warranty Costs

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 leap-frog 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.

Case Studies

GE Digital in Automotive: By the Numbers

40,000+ users in automotive

30+ years of partnering with OEMs and Tier suppliers

8 of the top global automotive OEMs rely on GE software

65% of cars manufactured in North America

99% build to sequence rates for 400,000 vehicles per year at just one site

100+ facilities' data silos eliminated at one global automotive OEM

0 unplanned downtime in 3 years

70% reduction in maintenance training

38% increase in engine production

2–6% increase in equipment availability

10–15% increase in productivity

Outcomes

Experience the future of automotive manufacturing

The automotive industry is facing unprecedented levels of uncertainty. You are challenged to grow profits, increase market share, and build customer loyalty in the face of slowing demand and while investing in new technologies like electrification and autonomous vehicles. GE Digital, with decades of partnering with automotive OEMs and Tier suppliers, can help with digital transformation based on IoT innovation, expert domain knowledge, and proven automation, MES, historian, and analytics software.

Accelerate Beyond Automotive Challenges
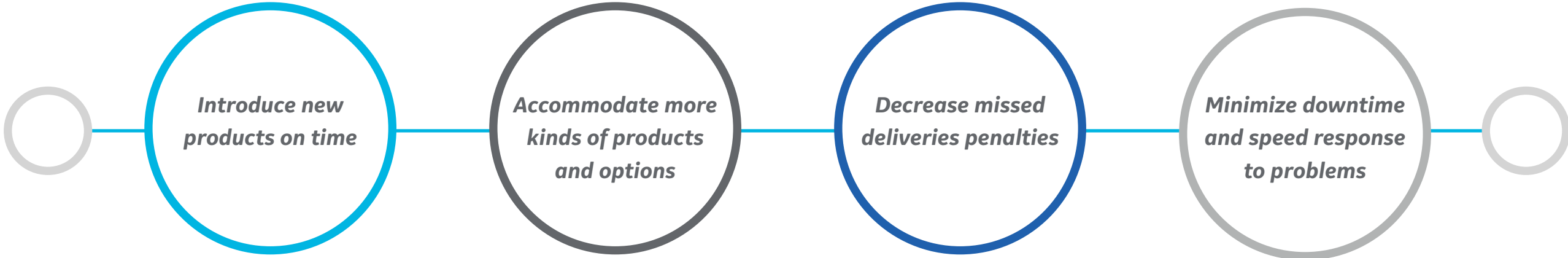
Reduce unplanned downtime

Tracking the performance and health of equipment optimizes maintenance, in turn, making these assets more reliable and available for use. By keeping equipment and production lines up and running, auto manufacturers will see better end production and reliability.

Improve efficiency

With uncertain growth expected across the automotive industry, manufacturers need to focus on efficiency and automation. By breaking down information and data silos, automotive manufacturers can tap into previously unused or underutilized data, speed operations, and produce vehicles and parts faster and with greater precision.

Optimize production and quality

With a lack of real-time information—from the plant floor to C-suite—it can be difficult to see critical information in time to accommodate market shifts or customer demands. By implementing effective digital industrial applications, personnel can gain deep visibility in complex work processes—enabling more data-driven insights, tighter control of production quality, staffing, and predictive maintenance scheduling.

Introduce new products on time

Accommodate more kinds of products and options

Decrease missed deliveries penalties

Minimize downtime and speed response to problems

Chery Jaguar Land Rover Brings Global Expertise to the Factory Floor

Zero
Downtime in 3 years

100,000
Integration points

500
Machines

Introduction

Company

Chery Jaguar Land Rover (CJLR)

Products

CIMPLICITY HMI/SCADA

Tracker

Proficy Plant Applications

Proficy Historian

Proficy Webspace

GE Digital's Professional Services

Established in November 2012, Chery Jaguar Land Rover Automotive Co., Ltd. (CJLR) is a 50:50 independent joint venture formed between Chinese auto manufacturer Chery Automobile Co., Ltd. and UK auto manufacturer Jaguar Land Rover. With a factory in Changshu, China, CJLR produces 130,000 high-end luxury vehicles per year.

Jaguar E-PACE, Jaguar XFL, and Jaguar XEL.

Challenge

CJLR was looking to reduce time to market while improving production and efficiency, bringing additional value to their customers. To do this, they wanted to run their manufacturing plant with zero losses or downtime and use the latest in Industrial IoT technology.

Solution

The company uses GE Digital's Proficy MES in their engine manufacturing facility in Changshu, connecting more than 100,000 integration points on a real time basis across 500 machines on the shop floor.

"GE has a very mature product in the MES. And also, GE's leading innovation space in the IIoT space. So we felt that as our partner, [GE] give us the technology foundation to achieve our business goals."

— Larry Shen - IT Senior Director, Chery Jaguar Land Rover

The Changshu power train plant is fully automated. GE Digital's MES provides real-time production data from the manufacturing floor, helping managers, operators, and machines make the right decisions at the right time. Assembly managers also use the data to benchmark the Changshu plant and an engine plant in the UK.

"With MES I can see OEE, FTT and real time production monitor and control. Also, MES gives me the consistent data I need to measure the entire production line."

— **Larry Shen - IT Senior Director, Chery Jaguar Land Rover**

By integrating the Microsoft Holo-lens 'Mixed Reality' headsets with GE Digital's Manufacturing Execution Systems suite, CJLR frees up employees' hands, reducing operational steps, and effectively improving production takt time.

Result

Innovation is key to help Chery Jaguar Land Rover overcome the technology disruptor coming out of the automotive industry and drive values to the business. Using GE Digital's MES and Holo-Lens mixed reality has helped them not only reduce time to market and reduce costs for launch, but also helped improve the efficiency and repeatability of training new employees.

"This year is the third year that we had GE Digital MES in place for our engine facility and so far we had zero downtime."

— **Larry Shen - IT Senior Director, Chery Jaguar Land Rover**
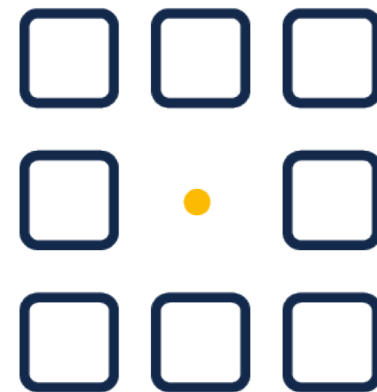
Volvo Car Engine: Our MES Journey – Building for the Future

- *Zero Quality problems*
- *No downtime*
- *Global standardization*

Summary

Company

Volvo Car Engine

Production Plants

- Skövde, Sweden
- Zhangjiakou, China

Products

- Proficy Plant Applications
- CIMPLICITY
- Proficy Workflow
- Proficy Webspace

Building for the future was the intent when Volvo Car Engine started the development of a new MES, built on GE Digital Proficy solutions, for the new engine plant in China.

Learning from the first experiences, the solution and the way of working were developed, and the software was then deployed in the Swedish Engine plant. Shortly after, the improvements were rolled back to the China plant and deployed with zero production downtime.

Learn more about how the business targets, teamwork and involvement from the shop floor played important roles on the way to a global solution and how Volvo Car Engine looks upon the future.

Note: Volvo Car Engine worked with the GE Digital Professional Services team for a solution that includes: Proficy Plant Applications, CIMPLICITY HMI/SCADA, Proficy Historian, Proficy Workflow, and Proficy Webspace

About the speaker:
Oscar Svensson, Global Program Manager for MES Solutions, Volvo Car Engine

Oscar Svensson is the global program manager for the MES solutions at Volvo Car Engine. With plants operating in China and Sweden, one of the responsibilities is to drive standardization and common solutions as well as supplying a platform for quality assurance, data collection and traceability. With a background in logistics, Oscar has been a part of the MES Journey within Volvo Cars Engine since 2016. He holds a diploma in economics and logistics from the University of Gothenburg.

SAGW Reduces Inspection Costs by 40% using Proficy and Process Digital Twins

20%

Improvement in equipment utilization

40%

Reduction in Inspection costs

30%

Reduction in inventory

80%

Reduction in required storage space

Introduction

Company

SAGW

Products

- CIMPLICITY HMI/SCADA
- Tracker
- Proficy Plant Applications
- GE Digital's Professional Services

Summary

SAGW has transformed their manufacturing processes by using GE Digital's Proficy Plant Applications to create a "Process Digital Twin" improving equipment utilization by 20% and reducing inspection costs by 40%. The availability of real-time data has led to a 30% reduction in inventory and an 80% reduction in required storage space.

Challenge

China's SAGW (Shanghai Automobile Gear Works) is a subsidiary of state-owned SAIC Motor Corporation. The company manufactures, markets, and exports automotive transmissions and key components for passenger and commercial vehicles. With 7000 employees across 5 heating treatment lines, SAGW produces more than 3.8 million units annually.

Like many companies in the automotive industry, SAGW has used GE Digital's CIMPLICITY HMI/SCADA and Tracker for plant-wide connectivity, visualization, and control for years.

However, SAGW's production was encumbered by several manual processes that were leading to long, cost-prohibitive has lead-times, production disruptions and a lack of actionable data. Several steps of production depended on manual inputs from operators, which led to inconsistencies of output and quality control challenges. Destructive inspections, where operators must sacrifice valuable materials on the product line, took six hours to complete, leading to product waste and costly downtimes.

Paper-based processes made extrapolating meaningful and accurate data difficult. Storage facilities were overloaded with inventory and there was a general lack of shared information between manufacturing and warehousing.

Solution

Data Models Optimize Multiple, Fast-Moving Processes

The software creates a "process digital twin" that helps SAGW operators to operate, analyze and optimize their production processes. Taking digital transformation to the next level, SAGW implemented Proficy Plant Applications. Part of the GE Digital Proficy Manufacturing Execution Systems (MES) suite, Proficy Plant Applications helps process manufacturers manage highly automated, fast-moving processes.

By creating data models of five production lines, the SAGW team was able to use a simulation solution to optimize the work order list to help reduce lead-time for daily production. An operation sciences team used machine learning and big data analysis solution to build a quality prediction model to speed production and reduce costs. And the real-time sensor data collected to GE Digital's MES helped clean up previously cluttered communication between SAGW's warehouse and production lines.

Results

Improve Equipment Utilization, Reduce Inspection Costs and Streamline Inventory Management

Since implementing Proficy Plant Applications, SAGW has documented a significant return on investment on key performance indicators, including a 20% improvement in equipment utilization, and a 40% reduction in inspection costs. In addition, the availability of real-time data has led to a 30% reduction in inventory and an 80% reduction in required storage/warehouse space. SAGW is using their success with Proficy Plant Applications to illustrate their smart factory digital journey and plans to expand to additional factories.

Ranked seventh in the global automotive market, SAIC Motor Corporation is the largest automotive company in China, with annual revenue exceeding 136 billion USD. SAIC and GE Digital have partnered to deliver Digital Transformation blueprints employed at the primary SAGW heating treatment plant in Shanghai.

Perodua Automotive

The Shop Floor Control System provided by GE Digital has been well received by the operators, supervisors, and management of Perodua for its ease of use and for the up-to-date, extensive production information they receive.

