



# Manufacturing Execution Systems (MES) Guidebook for Efficient Operations

Improve operational performance with a modern Smart Factory

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# Manufacturers Get Smarter to Meet Sustainability Goals





Interview with Matt Holland, Vice President and Chief Commercial Officer, Manufacturing and Digital Plant, GE Digital

### Matt, what are you hearing from companies about sustainability? What's changing?

Our customers are facing skyrocketing energy prices that are driving unfavourability in their operating budgets as well as their sustainability agendas. In some markets, this is to the point that business viability is in jeopardy.

Furthermore, regulations are forcing industrial companies to act quickly to comply with new environmental rules.

*More than ever, manufacturers need to understand the tradeoffs and synergies inherent in their decisions, especially when adding sustainability factors to existing performance metrics. They need to understand their products' carbon intensity to meet climate commitments and carbon goals. The ability to attribute energy usage directly to products is a prerequisite for these calculations.*

### How is GE Digital helping to address these challenges?

To remain competitive, build resilience, and lower risk, manufacturers need software that provides more granular energy and utilities data, greater visibility, and insights they can act upon.

Software solutions are smart enablers for industrial companies on a digital transformation and lean sustainability journey. Building on our interviews and customer successes, we focus sustainability innovation efforts on three key problems worth solving:

- **Measure use:** To deliver sustainable industrial systems, a holistic set of data is required to build the right metrics/KPIs to drive action. This extends beyond traditional production metrics to include the social, environmental, and economic impact of each resource used.
- **Use less:** There is a pressing need to reduce resource consumption (materials, energy, and utilities) to achieve sustainability goals and meet regulatory requirements. This requires the ability to measure, reduce, and optimize usage at the process, equipment, and product level.



- **Track and Trace:** A major challenge is understanding the history of each product, part, and material. The majority of those interviewed seek to track and trace their raw materials, products, and components to understand their condition, quality, performance, composition, and history (e.g., recycled content). This will inform their operational strategies for reuse, recycling, as well as strategies for product differentiation. This is a foundational component for the “Digital Product Passport.”

#### REDUCE AND RECOVER FOR SUSTAINABILITY FROM LINEAR



#### TO SUSTAINABLE





## What are the steps that you recommend to customers?

First, our strategic workouts with customers are critical to guide steps that deliver the most value to meet individual sustainability goals. As general steps, we recommend:

1. Begin to operationalize your energy transition and decarbonization strategies by putting the right data in the hands of employees whose daily actions influence the energy you consume.
2. Lay the groundwork for easy product carbon intensity calculations for all your SKUs and prepare for future operational carbon management requirements.
3. Lower conversion costs of making your products and the variable industrial costs (VIC) of running your factories - whether you have one or a hundred - while making your business quantifiably more sustainable by improving efficiency, absolute consumption, and waste of energy and water.
4. Start small and test then deploy across the enterprise. Our software including analytics and optimization runs in the cloud for exceptional availability and scalability no matter the organization's size.

## Can you give us some examples?

Absolutely, here are just a few:

- Skjern Paper partners with Novotek, and they use our Proficy CSense analytics software to improve product quality and reduce waste. In fact, analyst firm IDC recognized Skjern Paper for its use of industrial analytics to improve quality and support its commitment to sustainability.

For background, paper plants have hundreds of PID control loops that can cause process variation and contribute to quality issues and waste, if not maintained in a healthy condition. At the same time, while Skjern Paper has extensive quality assurance systems, the team did not have many real-time ways to measure paper quality, making real-time quality control difficult. Operators would check quality samples for a whole reel of paper at the end of a production run, which involved a delayed lab analysis and the inability to adjust production earlier in the process.

With a goal of avoiding or reducing 5% of quality rejects, especially when switching between different products, Erik Møller, technical manager at Skjern Paper, took advantage of free consulting with a GE Digital AI and ML expert to jump start the analytics project. After just six hours of consulting, Skjern Paper was able to gain insights and take the project to the next steps. "Decreasing scrap and chemical usage and increasing production capacity through CSense are all ways that we are helping the environment," Møller explained.



- A major automotive manufacturer reduced inspection costs by 40%, experienced a 20% improvement in equipment utilization, a 30% reduction in inventory, and 80% reduction in required storage space with GE Digital's CIMPLICITY HMI/SCADA and Proficy Smart Factory MES manufacturing software. Paper process elimination enabled accurate and meaningful data for decision making, as well as the sharing of data with value chain partners.

## Any final thoughts?

Digital transformation is a critical part of the journey to sustainability. We can develop smart factories that support sustainability goals by modernizing our technology infrastructure – connecting OT systems, collecting data, gaining visibility for action, and optimizing operations.

In combination with a lean culture, smart factory technology reduces waste, energy usage, chemical usage, and more.

You aren't on this journey alone. GE can help with the full breadth of our proven sustainability solutions, our ability to deliver on key metrics, and our vast experience with our own manufacturing as well as co-innovation partnerships with industrial organizations around the world.

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*One of the world's largest glass container manufacturers improved quality, safety, and efficiency by adopting GE's software. The company has helped protect the environment by significantly lowering energy needs and reducing furnace emissions by 80%. Optimizing production also reduced defects by 25%, downtime by 25%, and annual operations costs.*

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# Cloud MES: The Fast Track to Modern Manufacturing

How to reduce total cost of ownership (TCO) up to 30%, decrease maintenance, and improve security





Manufacturers have long used Manufacturing Execution Systems (MES) to manage and optimize operations, but traditional on-premises solutions require time and resources to implement and maintain. Resultingly, manufacturers often have a “set and forget” approach when it comes to these OT systems.