Keeping production on track

GE Digital gives automaker and suppliers real-time window into production status

To help improve the productivity of their manufacturing operation, the management of Perodua (Perusahaan Otomobil Kedua Sdn Bhd), Malaysia's second largest car manufacturer, decided to implement a method for "just-in-time" ordering of part supplies based on vehicle orders. The team envisioned a solution that would integrate distributor and supplier systems with Perodua's ERP system to access plant floor data in real-time. Distributors would be able to track the progress of their orders vehicle-by-vehicle, and vendors would have the ability to coordinate their part supplies to the facility on a just-in-time basis.

Perodua turned to GE Digital for assistance in making their vision a reality. Perodua Information Technology personnel were impressed with GE Digital's proven experience in implementing these types of solutions and felt confident that GE Digital would be able to create an automatic data collection and product tracking solution that would enable them to meet their productivity goals.

GE Digital teamed with local system integrator, Temigas Sdn Bhd in Malaysia, to implement a phased approach solution, the first of which is a Shop Floor Control System (SFCS) in Perodua's body, paint, and assembly shops. GE Digital did

most of the system design and implementation on-site with local systems integrators working closely with Perodua to ensure that the system met their requirements.

The specific objectives for the SFCS in improving Perodua's manufacturing operations are:

- Reducing work in process (WIP) inventory

- Identifying quality problems as quickly as possible

- Reducing rework time and volume

- Identifying production bottlenecks

- Reducing operator errors

To meet these objectives, the automation team created a reliable, state-of-the-art system based on CIMPLICITY industrial automation software with a Tracker module to satisfy the following key requirements:

- Track WIP

- Capture quality defect and rework information

- Automatically generate part-supply triggers from the production lines to logistics and other subassembly areas

- Generate production and quality-related reports on the fly

- Generate tax and delivery documentation automatically

- Automatically route bodies inside the paint shop through various processes

- Ensure data integrity of the vehicle production information

- Make all the above information readily available on the desktops of management to enable real-time decision making

The system architecture consists of two high-end servers The CIMPLICITY Tracker server implements the process logic, including WIP tracking, routing, and quality data capture. This server, which interlocks and serves data to all viewer nodes, is configured as the domain controller to which all shop floor computer nodes and PLCs are interfaced. The SFCS database, running on another server, contains such production information as schedules, model description, color code, tax ID generation, engine description, logged WIP data, quality defects, and much more.

The automation team created a reliable, state-of-the-art system based on CIMPLICITY industrial automation software with a Tracker module.

More than 30 GE Digital display stations, preloaded with CIMPLICITY software, are stationed in the body, assembly, and paint shop. The display stations are automatically updated with vehicle data as each new vehicle arrives at the station. Operators log defect data into the SFCS by clicking on the graphical image of the body parts shown on the display station screen.

Results

- Reduced work in process (WIP) inventory

- Faster identification of quality problems and production bottlenecks

- Decreased rework time and volume

- Fewer operator errors

To implement tracking, the shop floor is mapped into 120 regions, based on the process carried out at that region. Triggers for tracking in the body and assembly shops are received from 15 bar code readers located at key transition points. The bar code scanners are interfaced to PLCs. The PLCs are directly interfaced to the plant's Ethernet network and communicate with the Tracker server. In the paint shop, operators can determine the location of each vehicle by tracking the carriers (hangers and dollies) that carry the vehicle using Smarteye bar code readers and limit switch signals received from the paint shop conveyor system.

To receive vehicle tracking trigger signals from the paint shop and assembly shop conveyor systems, the CIMPLICITY Tracker Server interfaces with two PLCs via Ethernet. Tracker also sends the various interlock signals and routing control signals to these PLCs. Trigger sensors indicate the vehicle ID, time stamp of the entry of the vehicle into the region,

and time stamp of exit of the vehicle from the region. As the vehicle moves through each region, attributes such as chassis number, color, model type, customer information, defects, and engine number are also tracked. With this information, it is possible to determine in real-time how many vehicles are at a particular region, when each vehicle arrived at that region, or how long it spent in that region. Routing control is implemented at 13 locations in the paint shop. Using routing control, the SFCS automatically batches jobs based on model, color, and other parameters. Routing control also enables the SFCS to detect a defective body on the conveyor and routes it to rework areas.

Not only does the SFCS generate extensive reports based on current production status and historical data, it also continuously calculates the productivity of each shop based on the production status and line speed. CIMPLICITY viewer nodes are installed on the desktops of production engineers and management, enabling them to monitor and control production status in real-time and generate reports on-the fly.

After going live, the Shop Floor Control System was successfully integrated into Perodua's production system. The SFCS solution provided by GE Digital has been well received by the operators, supervisors, and management of Perodua for its ease of use and for the up-to-date, extensive production information they receive. As a mission-critical application for the plant, Perodua's SFCS is envisaged to eventually be fully integrated into their Computer Integrated Manufacturing (CIM) environment as the next phase of the project.

Introduction

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SAIC-GM

Shanghai Automotive Industry Corporation (SAIC) and GM — Designed for success

SAIC-GM Taps GE and CIMPLICITY to Drive Turnkey Automation Solution

When the Chinese government named the automotive industry a pillar industry for development, it seemed only natural that the Shanghai Automotive Industry Corporation (SAIC), China's largest passenger automobile manufacturer, and General Motors (GM), the world's largest full-line vehicle manufacturer, would team up to form SAIC-GM.

SAIC-GM's production facility in the Pudong area of Shanghai is a $1.5 billion, 5,920,200-square-foot (550,000-square-meter) plant that includes a press shop, body shop, paint shop, general assembly shop, and powertrain shop. Considered the largest and most innovative automobile complex in China, SAIC-GM primarily supplies China's businesses and government, producing Buick mid-size sedans, the Buick GL, wagons, and luxury compact sedans.

Before the first Buick rolled off the line, SAIC-GM selected the diversified services, technology and manufacturing company

— the General Electric Company — to unlock a $65 million turnkey communication and control and power distribution system, as well as provide process equipment and support, that would actively support GM's production practices. With GE's automation team in the driver's seat, GE Electrical Distribution & Control was soon riding shotgun, together

designing a state-of-the-art communication and control and power distribution system to operate within GE's overall communication plan.

For its part, GE's automation and MES team developed a $15 million communication and control system guided by its renowned CIMPLICITY, manufacturing enterprise-wide software and supported by Microsoft® Windows®, and Intel-based server and workstation computers. Four subsystems — the Process Monitoring & Control (PMC) system, the Target Control System (TCS), the Automatic Vehicle Identification (AVI) system, and the ANDON system — are connected by a GE provided network to monitor and control SAIC-GM's five shops. With thousands of machines and miles of conveyor systems, GE's turnkey automation solution effectively minimizes idle equipment and personnel, maximizes uptime and productivity, and operates seamlessly within the broader scope of the GE framework.

Results

- Maximum uptime and productivity
- Real-time data reporting
- Lower inventory and reduced material consumption
- Greater quality, less rework

Auto Assurance: SAIC-GM's Production Monitoring and Control System

Process Monitoring & Control (PMC) System

Working to maximize equipment uptime and process productivity, SAIC-GM's PMC system employs over 400 PLCs collecting data from 60,000 I/O points. CIMPLICITY HMI/SCADA software monitors production equipment conditions, generates and logs alarms, and communicates process status in rich graphic displays. The user-friendly but powerful CIMPLICITY software allows operators to generate nearly 4000 different reports and trending charts, including production counts, WIP totals, and process cycle times. Control functions are also provided by the system to allow authorized operators to start and stop production lines.

To support troubleshooting and repair efforts, CIMPLICITY quickly detects equipment and production problems, immediately notifies the appropriate maintenance team, production manager, or process support engineer, and provides diagnostic data for speedy repair efforts. Essential to a facility of this size, SAIC-GM's PMC system minimizes production downtime that can result from mechanical or production-related problems.
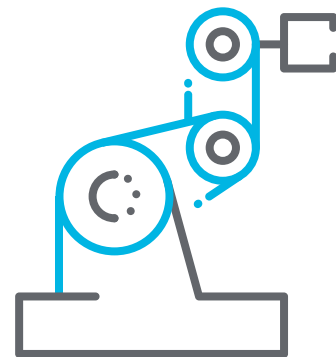
Target Control System (TCS)

SAIC-GM's TCS controls the movement of vehicle bodies into and out of the body distribution center using several modes of operation from fully automatic to fully manual. Like the PMC system, the TCS also employs CIMPLICITY software, but with the added feature of Tracker — a comprehensive CIMPLICITY option that provides tracking and routing control of the serialized vehicle bodies as they move through the production process.

With Tracker, SAIC-GM can dynamically collect and store a variety of vehicle body data, including process parameters, time stamps, and quality measurements. Operators can easily determine the location of a tracked vehicle body, display its data, and provide control commands to production equipment to process and route the body. Communication to

Automatic Vehicle Identification system and Conveyor controls is supported over the plant Ethernet network.

In addition to tracking vehicle bodies, CIMPLICITY determines where to store vehicle bodies arriving from the body shop, sequences vehicle bodies into the paint shop, decides where to store vehicle bodies returning from the paint shop, and again sequences vehicle bodies into general assembly. The TCS and similar routing control systems are used extensively in automotive facilities to efficiently and effectively control vehicle flow based on parameters such as production schedule, optimum color blocking, consistent load balancing, and material availability. For SAIC-GM, the TCS effectively optimizes production flow and productivity and, due to its efficiency, minimizes paint costs and reduces paint emissions.
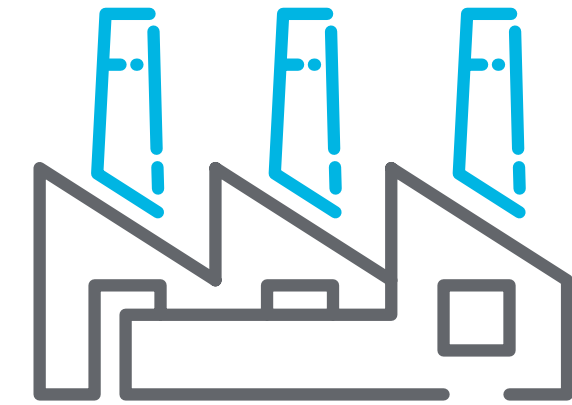
Automatic Vehicle Identification (AVI) System

The plant's Automatic Vehicle Identification (AVI) System identifies and tracks vehicles in the body shop, paint shop, and general assembly shop. Vehicles are identified by writing vehicle identification and configuration data to radio frequency (RF) tags mounted on each vehicle carrier. Vehicles are tracked by reading the vehicle data from the RF tags as they move through the production process.

There are two independent AVI systems; one is for the body shop and body distribution center (BDC), and the other is for the paint shop. The body shop/BDC system consists of one PLC networked with eight tag read/write stations located in the body shop, body distribution center and paint shop exit. Two of the stations in the body shop have automatic bar code scanners that read data from a label affixed to the body so that it can be uniquely identified by the AVI system when it enters the production stream. The paint shop AVI system also uses a PLC with 14 tag read/write stations. Each system controller interfaces with its own CIMPLICITY HMI-based operator station mounted adjacent to the associated system controller. The stations are available for system monitoring, maintenance, and supervisory control functions.