Today, set and forget is no longer acceptable. Cybersecurity, new software capabilities, and agile operations all require being on the latest version. Furthermore, cloud-based analytics require OT data availability and a single source of truth. Continuous improvement and optimization also require increased visibility across enterprise performance.

The bottom line: with significantly easier implementation and decreased maintenance, cloud-based MES offers next generation innovation and is the answer to support modern manufacturing.

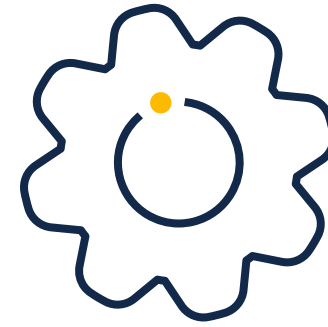
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*Lowering capital expenditures (CAPEX) and operating expenses (OPEX) compared to on-premises implementations, cloud-based MES can help manufacturers to reduce total cost of ownership (TCO) up to 30%, decrease maintenance, and improve security.*

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## MES in the Cloud

For many years, industrial companies were committed to implementing cloud technologies for business data but skeptical about putting their OT data and applications there.



But as increasing amounts of enterprise data across the organization are being securely and cheaply moved to cloud solutions anyway, many manufacturers are asking themselves – what’s the right way to balance needs of the plant floor with advantages of cloud technologies?

Fully hosted as a managed service, cloud MES provides companies with the robust, composable no-code technology to improve their operations in real-time, along with the flexibility to deploy in a way that best suits their needs.

Manufacturers can decrease maintenance resource overhead and increase performance with the latest features and newest software releases provided quickly through the cloud infrastructure. With a cloud-based, managed MES solution, manufacturers no longer have to worry about patching the OS and supporting software. Additionally, manufacturers can increase security through software managed at scale including vendor-managed security updates.

## Viable Fast Track to Modern Manufacturing

Large companies have traditionally taken advantage of MES more than small- and mid-size manufacturers because they usually have greater resources available to support deployment and maintenance. With MES as a Service, manufacturers of any size can achieve a fast track to modern manufacturing operations and frontline guidance, enabling connected workers across the enterprise.



By reducing the costs and human power needed to deploy and maintain an MES, any manufacturer can implement an adaptable cloud-based production system and gain the real-time operations optimization to support digital transformation, continuous improvement, and lean initiatives.

Furthermore, some cloud-based MES can save manufacturers time with dozens of out-of-the-box screens specific to their process, discrete, and mixed manufacturing. The software can improve operator response with rich visualization, and manufacturers can easily customize MES screens without writing code – further reducing the resources needed.

### Advantages of OT Data in the Cloud

By moving to a cloud-based MES application, manufacturing companies are also discovering four key benefits to having their OT data in the cloud.

#### 1. Revealing hidden opportunities to boost operational efficiency

With OT data in the cloud, analytics can transform and contextualize time-series and transactional data across an enterprise into actionable insights and uncover improvement potential. For example, data-driven predictive maintenance can save up to 12% of scheduled repairs, reducing overall maintenance costs up to 30%, and breakdowns up to 70%.

Manufacturers are looking at predictive analytics to improve operational efficiency and get a competitive edge. With cloud-based OT data availability, forward-leaning manufacturers are getting more sophisticated about putting analytics to work.

#### 2. Speed and Agility

On a day-to-day basis, factories run faster by storing operational data in the cloud for analysis instead of storing on

site. Operators aren't held up by MES systems struggling to cope with large volumes of on-prem data for analysis. At one site, operators had an 85% boost in productivity of the MES once it no longer had to deal with vast amounts of locally stored data. The entire factory just ran faster.

#### 3. Intelligence and Insights

Different roles in the business require different information. Many manufacturers suffer from excessive costs related to materials, labor, packaging, and shipping.

By implementing cloud MES, manufacturers also unlock new ways to combine and view data remotely, compare dashboards across multiple plants, and track from the enterprise level to the shop floor. This helps every team make the best decisions based on the best data – faster.

For example, the supervisor needs information to optimize product flow, machine and operator efficiency, and manage safety incidents. The supply chain manager needs to optimize revenue targets and year-to-year growth while reducing costs. And the operations manager is focused on increasing monthly and quarterly manufacturing efficiency and reducing any non-value-added steps in manufacturing.

Today's MES technology harnesses invisible data and makes it easy to give each person visibility to the information they need to do their job.



#### 4. Cost Reduction with OT Data in the Cloud

And if those other reasons aren't compelling enough, the most straightforward business case: storing years of operational data is often a compliance requirement, but on-site server costs quickly add up. It is now more affordable for manufacturers to keep their OT information in the cloud – reducing the need for on-prem server storage. Manufacturers can achieve ROI quickly just by reducing these costs associated with OT data.

### Greater Agility with Cloud MES

With the agility offered by cloud MES, manufacturers can finally leave the set-and-forget approach behind and instead drive a future-proof foundation for modern manufacturing and digital transformation.

Cloud-based manufacturing applications are becoming more and more prevalent with implementations providing significant benefits for manufacturers of any size including reduced total cost of ownership up to 30%, decreased maintenance, and improved security. Furthermore, OT data in the cloud in conjunction with the MES drives the data and visibility needed for cross-business optimization in today's modern manufacturing environment.

Top two reasons to move to the cloud	
	
<b>Reduced TCO and enhanced performance</b>	<b>Increased security</b>
<ul style="list-style-type: none"> <li>• CAPEX vs OPEX</li> <li>• Low resource overhead</li> <li>• All supporting software included</li> <li>• Keep up with the latest features and newest releases</li> <li>• OT data for analytics</li> </ul>	<ul style="list-style-type: none"> <li>• Security managed at scale</li> <li>• Faster turnaround for security patches</li> <li>• Zero reduction in performance due to vulnerabilities</li> </ul>





# 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.



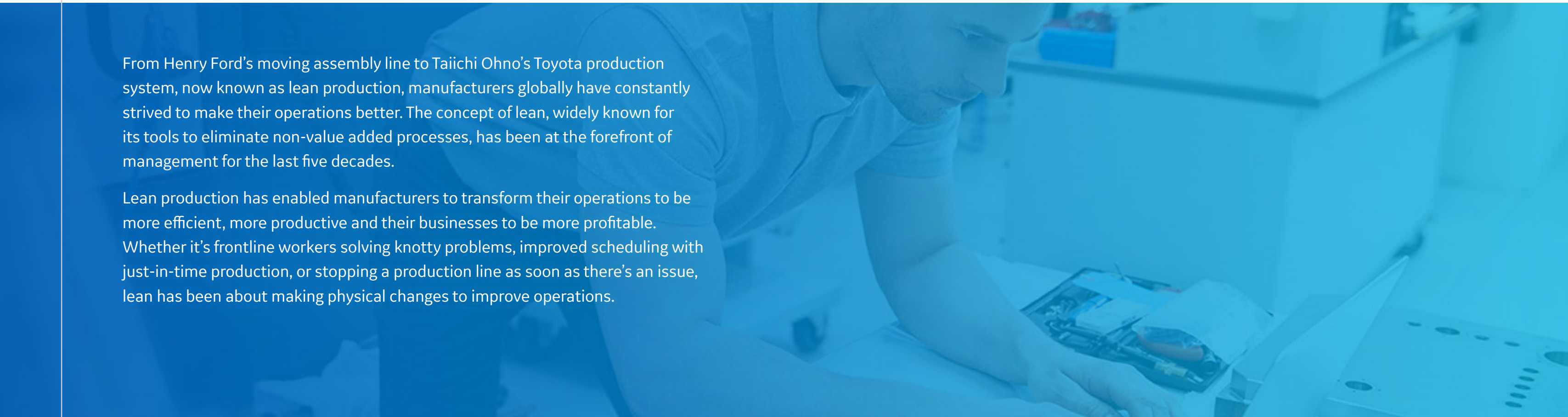


# Lean manufacturing in the age of the Industrial Internet

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...

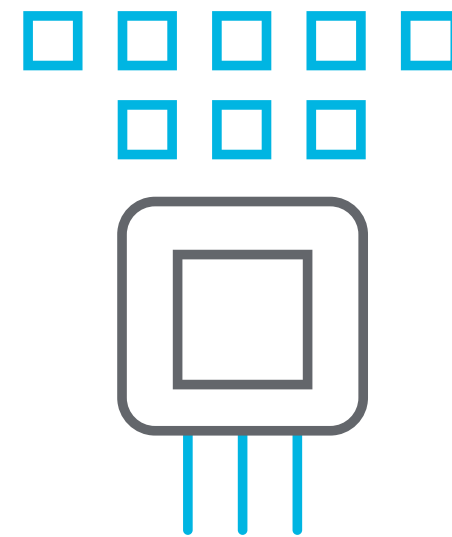
Imagine a manufacturing environment where your machines and devices are connected, and people have access to operational insight wherever they are with business intelligence at their fingertips. Envision a production floor where operational data transforms into intelligent foresight to tell workers, 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.

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*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.*

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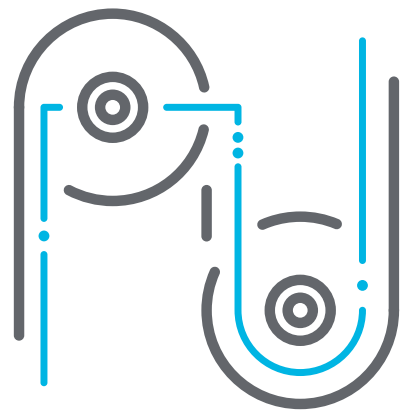




# The challenges in manufacturing

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.

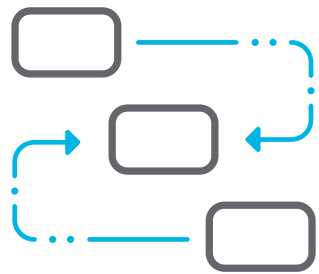
**The two disciplines, lean and Six Sigma, can be especially successful when working in tandem.**



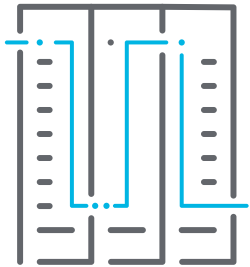


# Building the foundation

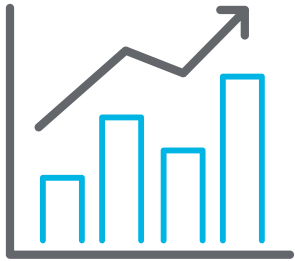
From a lean Six Sigma perspective, let's explore how leveraging MES software technologies are best suited to support these initiatives. To begin, there are some fundamental questions that need to be answered in order to effectively lay the foundation.



Am I collecting the right data?



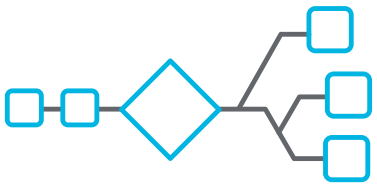
Do I have an effective and efficient way to store and access it?