Each AVI system also communicates directly with the TCS and SGM's FLEX system via the network, reporting vehicle locations and vehicle data to both. The AVI system also receives data from the FLEX system for storage on the RF tags. This data is read from the tags by other systems and is used for controlling the production process.
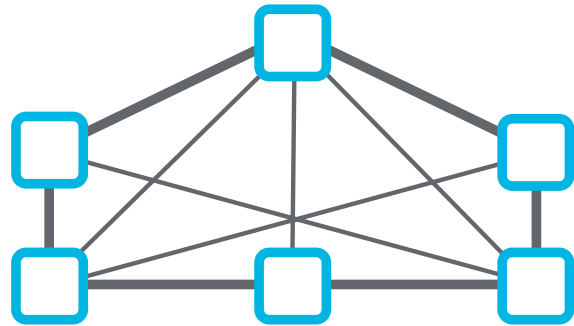
ANDON System

The Quality and Material ANDON System consists of two similar but separate subsystems. The Quality ANDON subsystem enables factory personnel to request help when a product or process quality problem is identified. Help is requested by pulling cords located along the production line. The action of pulling a cord sends a signal back to the operator interface, illuminating a section of a large display called an ANDON board that indicates where the problem exists along the production line. The Quality ANDON subsystem supports the synchronous manufacturing principles of producing quality products utilizing in-station repair rather than final process repair.

The Material ANDON subsystem allows each production area to automatically or manually request material before inventory is completely consumed. Factory personnel manually request more material by pressing a button. Material can also be requested automatically by sensors that detect a minimum inventory level. The manual or automatic request sends a signal back to the Material ANDON System, which displays the request in the material storage area. Fork truck drivers then deliver the requested material to the location, again supporting the synchronous manufacturing principles of just-in-time delivery.

Both the Quality and Material ANDON systems feature built-in tracking and reporting capability that compiles the number of ANDON calls, the number of line stops, and the resulting downtime. Problems are detected and resolved quickly and inventory is minimized. As with the PMC and TCS, the ANDON system avoids the high cost of idle equipment and people due to production problems and drastically reduces the opportunity for poor quality and rework.

Driving It Home

Fitting nicely into the framework of GE's master communication and control plan, GE's automation and MES team successfully integrated a comprehensive production monitoring and control system that will allow SAIC-GM to continue breaking new ground in auto manufacturing.
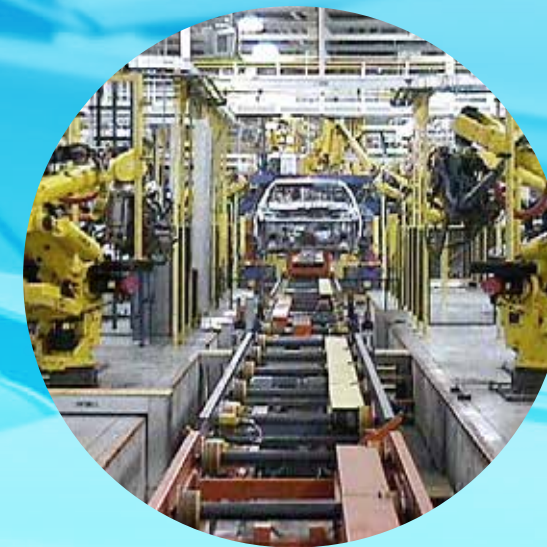
A Look Inside SAIC-GM

Press Shop

The 139,931-square-foot (13,000-square-meter) press shop features two 180-inch press lines with automatic pick-and-place panel transfer systems. Each line has five fully automated presses. SAIC-GM stamps 26 external metal parts at a rate of 500 parts per hour.

Body Shop

In the 265,868-square-foot (24,700-square-meter) body shop, heavy parts are lifted and moved by manipulators while 44 robots perform quality-sensitive tasks such as welding and sealing. The shop has agile tooling and a programmable design in the framing station that allows it to produce bodies for two completely different vehicles. An Electrified Monorail System (EMS) in the underbody sub-assembly and body side sub-assembly areas maximizes the flexibility of model mixing in the production schedule.

Paint Shop

The 548,958-square-foot (51,000-square-meter) paint shop is a state-of-the-art, environmentally friendly facility. Here, for the first time in China, provisions were made for the future use of waterborne primer and paint, which will effectively reduce exhaust emissions. Also for the first time in China, color-specific primer, which improves paint quality, is applied to all vehicles.

General Assembly Shop

The 452,084-square-foot (42,000-square-meter) general assembly shop features a unique T-shape layout pioneered by General Motors. A prerequisite for just-in-time production, the building shape offers three distinct advantages: docking

stations permitting line-side direct delivery of parts; a centralized nerve center; and options for future expansion without interrupting production. Three automated conveyor systems complete the efficient assembly process.

Powertrain Shop

The 409,028-square-foot (38,000-square-meter) powertrain shop manufactures five major engine components for 4 and 6-cylinder engines that are used on its engine assembly line. This state-of-the art engine assembly line can produce the mix of 4 and 6-cylinder engines required for the vehicles SGM-GM produces, as well as for other vehicle manufacturers in China. It also produces 5 major components for, and assembles, the first automatic transmission used on a production car built in China.
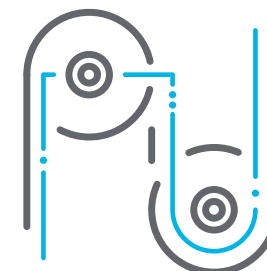
Jaguar Land Rover Improved Ability to Handle Complexity and Variability in Demand

Challenge: *Increase output to meet rapidly growing global demand. Develop robust MES to serve as the new standard across expanding network of global facilities.*

Action

- GE and its Professional Services team was chosen by the customer to build out the global blueprint for the MES system

- New MES was designed using CIMPLICITY and Tracker and deployed in a new production facility in Brazil. The MES was extended to a new site in the Middle East and 4 existing sites in the UK

Results

- 6 customer sites operating on new MES using CIMPLICITY and Tracker

- Increased total output and revenue

Subaru: Building the Fastest Growing Car Company in America

300%

Production volume increase over 12 years

24 day

Record turnaround time for Legacy model

98.6%

Trim Shop uptime

8 years

Uptime & quality increased YoY for 8 years
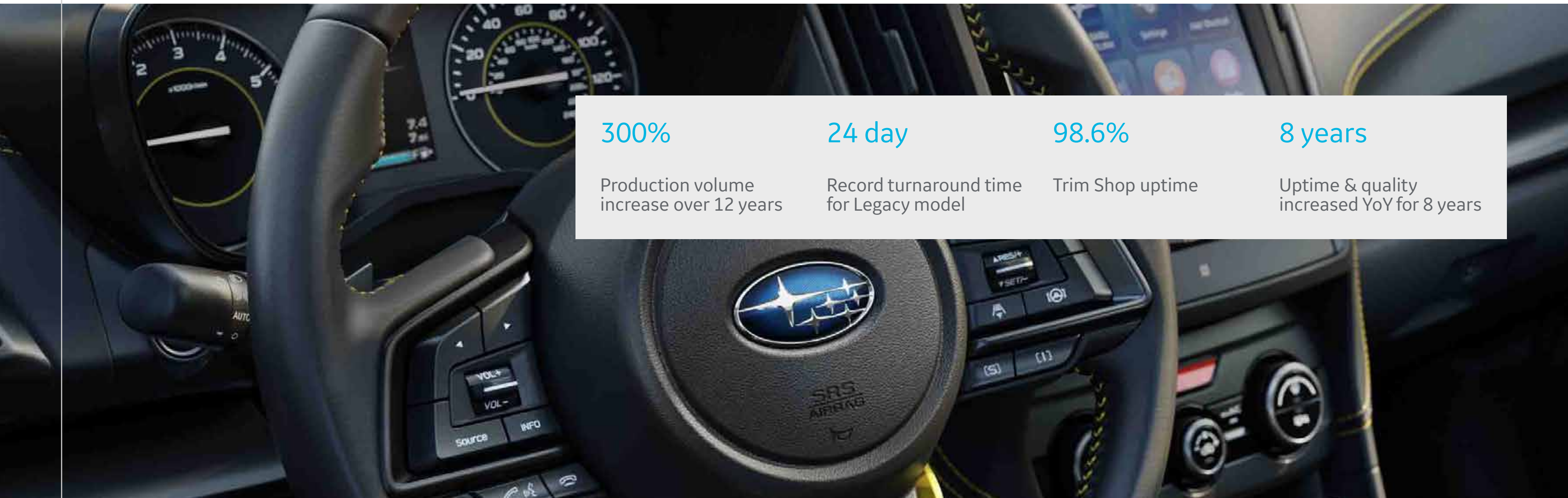
Introduction

Company

Subaru of Indiana Automotive, Inc.

Products

- iFIX
- Proficy Historian
- Proficy Plant Applications
- Proficy Operations Hub
- Asset Performance Management

At Subaru, the fastest growing car company in America, uptime is critical! Discover how Subaru meets the challenges of:

- Growing demand that drives significant volume
- Quality at the heart of what Subaru does
- Flexibility and adaptability for customers

Transforming automotive manufacturing

How is the world's fastest growing automaker embracing change? By leveraging digital industrial applications, Subaru is not only increasing its production to meet customer demand—it's doing it in record time.

Subaru of Indiana Automotive, Inc. (SIA), sits on 820 acres of land in Lafayette, Indiana. The 3 million+ square foot plant manufacturers four models for Subaru: Ascent, Outback, Legacy, and Impreza. In recent years, SIA produced around 342,000 cars per year. To put that into perspective, they typically roll a new car off the production line every minute. That's a lot of cars! And, with almost 17 miles of conveyor—there are literally a lot of moving parts to keep functioning properly.

Aiming for zero unplanned downtime

With this size facility and production and quality demands always increasing, the company knew it needed better visibility into real-time data in order to work toward its goal of zero unplanned downtime.

For the last 10+ years, Subaru has utilized iFIX HMI/SCADA and Proficy Historian from GE Digital in its manufacturing process to improve uptime, increase use of real-time data, leverage predictive analytics, and monitor quality. Without these industrial applications, the company says it would not be able to run at the production rates it currently does.

Take its paint shop, with 1,400 motors pushing cars around the facility—the team can now see how each motor is operating and identify issues quickly (and often remotely), which has drastically increased efficiency.

Experiencing record breaking turnaround times

Subaru is also making better use of historical data captured in the software. If a car produced 6 months ago has an issue, the team can now go back and look at that specific car to see how it was assembled and if there is any room for improvements and adjustments in the manufacturing process. This ensures new vehicles won't have the same

issues. Previously, this is the type of data that would have been near impossible to leverage, due to the production volume at the facility.

In fact, GE Digital's industrial applications are helping Subaru meet production and quality targets like never before—and delivering industry-record turnaround times between customer orders and delivery for the Subaru Legacy model— in just 24 days.

Beyond SCADA

Proficy Historian and Proficy Plant Applications

In addition to a foundation of iFIX, learn how Subaru leverages Proficy Historian for trending and analysis, and Proficy Plant Applications to identify issue events that may impact production – driving additional productivity gains.