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

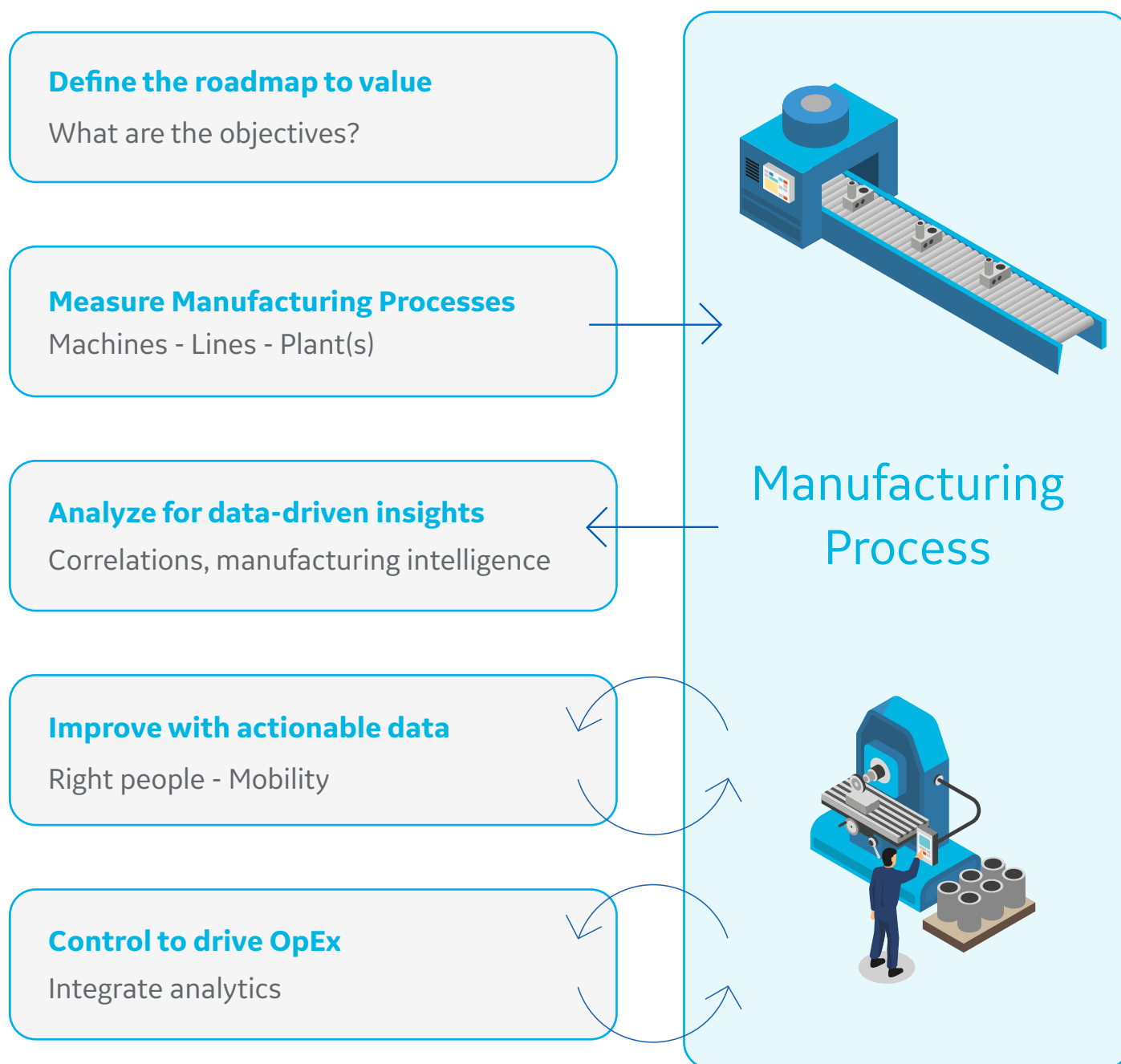
You need to identify the outcomes you desire and prioritize your goals. For example, your goals may include one or more of the following: produce products faster, reduce work in progress, tighten control on quality, streamline the supply chain and reduce warranty costs. Addressing these areas at once 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







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

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## 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.

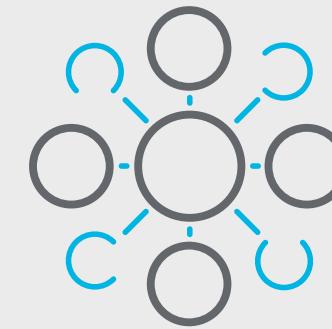
Data-driven insights through advanced analytics help enhance asset performance by detecting and predicting the why, when, where and how of future potential production anomalies. Perhaps more important is the ability for manufacturers to assess through simulation what a potential change in the manufacturing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

## Case Study

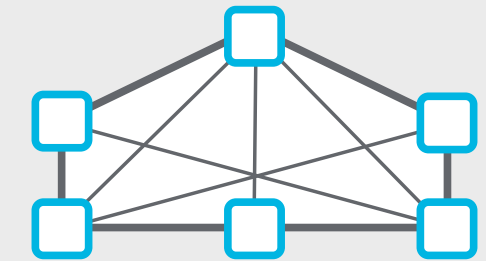
For example, a large-scale manufacturer leveraged the data collected from its plant floor in several different ways. Historical process metrics were used to pinpoint the cause of a quality defect found during final product test. Analytics applied to the data revealed a difference in operating procedures 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



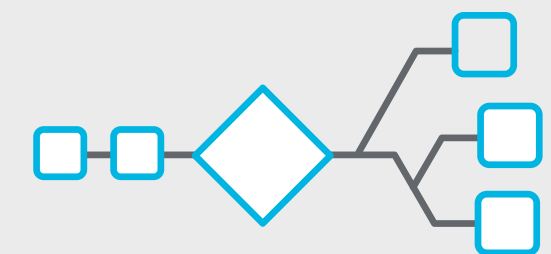
**01** Collect data from your systems



**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.

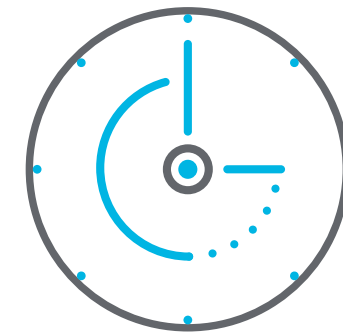
## Case Study



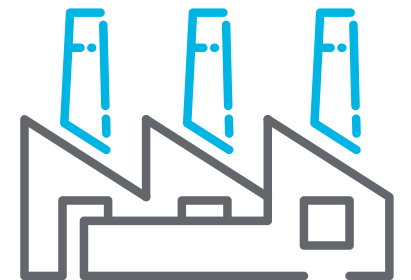
**15%** improved labor utilization



**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

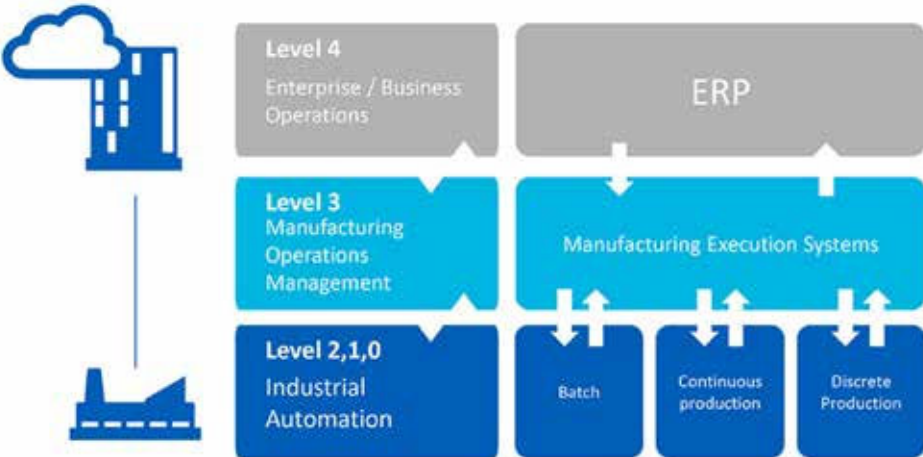
**Lean principles focus on eliminating waste throughout the manufacturing process.**

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

<b>Dashboards</b>	Ad hoc metric, such as trend charts and graphics. Example: Shows metrics by department and by team, with targets and goals.
<b>Huddle Boards (Agile Kanban Boards)</b>	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.
<b>Story Boards (A-3)</b>	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.
<b>Andon Boards</b>	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.

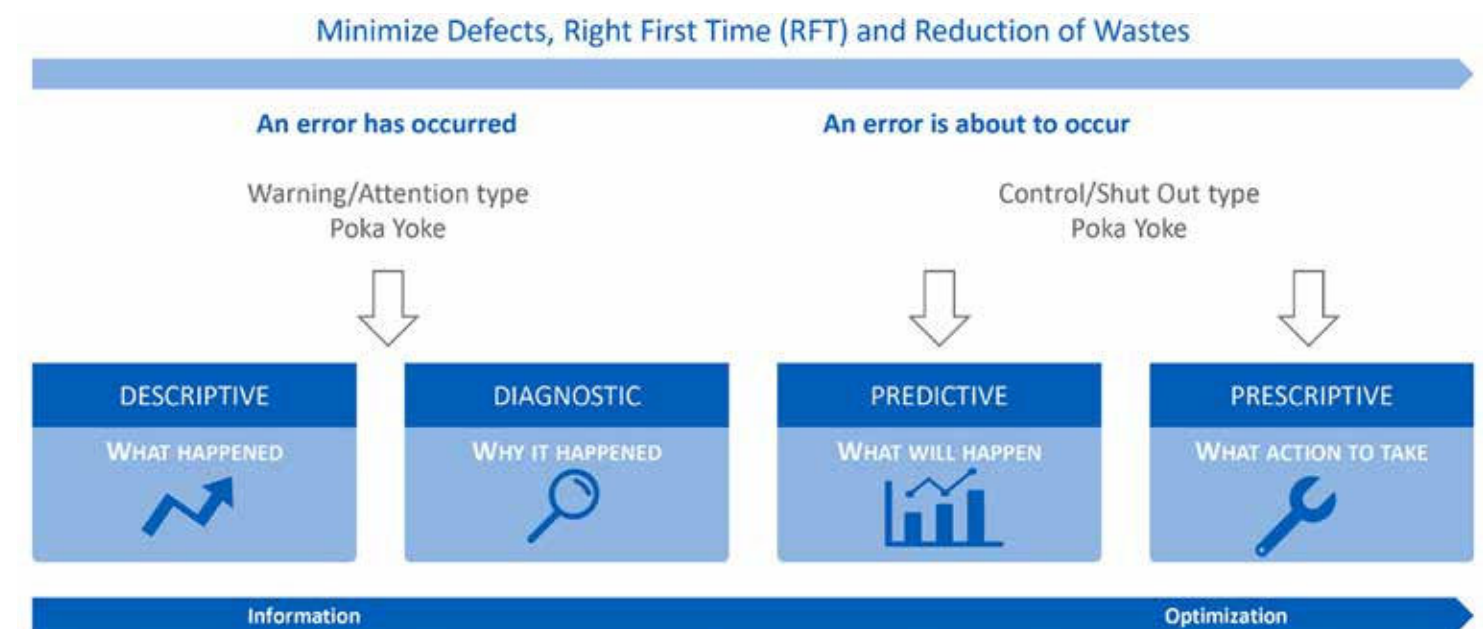
A systemic digital Lean process goes beyond reducing the total cost of ownership and improving productivity; it motivates employees and makes them more accepting of change, and it drives a culture of growth.

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.