Reducing Downtime

Putting data to work with Proficy Operations Hub

Subaru has a lot of collected data. With Proficy Operations Hub, the team will use the data better to help reduce production interruptions (downtime). Proficy Operations Hub will help Subaru:

- Identify what might become a quality issue before it does

- Achieve a centralized development tool

- Have a tool to help the team collaborate with all areas of the plant

- Provide tools to management to make educated decisions on real-time data and historical issues the team may have had to deal with

APM in the Trim Shop

Subaru's goals related to Asset Performance Management are:

- Identify problems with equipment and be more proactive in maintenance

- Get a better understanding of the equipment's life cycle

- Improve overall uptime with different equipment

About the Speaker

Trent Lester, Group Leader for Integration of Production Control Systems, Subaru of Indiana Automotive, Inc.

Trent Lester is the Group Leader for Integration of Production Control Systems at Subaru of Indiana Automotive, Incorporated in Lafayette, Indiana. In his current role, Trent is responsible for oversight and management of numerous computer systems that facilitate, monitor and track production in an entirely virtualized environment. The Lafayette-based plant is responsible for producing five Subaru models including: the Legacy, the Outback, the 4- and 5-door Impreza and the 7-8 passenger Ascent. The principal focus of Production Control Systems is automation, data collection and machine controls through the GE Digital software suite. His more than 20 years of experience at Subaru extends beyond IT as he has worked in the production environment in many different capacities. Trent was born and raised in Lafayette, Indiana, where he resides today with his wife and three children, ages: 14, 17 and 20.

See what's next for Subaru – including Proficy Operations Hub to further deliver on key outcomes and support growth.

Global Automotive OEM Eliminates Data Silos Across 100+ Facilities

Challenges

- Unable to consolidate data from 100+ facilities under a single umbrella

- Need to optimize and continuously improve operations across all facilities worldwide

Action

- GE and the customer extended a 30-year partnership that includes CIMPLICITY HMI/SCADA, Tracker, Proficy Historian, Professional Services, and more

- The customer gained access to products not previously in its portfolio to consolidate and manage data

- Access to full GE Digital manufacturing software suite was extended to all customer facilities
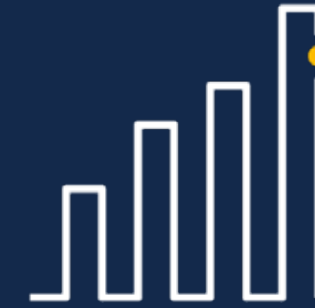
Results

- Consolidated process data under manufacturing umbrella

- Extended partnership with GE Premium Support to ensure optimal operational efficiency

- Achieved critical foundation for analysis and analytics

- Improved decision making with better information

- Increased efficiency with data and analysis

MES Solutions from GE Digital

Proficy Smart Factory

Reach manufacturing excellence through on-premise and cloud-based MES, leveraging IoT insights and intelligence

Becoming a digital industrial manufacturing company

You're tasked with meeting production targets while keeping costs and risk under control. It's up to you to find the capacity needed to produce what the market wants, when it wants it, and at increasingly higher quality—even when it means quickly changing lines and entire facilities over to new products.

Products can be conceived, developed, and sold over the Internet in a matter of weeks or days, meaning your organization is probably already competing on your ability to manufacture to order.

You currently rely on the expertise of your people to achieve production targets. But long-term attrition of operational "know-how" as your people with intimate equipment knowledge exit the workforce is inevitable.

You have automated select activities, primarily by purchasing point-product solutions. But production data is all too often gathered manually and isolated in siloed systems and different formats. As a result, you may lack the comprehensive visibility into equipment, people, processes, and materials that would afford you the flexibility to make the goods people want to buy today.

Business challenges

- **It's difficult to start and stay ahead** when no two facilities are the same, and you lack a common system for gathering and analyzing data

- **Your current systems don't provide the visibility you need to take the right actions** when separate systems for inventory, production, downtime, and quality all relay data manually, slowing the process and introducing the potential for human errors

- **Your plants can't keep pace with customer demands** without advanced warning of changing preferences derived from sophisticated analysis of all available data and agility to leverage those insights

What if you could…

- Use the data your equipment is already generating to monitor production, predict order performance, detect downtime, capture waste, and more then automatically aggregate and summarize this data for powerful digital intelligence in real time?

- Get value fast by using out-of-the-box mobile operator screens and extend or customize them to meet the needs of your people and facility?

- Use this foundation to immediately begin delivering actionable insights to the right people at the right time—giving your people all the information they need to quickly optimize production?

- Use these digital industrial applications to adapt facilities with the agility to continuously change to meet customer demands?

Delivering the Smart Factory

Proficy Smart Factory is a solution suite that seamlessly spans on-premise and cloud-based MES capabilities. Transform your manufacturing business through insights and intelligence powered by data integration, the Industrial Internet of Things (IIoT), machine learning, and predictive analytics. By bringing together the digital world with the physical world of manufacturing, Proficy Smart Factory can deliver holistic performance management for today's connected enterprise.

Proficy Smart Factory provides the no-code / low-code tools to successfully transition to a digitally driven model:

- Track data across plants, equipment, materials, and people

- Specify metrics to track across all your equipment

- Use intuitive browser-based, out-of-the-box screens as a digital cockpit for fast time to value

- Create custom views within role-specific dashboards

- Create the necessary visibility to quickly generate a new bill of materials, reroute components, change equipment schedules, and re-assign employees appropriately

- Monitor production and catch deviations and make adjustments to avoid wasted materials

- Predict overruns and shortfalls before they happen then reschedule your orders to optimize based on material, equipment and personnel availability

- Understand your operations better with traceability across the entire scope of the production process

- Leverage innovation best practices

- Achieve 30% lower Total Cost of Ownership (TCO) through cloud capabilities

Learn more about the benefits and outcomes you can realize with Proficy Smart Factory.

FIND OUT MORE
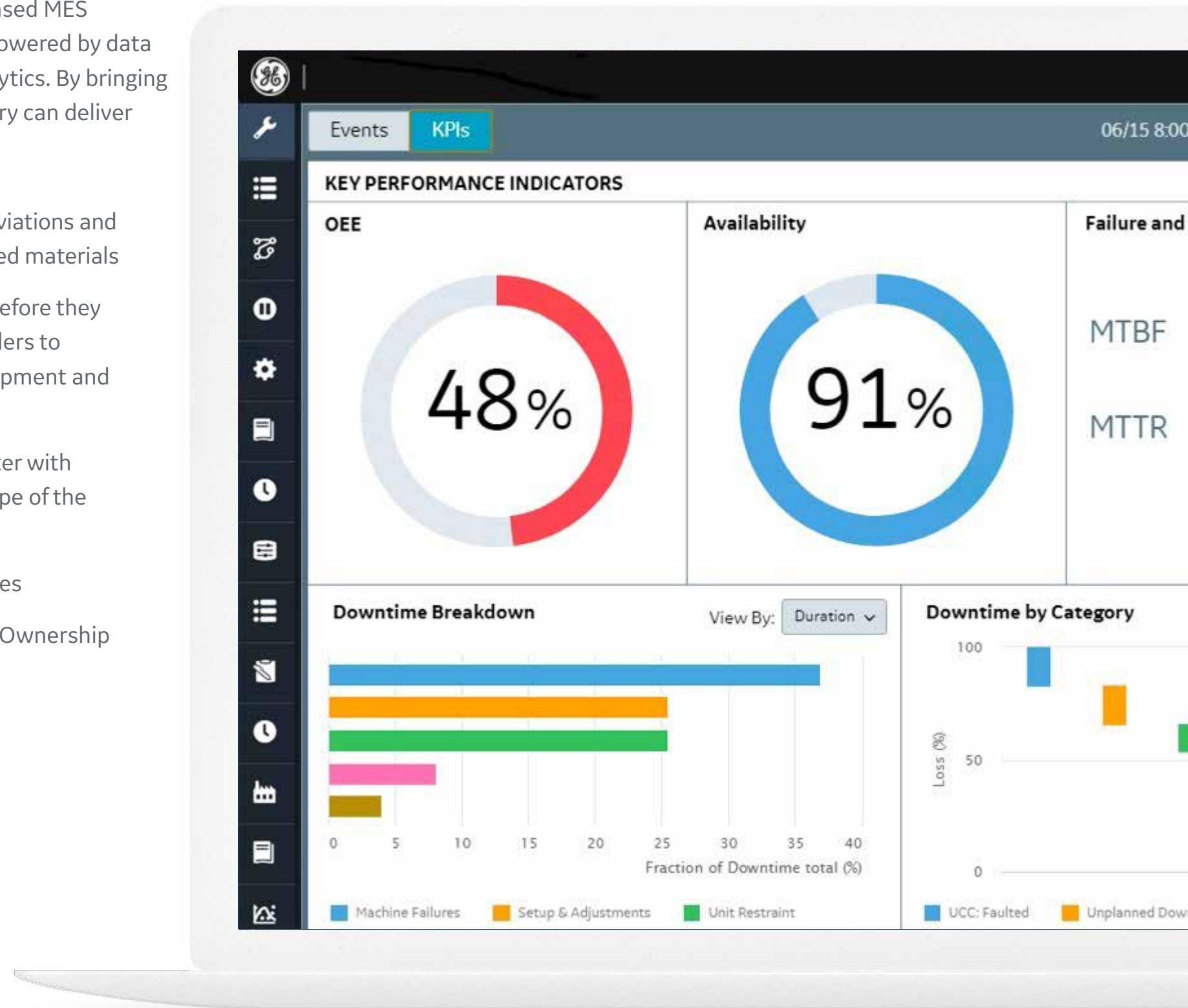
Unlock unprecedented efficiency and manufacturing optimization

Reduce costs

By aligning resources, energy, and efficiency management your manufacturing operations can reduce inventory, identify costly production gaps, lower energy and utility waste, and gain insight into throughput and critical processes.
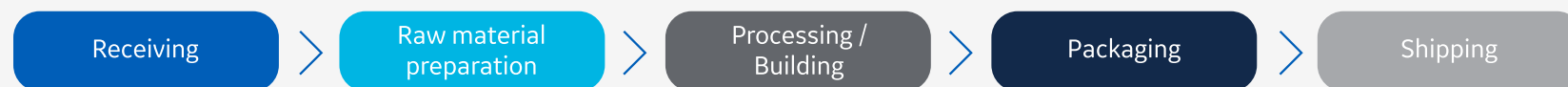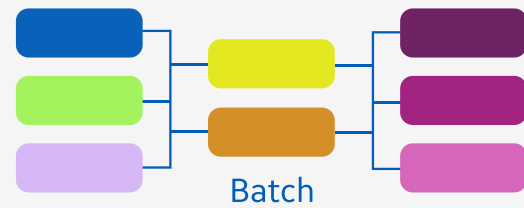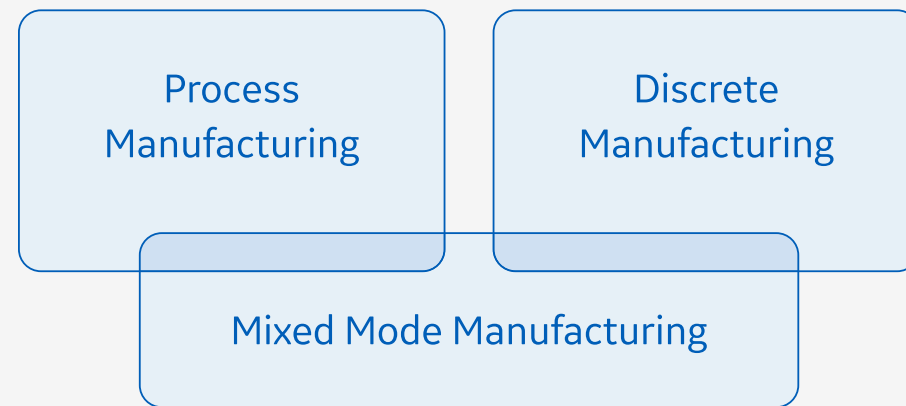
Improve quality

Capture robust quality data and related traceability information while, at the same time, performing analysis on process-oriented data and product-oriented data, and classifying materials as non-conforming, out-of-spec, or related to recalls.

Speed production

Improve on-time delivery performance and respond optimally and with agility to late stage changes, gain up-to-date visibility of all work-in-progress orders, get more successful new product instructions (NPIs), and shorten design-to-delivery cycles.
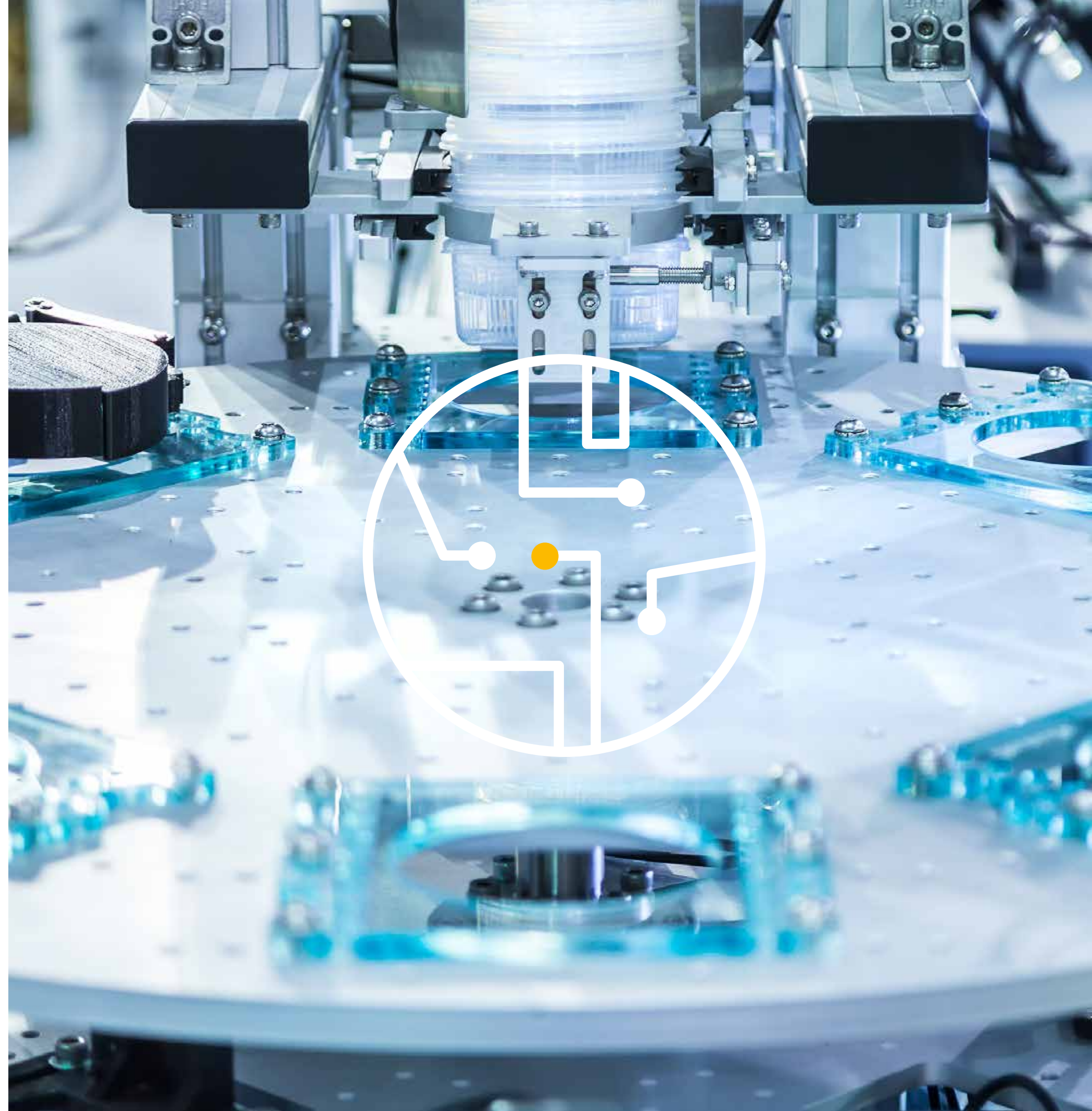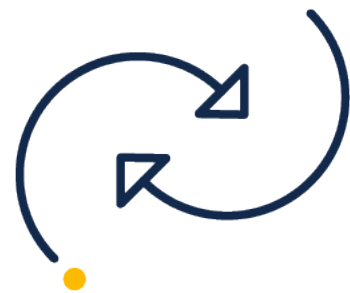
Reduce costs and increase visibility with one seamless MES for all types of manufacturing

Process Manufacturing

Discrete Manufacturing

Mixed Mode Manufacturing

Batch

Receiving → Raw material preparation → Processing / Building → Packaging → Shipping

Gartner Peer Review Insights – Last 12 months*:
100% would recommend GE Digital

Gartner Peer Insights reviews are unedited independent comments form our customers about their experience with our MES.

We appreciate the overwhelming response from our customers and invite you to read their reviews as you explore the right solution for your organizations.

*As of brochure time of publication (October 2022)

GE Digital Receives Top Scores in Gartner MES Reports

Gartner Magic Quadrant for Manufacturing Execution Systems Report and Critical Capabilities Report

We're a
LEADER
2022 Gartner®
Magic Quadrant™

When it comes to MES Critical Capabilities and MES Use Cases, GE Digital has scored at the top.

#1 in the following MES Critical Capabilities:

- In-Process Quality Management

- Data Management/Data Collection

- Production Equipment Integration

At GE Digital, we're proud to offer our leading MES solution and help our customers around the world.

Align your manufacturing requirements with the critical capabilities from GE Digital that you need in your business.

Gartner.

1st of 19 Vendors | 4.06/5.00
Continuous Process Manufacturing Use Case

2nd of 19 Vendors | 3.98/5.00
Complex Discrete Manufacturing Use Case

2nd of 19 Vendors | 4.00/5.00
Batch / Repetitive Flow Manufacturing Use Case

2nd of 19 Vendors | 4.08/5.00
Highly Regulated Industries Use Case

Source: Gartner (May 2022)   © Gartner, Inc

Critical Capabilities Report

Magic Quadrant Report

The World's Single MES for Your Entire Enterprise

Drive results with one MES for Process, Discrete, and Mixed Manufacturing

Proficy Smart Factory is a powerful operations management solution for process, discrete, and mixed manufacturing environment manufacturers that collects and analyzes data and helps manage highly automated fast-moving processes as well as slower moving, labor-intensive jobs. It automates and integrates the information related to activities for managing production execution and optimizing performance holistically, helping to balance the trade-offs between competing priorities of production operations.

Proficy Smart Factory allows you to:

Increase efficiency with customization

With a completely browser based and mobile ready UX, Proficy Smart Factory offers both operators and supervisors a personalized, modern user experience.

Reduce rework

With increased visibility into data and quality, you can reduce rework and the risk of errors, while staying current on recall information.

Turn data into value

Gain enterprise-wide visibility into your data to improve analysis and compliance, while at the same time reducing IT costs and footprint. Additionally, Proficy Smart Factory's out-of-the-box persona based UIs run in our no-code rapid application development environment called Proficy Operations Hub so you can easily extend standard visualizations with your own to meet your needs.
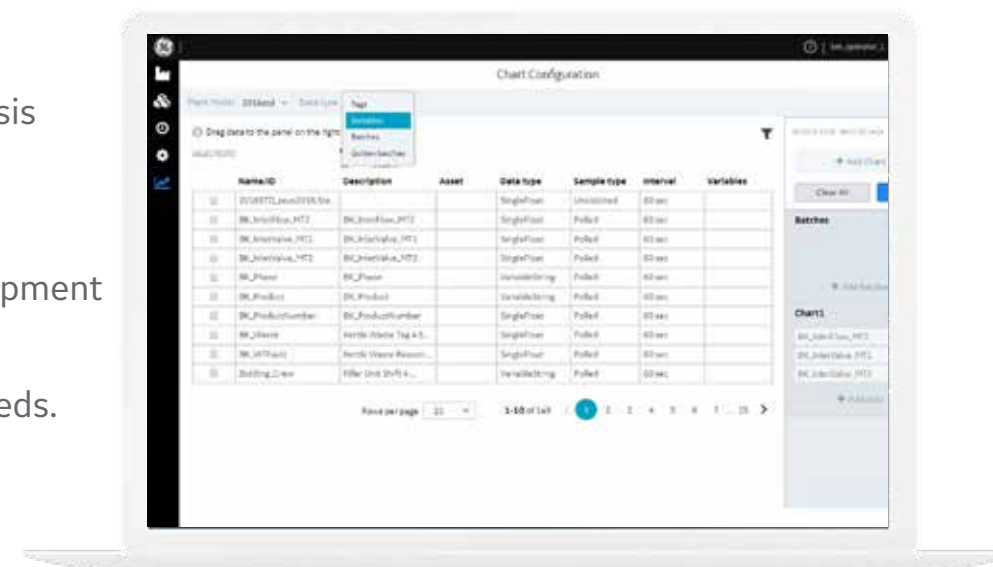
Proficy's MES Capabilities

- Efficiency Management

- Quality Management

- Production Management
  (Non Serialized and Serialized)

- Batch and Process Analysis

- Manufacturing Product Data Management

- Scheduling

- Digital Operations: Centralized,
  Remote and Mobile

- Hybrid Cloud Industrial Data Management
  for Analysis and Reporting

- Industrial Advanced Analytics

- Dynamic, Interactive Work
  Process Management

Efficiency Management: On-Prem & Cloud

With Proficy Smart Factory, you can better utilize plant assets by leveraging a comprehensive view of Overall Equipment Effectiveness (OEE).

Proficy Smart Factory tracks and monitors OEE and other critical key performance indicators such as downtime, waste, and production counts, MTBF, MTTR, and more, all by reading signals directly from the equipment or, if not available, via manual inputs.

Our proven efficiency management capabilities provide drill-down functionality, making it ideal for managers trying to increase production throughput without adding equipment, people, or material costs. Manufacturers can correlate events and reasons to actual production parameters in context of shift, crew, order or any other event that makes sense for your facility. Standard and ad-hoc reports and dashboards improve real-time decisions, supporting Lean and other continuous improvement programs.

Proficy Smart Factory allows you to:

Identify and improve areas that are causing operational inefficiencies
Use Proficy Smart Factory to detect and minimize scheduled and unscheduled downtime events, reduce waste and rework, and improve machine run-time effectiveness.

Perform root cause analyses to make data-driven decisions
Gain insight into production operations by shift, equipment and products. Proficy Smart Factory helps you evaluate operations over any period of time— from real-time to annual summaries. Furthermore, link capital expenditures to expected plant profitability improvements.