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*Digital Kaizen democratizes the digital world and the data users can get to, and allows for easy collaboration and continuous improvement.*

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**Figure 3: Machine learning and analytics will shift businesses along the spectrum from responding to errors to predicting them**



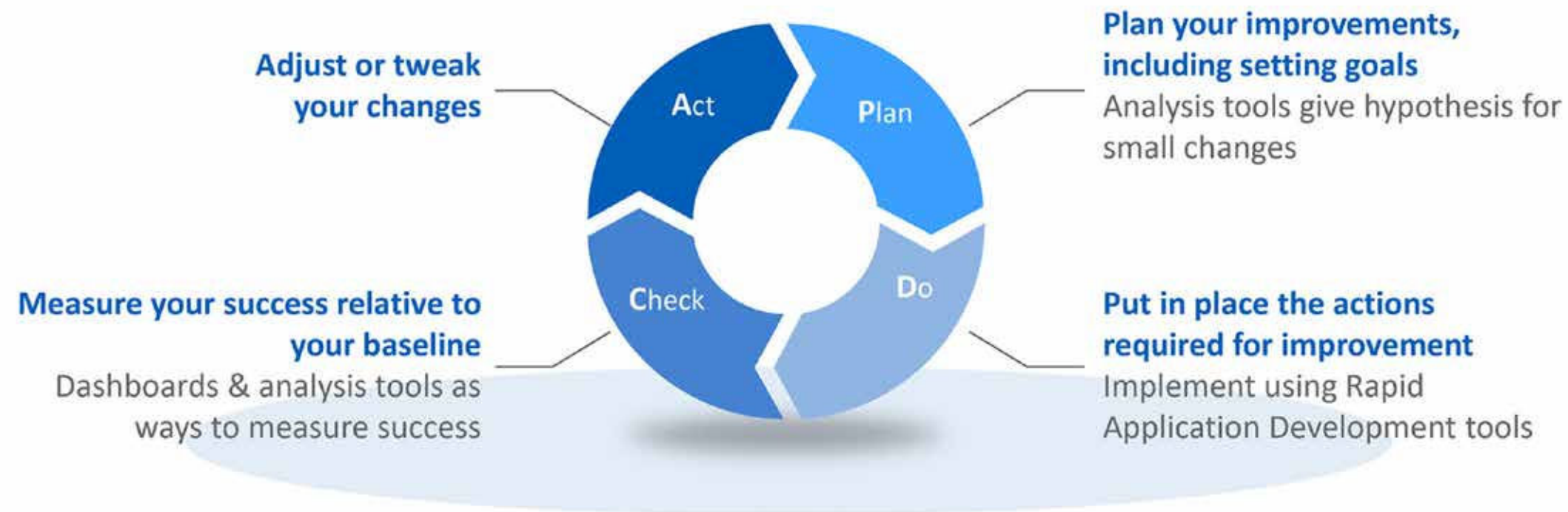


# How technology is changing the game

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](#)



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

According to ARC Advisory Group, 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

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*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.*

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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.

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*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.*

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## 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.