Manage production operations in real-time through comprehensive reporting
Track uptime, downtime and overall plant and machine efficiencies through web-based KPIs. You can schedule reports for all decision-makers – from operators to plant managers. Get notified on exceptions to desired operations to make real-time changes.
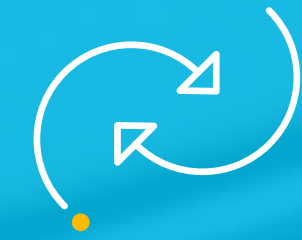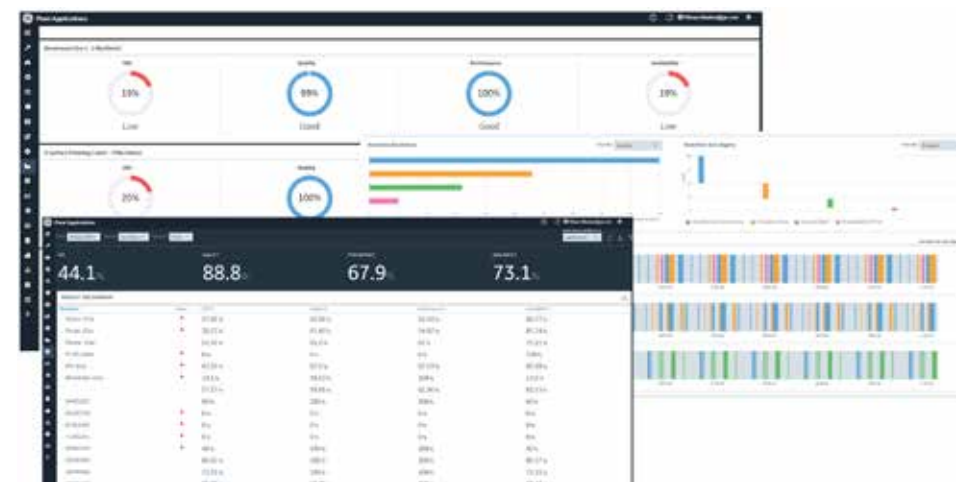
Increase Your OEE with Proficy MES

- Critical KPIs: OEE, downtime, waste, production counts, and more

- Exceptional connectivity: connects to various historians to capture equipment signals to detect data related to downtime, quality and production

- Root cause analysis by automatically or manually associating events with causes

- Ad-hoc reports and dashboards for real-time decision-making

- Ability to summarize and analyze data by context

Quality Management: On-Prem & Cloud

Proficy Smart Factory ensures consistent and integrated quality control, delivering capabilities that GE developed in partnership with the world's largest manufacturers to support their best practices to reduce variability and ease compliance.

GE Digital helps you increase product quality by lowering waste, scrap and product recall costs. Consistent product quality improves all aspects of production operations and customer satisfaction, dramatically improving plant performance and profitability. Proficy Smart Factory is an ideal solution for manufacturers launching Lean, Right First Time, Six Sigma and other process improvement initiatives.

Proficy Smart Factory allows you to:

Increase product and process quality and consistency

Proficy Smart Factory ensures consistent quality in your products, helping you define the product specifications and recipes required for quality production and providing real-time trends, statistics, SPC, and notifications to control quality levels. Our solution integrates process, inspection, and test data from both manual and automated sources and houses this information in one, integrated place – including support for 21 CFR Part 11. Additionally, you can attach operator comments including videos and pictures you can annotate directly on your mobile device, specifications, recipes, and procedure documents to this information.

Lower costs of production by reducing waste and rejects

Capture reasons for out-of-spec conditions to resolve quality issues faster. With Proficy Smart Factory, you can reduce rejects and downgrades, decrease customer complaints and returns, and speed compliance with ISO, 21 CFR Part 11 and other requirements.

Maintain consistent, high quality production through real-time monitoring and visibility

Create ad-hoc quality reports to research quality issues based on performance improvement and proven methodologies. Calculate quality KPIs and publish them to the web – and notify and alert personnel to out-of-spec conditions for the fastest resolution. Identify your "golden batch" and compare it to the current running orders to quickly identify deviations.
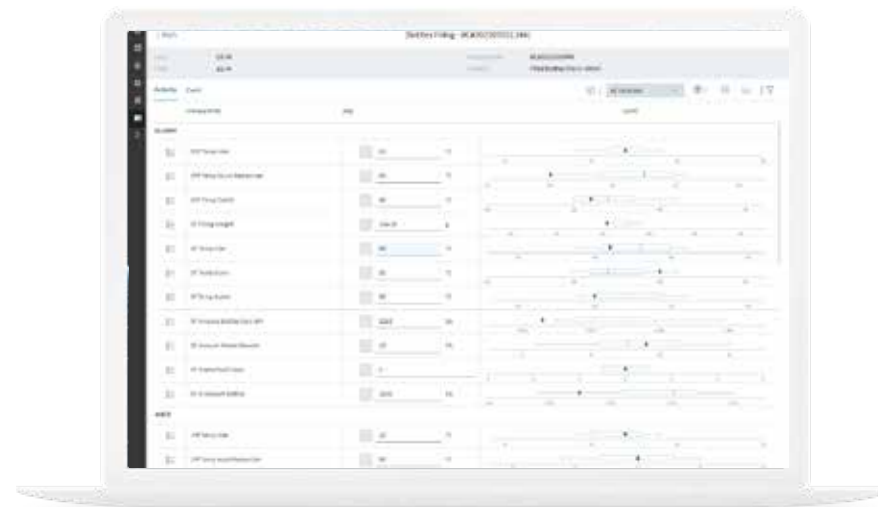
Improve Consistency and Ease Compliance

- Real-time trends, statistics, SPC and notifications to control quality without slowing manufacturing speed

- Integrated process, inspection, and test data from both manual and automated sources

- Related information stored, including operators' comments, specifications, recipes and procedure documents – supporting 21 CFR Part 11 and eSignature

- Define the product specifications and recipes that are required for quality production

- Capture reasons for out-of-spec conditions

- Integrate process and laboratory data

- Trend and analyze quality data across shifts, work cells and products to identify root cause in problem areas

- Integrate log-sheet information for real-time performance and quality management

- Improve consistency, drive out variability with simple SPC/SQC

Non-Serialized and Serialized Production Management: On-Prem & Cloud

Proficy Smart Factory manages both non-serialized and serialized production operations by providing insight into how products actually flow through the plant, developing product genealogy reports and making scheduling changes to reduce excess inventory.

Meeting the needs of diverse production management, Proficy Smart Factory oversees production operations, supporting production schedule execution and product tracking against scheduled completion times with adjustments to optimize efficiencies. Our solution supports full traceability of individual products through every step of the manufacturing process allowing for auditable genealogy and production reporting.

Proficy Smart Factory allows you to:

Improve operational efficiency by gaining knowledge and control over real-time production operations
With Proficy Smart Factory, you can reduce inventory costs, control the flow of product between equipment, manage and report on in-process inventories, and integrate quality and production tracking to improve the accuracy of schedule execution.

Generate more revenue by meeting customer demands and government regulations through product genealogy reports

Track products and materials through their entire production lifecycle, quickly develop Certificate of Analysis (COA) reports, limit the scope of recalls and quarantines, and provide faster response to customer issues.

Enable Lean and continuous improvement
Improve performance with capabilities designed to solve the toughest manufacturing challenges and drive continuous improvement – while leveraging GE's renowned expertise in Lean, as one of the largest manufacturers in the world, and our work with other top manufacturers.
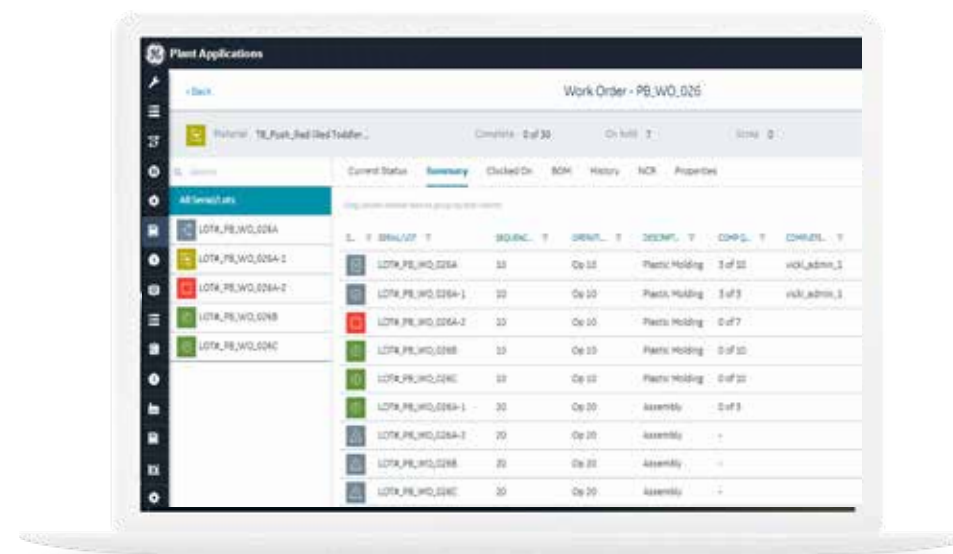

Optimized Production Operations

- Track order completion status

- Production tolerances on non-serialized material and default record quantity

- Manage material delivery to the process

- Track true/actual resource consumption and feed back to ERP

- Drive label printing and identification

- Orders dispatch from schedule

- Oversees production operations, including functions to control product flow between equipment

- Monitors consumption of resources

- Supports full traceability of individual products through every step of the manufacturing process allowing for auditable genealogy and production reporting

- Turns production data into performance metrics – monitors automatically & manages consistently

- Send COAs to customers automatically

- Support regulatory and internal compliance (energy, environmental, food safety, costs, etc.) – including eSignature capabilities and 21 CFR Part 11 support

High Value, Volume & Variability Serialized Production: Routing, Sequencing and Tracking

Proficy Smart Factory also provides comprehensive tracking and order execution management that meets the critical needs for serialized production that involves high volume, high value, high variability products such as automotive, appliances, electronics, agriculture and heavy equipment, recreational riding products, and more. In these environments, it tracks each serialized item that moves through your production process—providing detailed, continuous information to help you make the best decisions for a competitive edge.
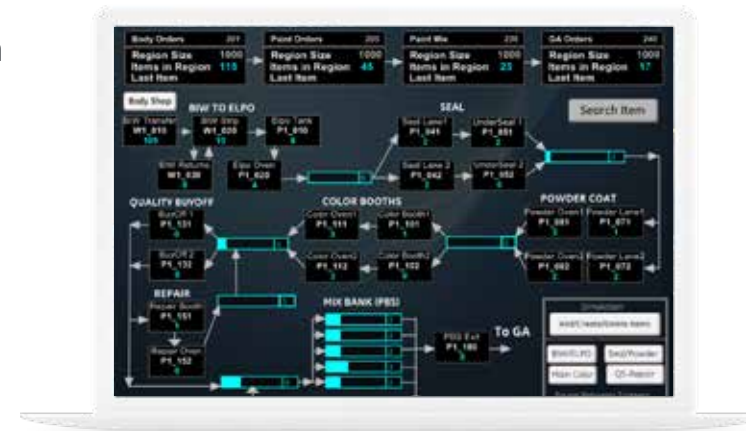
Proficy Smart Factory allows you to:

Increase throughput and launch new products faster
With Proficy Smart Factory, each serialized item that moves through your production or packaging process can be tracked. You get the detailed, continuous information you need to optimize your manufacturing process while managing inventory levels and locations, scheduling resources and routing materials much more effectively.