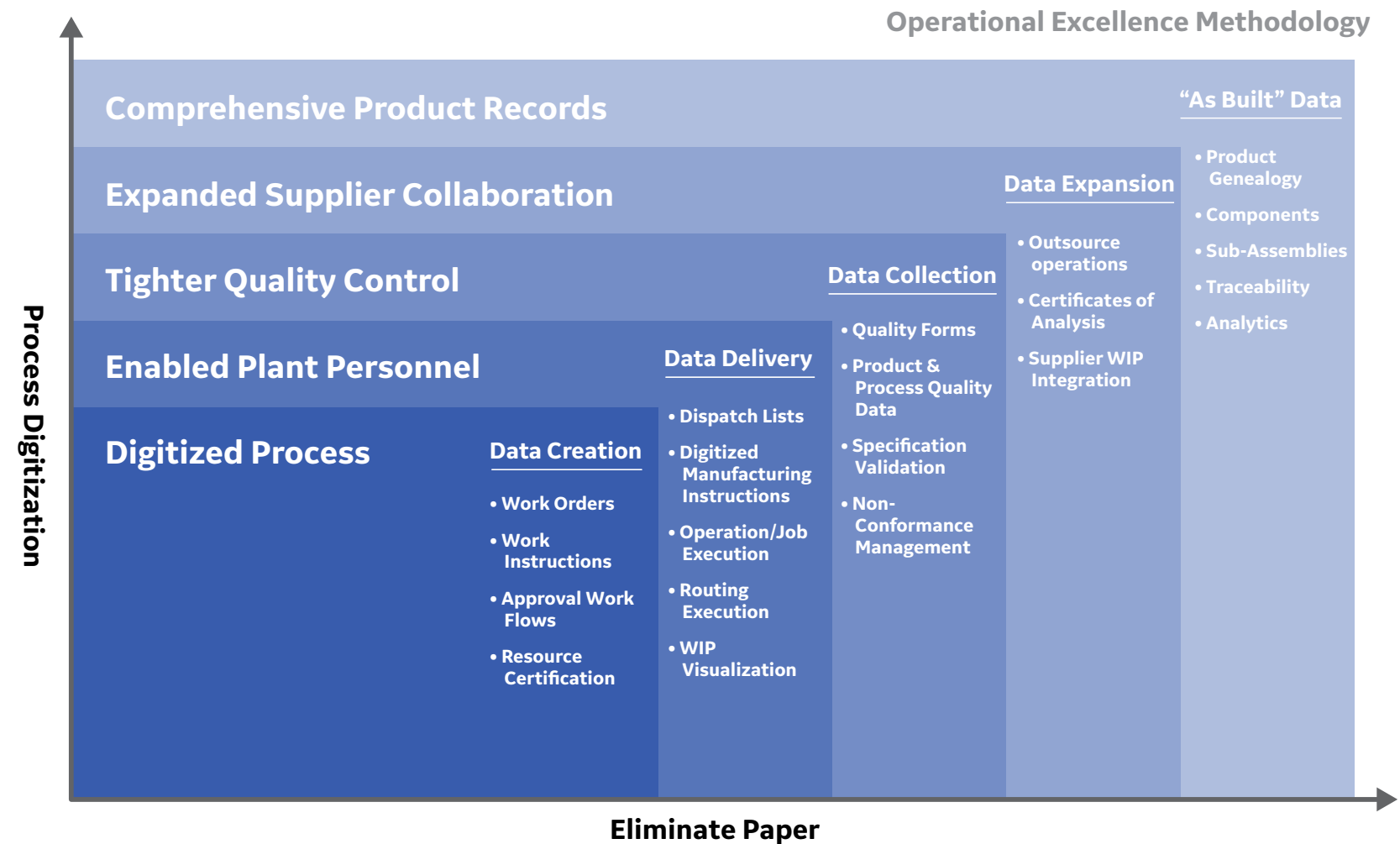
## Comprehensive Product Records

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





## 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



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.







# Diverse and Mixed Manufacturing

Improve Efficiency Across Your Process and Discrete Operations





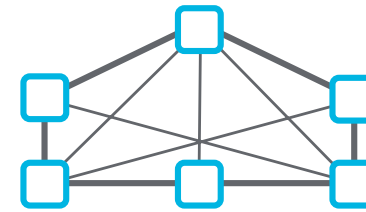
# Pressure to do more in manufacturing

The manufacturing industry is always driving for more efficiency. According to a study by IDC, there is an opportunity of \$4.5 trillion in economic value-add across the manufacturing value chain—\$1.1 trillion in the factory itself.

To capitalize on this, manufacturers seek to address indicators of such inefficiency, including time-to-market being affected by just-in-time needs and pressure for reducing parts inventory, cost overruns, and machine downtime. Additional problems might include delays or bottlenecks in the rest of the organization because they can't keep up with factory improvements in cycle time and deficiency gaps in the standard languages for modeling production and manufacturing processes.

In today's manufacturing world, complexity is a significant challenge because it is not uncommon for enterprise organizations to be in more than one business. For example, GE is one of the largest and most diverse manufacturers on the planet, producing everything from airplane engines to wind turbines to CT scanners. Manufacturers need to find the capacity to produce what the market wants, when it wants it, and at increasingly higher quality—even when it means quickly

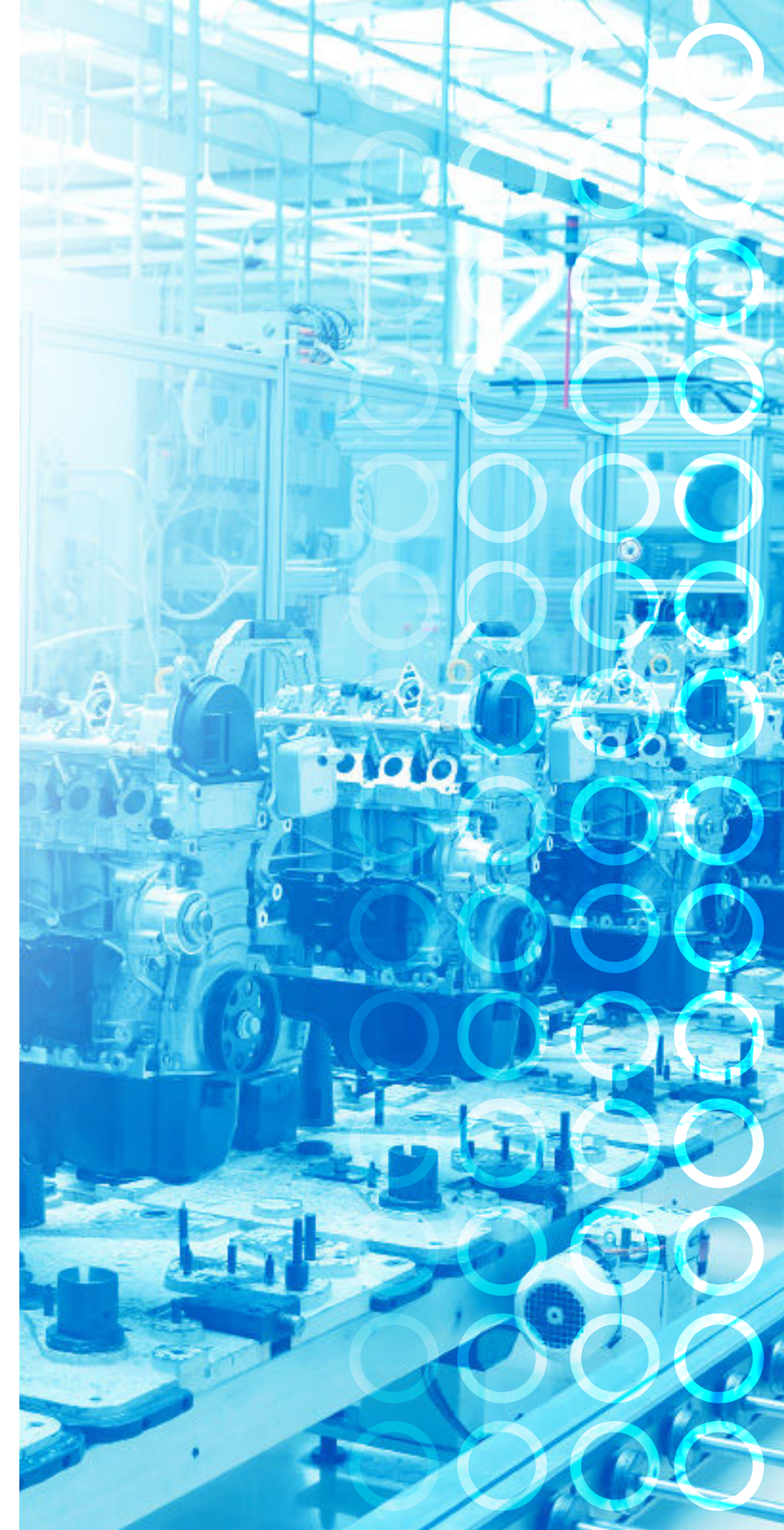
changing lines and entire facilities over to new products. Today, products can be conceived, developed, and sold over the Internet in a matter of weeks or days, meaning today's manufacturers are already competing on their ability to manufacture to order.