Implement Lean production
With Production Routing and Order Execution Management, Proficy Smart Factory helps manufacturers and suppliers understand real-time sequence requirements and handle situations that occur on the plant floor when the sequence is broken— enabling manufacturers to build right the first time. It helps facilitate a large reduction in WIP inventories along with finished goods inventories while meeting production targets.

Improve inventory, production orders
Better manage inventory, production orders, and routing materials with detailed data using Proficy Smart Factory. It empowers your operators with real-time information and control of their operations to accommodate a variety of production flow adjustments.

Real-time flow management of jobs
Proficy Smart Factory provides the ability to not only track the real-time location of jobs on the production floor but can be configured to perform routing logic on the movement of jobs throughout the facility. This unique capability allows manufacturers to manage the manufacturing, routing, and delivery of multiple product components into complex product assemblies.

High Value, Volume & Variability Production

- Production routing and tracking, including WIP inventory control

- Product genealogy and traceability for audit trails and regulatory compliance

- Error proofing

- Order management and broadcast management

- Sequence & substitution management

- Defect containment

- Hold management

- Facilitates build to order / build to sequence production

Batch Analysis: On-Prem & Cloud

Proficy Smart Factory provides an evaluation of scheduled and completed product recipes while generating batch records to help increase the overall quality and consistency of products.

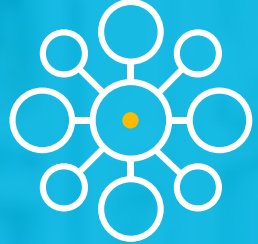With our unique layered applications approach and interface to standards-based commercially available batch execution systems, Proficy Smart Factory is a great fit to extend both new and existing batch execution systems. It supports ISA-88 recipe analysis for products as formulation (BOM), procedures, and equipment.

Our solution also provides analysis of scheduled and completed recipes and generates electronic batch records (EBR) to help increase the overall quality and consistency of products.

Proficy Smart Factory allows you to:

Increase quality and consistency of batch operations and reduce variability in batch processes
Compare cycle times, parameters and variables across batches. Report and summarize batch data in support of improvement initiatives. Trend related parameters across batches to understand and control process variation.

Lower costs by leveraging existing systems and infrastructure to drive improvements
Leverage both new and existing batch systems through standard interfaces. Combine quality, production tracking and other core manufacturing functions with batch operations providing a complete picture of plant operations.
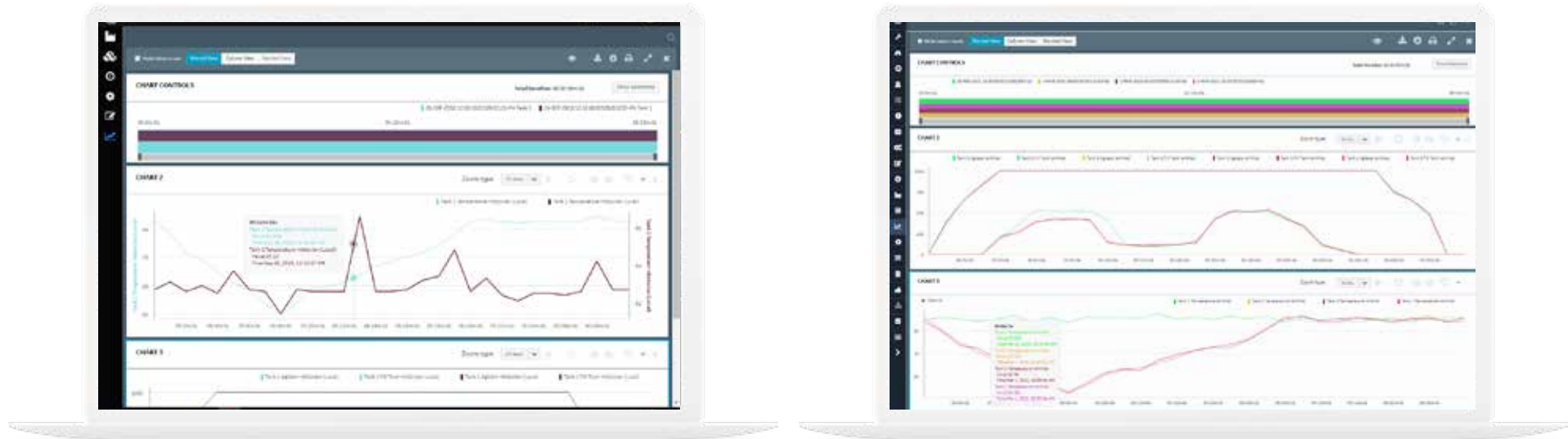
Control Variation in Batch-Related Production

- Supports ISA-88 recipe analysis for products as formulation, procedures and equipment

- Fits both new and existing systems thanks to its unique layered applications approach and interface to standard-based commercially available batch execution systems

- Provides analysis of scheduled and completed recipes

- Generates batch records to help increase the overall quality and consistency of products

Manufacturing Product Data Management

Increase throughput with accurate manufacturing product data across the enterprise.

Is your manufacturing struggling with varied products to overcome supply chain issues or meet changing consumer demands?

Uncertain supply chains and constant product innovation introduce variability and inefficiencies into daily manufacturing processes. With more products and/or regulatory standards, production gets out of sync with the latest product manufacturing information, resulting in lower quality, increased waste, and operations headaches.

Proficy Smart Factory allows you to:

Stay in sync with the constant updates to product manufacturing information
Get out-of-the-box tools to unify product manufacturing information from disparate data systems such as ERP and PLM. Transform and organize this raw business-oriented information into production-ready formats including recipes and specifications. Orchestrate the information across your factory floor systems at a single site or multiple sites.

Map data across ERP, PLM and MES
Stop cobbling together plant systems or manually trying to capture the right product manufacturing data on paper. Our solution Proficy Orchestration Hub provides Manufacturing Product Data Management based on information unified across key systems.

Achieve relevant product data context recognized by MES
Our out-of-the-box Operations Product Data Management UI helps transform the business-centric product data to relevant product context as recognized by MES systems.

Organize, Orchestrate & Analyze

- Accurate product data based on unified-systems information

- Flexibility to maintain and manage product variances with compliance

- Ease of connectivity

- Flexibility to use existing connection technologies allowed by business systems

- Mix and match connectivity to get all Product data

- No code mapping – drag and drop multi-source mashups

- Base views created at install

- Transform unstructured business Product data to MES structured Specs, BOMs, and Recipes

Scheduling

With Proficy, you can achieve dynamic and effective production schedules in real time.

The Proficy Smart Factory scheduling capabilities enable companies to create and maintain dynamic and efficient production orders in real time based on resources and asset capacity. By providing an interactive graphical view of the production plan across the plant, Proficy Smart Factory helps planners to easily schedule and execute production orders then monitor the progress to ensure more efficient production operations.

Proficy Smart Factory tracks actual measured production, consumption, waste, and yields and updates ERP and other systems automatically. It also provides reports and analysis tools.

Proficy Smart Factory allows you to:

Reduce labor costs
Determine resources needed, scheduling down to minutes in a leaner operation

Optimize capacity
Valid schedules checked against finite capacity and material availability

Increase customer satisfaction
Improve capable-to-promise by giving reliable delivery dates
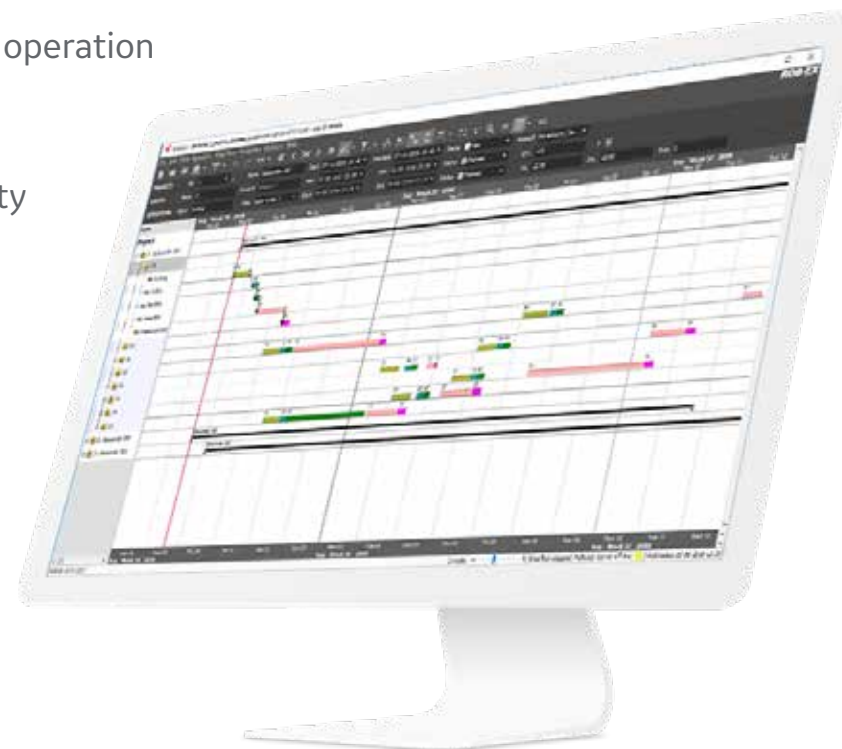
Better accommodate variation
Reschedule based on capacity changes, leveraging automated rules

Speed decision making
What-if simulation of scenarios improves and accelerates decisions

Increase collaboration
Combine local scheduling and central multi-site planning, allowing users to work simultaneously from the same plan

Optimize Production with Better Planning

- Interactive graphical view of the production plan

- Configuration of product routings and resources (staff, materials, equipment) for short-, mid-, and long-term planning

- Actual production, consumption, and events information

- Automated tool for "what if" scenarios and impact on future orders

- Integrated real-time tracking including mapping current situations with production schedules to optimize and meet customers' expectations

- Rescheduling based on capacity changes – including ability to make on-the-spot adjustments

- Integration with other systems including ERP

- Local scheduling and central multi-site planning as well as enablers multiple users to work simultaneously from the same plan.

- Access as Planners or Viewers

- Support for mobile devices, allowing remote operator access to on-line job lists

Digital Operations:
Centralized, Remote and Mobile

After capturing data, how are you getting valuable information from it in a desired way? Proficy Smart Factory delivers a set of comprehensive information for easy access and analysis—anywhere any time, on any device. Additionally, this solution provides a development environment to rapidly build industrial applications (visualization, connectivity, data aggregation).

Combining MES data as well as data from other systems including historians, Proficy Smart Factory improves plant operations with greater visualization, data in context, and a foundation for analytics.

With Proficy Smart Factory, users can leverage:

- Out-of-the-box MES screens

- Custom MES screens easily configured through Rapid Application Development

- A mix of out-of-the-box and custom screens

Proficy Smart Factory aggregates and visualizes MES data with other data sources.

Configuring screens in Proficy is as easy as 1, 2, 3. First, shrink Activities. Next, drag and drop Widgets. Lastly, select and configure your data source. Done!
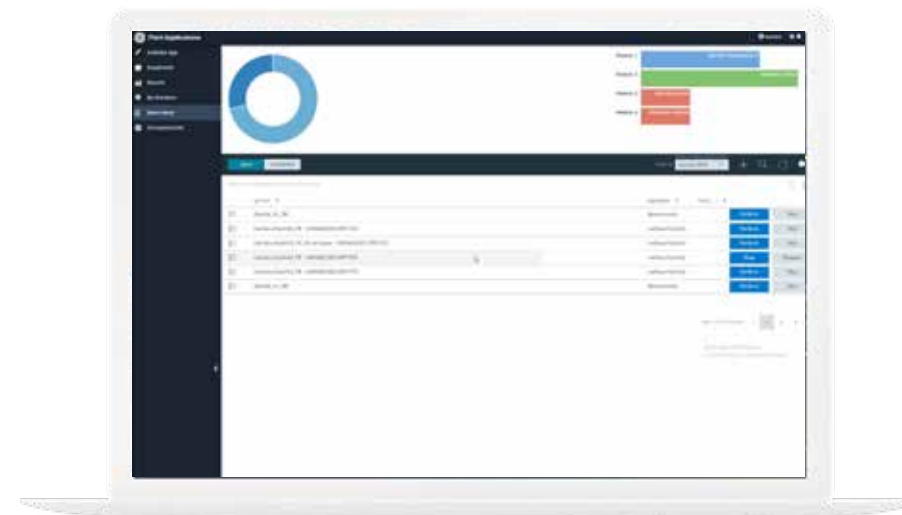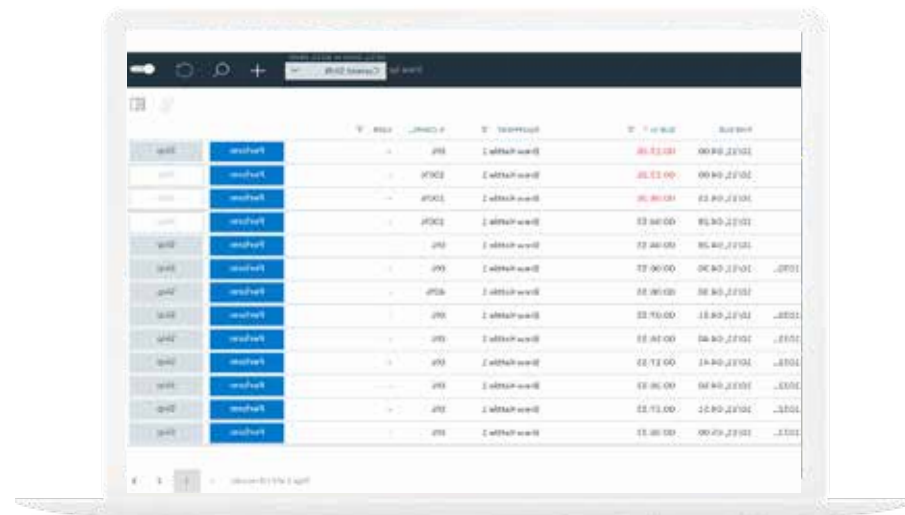
For the Plant / Manufacturing Manager, Operations / Line Manager

- Real-time visibility on KPIs: OEE (efficiency, quality, availability)

- Management dashboards – including non-OT data

- Mobile access for informed decision

For the Operations Personnel / Operator, Quality Engineer

- Real-time visibility on KPIs: OEE (efficiency, quality, availability)

- Dedicated dashboards that can be customized in-house

- A single pane of glass & single source of truth

For the Mobile User

- Information on the go – any time, anywhere

Industrial Data Management for Analysis & Reporting: On-Prem & Cloud (AWS/Azure)

With Proficy Smart Factory, you can leverage our industrial data management including best-in-class historian technology to capitalize on IoT.

Proficy Smart Factory provides a best-in-class historian that collects industrial time-series and A&E data at very high speed, stores it efficiently and securely, distributes it, and allows for fast retrieval and analysis —driving greater business value.

With decades of experience and thousands of successful customer installations around the world, the Proficy Smart Factory historian technology changes the way companies perform and compete by making data available for asset and process performance reporting and analysis.

Proficy Smart Factory allows you to:

Analyze data in context
With Proficy Smart Factory, you achieve powerful data management with asset model context and visualization. Proficy Smart Factory provides: data aggregation across multiple sources or historians, ability to define an asset model including tag mapping, and advanced trend analysis.

Improve data security
Data security remains our highest priority. Proficy Smart Factory uses the User Account and Authentication (UAA) service as a trusted source of tokens issued for authentication. The UAA is a multi-tenant identity management service, used in Cloud Foundry, but also available as a standalone OAuth2 server. Primarily, it can act as an OAuth2 provider. It can also authenticate users with Cloud Foundry credentials, and can act as an SSO service using those credentials, or others.

Achieve enterprise-wide industrial data management
For enterprise-wide deployments, Proficy Smart Factory features a model for cross-enterprise data access, cloud-like elastic computing on prem, scalability to 100 million tags, and the world's only cloud-native operational data historian.

Reduce data management time and costs
Decrease the costs to both store and access data with highly efficient compression algorithms, nearly zero database admin time, and tools to optimize performance. With just 1% compression enabled, Proficy is approximately 2x more efficient than a leading competitor and 30x more efficient than relational databases.

Real-Time and Historical Data: at Your Fingertips

- The world's only cloud-native operational data historian

- Collect industrial data at very high speed

- Normalize data and store it securely

- Distribute data and allow for fast retrieval and analysis

- Plant- and enterprise-wide capabilities: scales to 100 million tags

- 24/7 availability: avoid downtime and information gaps

- Stability and reliability for continuous improvement data analysis as well as mission-critical applications

- Easily deployable mirrored architecture

- Alarms & Events database, allowing retrieval of A&E in correlation to time-series data

- Multi-threaded for high performance

Reduce Costs and Improve Performance by Sending the Right Data to a Manufacturing Cloud

With Proficy and our hybrid cloud MES industrial data management model, you can easily and quickly increase the derived value by reliably bringing enterprise-wide manufacturing data into the cloud and transforming it into a structured data set for cross-plant storage, analysis, and analytics. At a cloud level, Proficy enables the consolidation of three data sets required for process optimization and analytical applications: asset data, ERP data, and manufacturing data.

Proficy Smart Factory allows you to:

Transform and consolidate data

Provides a reliable way to ingest manufacturing data and transform it into a usable format with S95-based contextual and aggregated data model. The transformed data models are accessible through easy-to-use and quick-response APIs.

Reduce storage costs

Separate the storage of historic and static data (cold data) from required data (hot data) to reduce on-site storage and maintenance costs through cloud server technology. Speed on-premises queries to improve operations agility.

Boost operations with analysis

Integrates data with multiple systems, creating an enterprise data set for reporting and analysis. Move raw and contextual data to data lakes to pool data into a single location, making it easy and fast to create a context for manufacturing analytics and improve operations.

Manufacturing Data Cloud

- Automated ingestion of enterprise-wide data

- Secure-by-design

- Hierarchy Model

- Contextual model

- REST API / OData end points

- Exposes slack to reduce data volumes – in some cases by more than 45% with a 20% related performance improvement

- Faster query speeds for analytics and reporting

Industrial Advanced Analytics:
On On-Prem & Cloud

With Proficy Smart Factory, you can improve asset and process performance with AI and machine learning.

Proficy uses AI and machine learning to enable process engineers to combine data across industrial data sources and rapidly identify problems, discover root causes, predict future performance, and automate actions to continuously improve quality, utilization, productivity, and delivery of operations.

Proficy has helped organizations around the world reduce costs by turning raw data into rapid business value. Engineers and data scientists can analyze, monitor, predict, simulate, and optimize and control set-points in real time.

Additionally, Proficy provides the capabilities to mine insight from historical data and rapidly develop, test, and deploy simple calculations, predictive analytics, and optimization and control solutions to reduce variability and improve operations.

Proficy Smart Factory allows you to:

Mine new insight from data

With Proficy, engineers can rapidly troubleshoot continuous, discrete, or batch manufacturing process performance by mining insight from available sensor and production data. Seamless connectivity, rich visualization, and predictive analytics enable users to analyze operating scenarios, quantifying the impact that operational changes will have on key performance metrics and identifying causes for performance variation.

Improve production throughput, yield, quality, and efficiency

Proficy enables engineers to rapidly develop analytic solutions that typically improve production throughput, yield, quality, and efficiency with significant margin. A comprehensive solution-development environment provides visual analytic building blocks. This allows users to build and test calculations, predictive analytics, and real-time optimization and control.

Enhance engineering productivity

Proficy also allows engineers to more easily capture expert knowledge and best practices—combined with insight mined from data —into high-value analytic templates for rapid enterprise-wide deployment. Visual drag-and-drop analytics accelerate time to value and reduce dependence on data scientists and programmers.

Leverage modern analytics visualization for faster response

Take advantage of modern, thin-client visualization for high-performance analytics at your fingertips, where and when you need it.

Analytics That Drive Plant and Enterprise Optimization

- Support for on-prem and cloud-based analytics
- Ability for engineers to optimize; no data scientist required

- Enables building rich analytic solution templates with no required programming

- Simple calculations, data cleaning, math, statistics, machine-learning models, real-time optimization, and advanced process control

- Plug-and-play connectivity to historical and real-time data sources

- Rapid wizard-driven data mining for engineers for fast time-to-insight

- Built-in support for data quality to make real-time data cleaning and validation easy

- Ability to develop, integrate, test, and deploy real time solutions

- Easy-to-use, drag-and-drop environment for subject matter experts

Dynamic, Interactive Work Process Management: Go Paperless

With Proficy Smart Factory, you can decrease operator errors, costs and risk with digitized, interactive work instructions and eSOPs.

Proficy Smart Factory provides operators with interactive, step-by-step instructions, guiding the right actions at the right time. Operators can easily move from a paper-based method of managing procedures to an electronic format for consistency and predictability.

Proficy Smart Factory allows you to:

Unify processes

Digitize manual and automated processes with one solution across a plant or entire enterprise-from plant operators and maintenance teams to field crews and leadership.

Speed corrective action

Filter MES alarms, take automatic actions, and push required actions to the right person.
With clear guidance, teams respond faster to events, and operations run more efficiently.

Decrease operator errors

Guide operators through the right steps to take, at the right time, with effective electronic work instructions.

Reduce costs and risk

Enforce and track processes to achieve higher quality, decrease waste/scrap, comply with regulations, and improve safety.

Capture and preserve knowledge

Document processes before experts retire and standardize best practices for consistency across operations.

Integrated, Interactive Work Instructions

- Guide operators with clear, step-by-step, interactive work instructions

- Document when, by whom, and how long work is performed

- E-signature and audit trails at your fingertips

- Trigger action based on time or events

- Embed videos, live feeds, pictures, manuals, and MSDS

- Automatic escalation and notification

Achieve manufacturing excellence with Proficy Smart Factory

Proficy Smart Factory is the synthesis of more than two decades of working with the world's most recognized brands in manufacturing and our own GE plants. Our software enables you to predict, adapt, and react more quickly and efficiently than ever before. Connect design, engineering, manufacturing, supply chain, distribution, and services into one scalable, intelligent system.

Contact Information

www.ge.com/digital