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*As a result, there is a movement underway in manufacturing that is profoundly changing the way products are manufactured. Mixed manufacturing environments are on the rise, with plants undertaking several types of manufacturing processes in one facility.*

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# The rise of mixed manufacturing

As defined, mixed manufacturing refers to plants that are undertaking several types of complex manufacturing processes within the same four walls. For example, manufacturers can be doing everything from mixing batches, cutting, and packaging all under one roof.

Certain industries have always had a combination of process and discrete manufacturing. However, today, as manufacturers are being asked to do more, there is a rise in mixed manufacturing within facilities. Furthermore, as companies undergo acquisitions and growth, a company might have one plant focused on discrete manufacturing and another on process. But, the company still needs to have commonality across those plants for enterprise visualization and optimization.

In particular, manufacturing software must meet the needs across all of a company's operations - whether process or discrete. Unfortunately, traditional Manufacturing Execution Systems (MES) have been tailored to meet the needs of specific industries rather than meet diverse manufacturing needs. Companies subsequently have several manufacturing solutions that are disconnected and creating islands of information. These hidden factories drive inefficiency, higher cost of maintenance, and lack the industrial data management needed for IoT-fueled optimization.

Unlike traditional MES software, Proficy Smart Factory from GE Digital supports all manufacturing environments - whether process, discrete or mixed - providing one seamless MES across an entire business for greater efficiency and enterprise-wide optimization.

As an example, GE is leading the way in mixed manufacturing with its facility at Chakan in Pune that combines manufacturing for six different businesses from power to aviation, and a second in Canada. Both facilities are leveraging GE Digital's portfolio of industrial applications to optimize operational processes and gain equipment efficiency.

A mixed factory has the capability to produce multiple, diverse products or individual products that require both process and discrete to manufacture such as batteries. Pune's factory connects digitally across three major areas of the value chain—product engineering, manufacturing, and supply chain operations—to integrate machine data and reduce downtime. The advanced manufacturing plant, which is located near Mumbai in western India, spans 67 acres and includes a 250,000 sq. ft. shop floor that manufactures a variety of products, and can switch to building other products for other industries. This means that GE can adjust its production in line with demand, using the same infrastructure and people in the facility. This helps cut costs, maintain economies of scale, and improve efficiencies.



# Implications of mixed-manufacturing factories

Performing different processes in one facility has implications on technology requirements. It is more streamlined to have one MES, SCADA and industrial data management solution for all machines and processes so that the staff only needs to learn one technology and only has to look in one place for process and performance data across the entire shop floor.

No matter what is being manufactured or what processes are required. Due to the varied production processes in a mixed-manufacturing facility, the technology should be able to handle both discrete and process. In the Pune facility mentioned earlier, operators weren't supported with a

system to fully notate reasons for machine downtime and had no unified system to access technical information, record production, or view quality data. This was addressed in its transformation to a mixed-manufacturing facility.

Keeping the production in one facility means that the health of each machine is vitally important to the overall plant production of multiple different products. This drives the need to connect the machines into one visualization and employ

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*And a mixed-manufacturing company benefits from a holistic view into its production that allows engineers real-time visibility into machine data and manufacturing performance to allow them to optimize labor and machine run time.*

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more sophisticated approaches, like predictive maintenance to prevent downtime. Predictive maintenance gives maintenance teams the analytics tools to predict possible machine tool failures before they occur.

Today, about 23% of manufacturing plants globally operate as smart factories, according to IDC's recent Manufacturing Insights Information Technology and Operational Technology Integration Survey. But IDC anticipates a drastic shift. 40% of manufacturers have already completed work to integrate information technology and operational technology, and 52% of manufacturers have an ongoing initiative to do so. Within five years, IDC says that more than half of manufacturers will have truly integrated their infrastructure in order to function as a smart factory. These are important building blocks to mixed factories.





# How GE Digital accelerated Pune's digital transformation

After its transformation to a mixed-manufacturing factory, Pune is now serving six different GE businesses—Power, Aviation, Thermal, Oil and Gas, Renewables and Transportation—and products for these businesses can all be built under its roof. Due to the implementation of GE Digital solutions, the machines and computers within the Pune facility communicate in real time.

The transformation involved getting connected through Proficy Smart Factory, a manufacturing solution including Proficy Plant Applications, Proficy Historian, and CIMPLICITY HMI/SCADA. As an example, engineers connected sensors from 20 computer numeric control (CNC) machines to integrate the machine data and enable visualization of performance across machines on a single screen. This real-time visibility of machine performance enables a lean operation and the reduction of waste. A cross-functional team leverages technology to analyze data and create a plan to reduce machine downtime, enable operators to notate downtime, and allow operators to view 3D work instructions or record production and quality data.

Asset Performance Management is leveraged to monitor how Pune's assets are operating in real time. This helps operators diagnose the current health conditions of all critical subsystems of a machine and enables a framework of condition-based maintenance when that machine's tag data, in combination with the machine's maintenance history, is modeled using analytics. This allows them to diagnose health conditions, provide predictive maintenance recommendations and identify equipment issues before they occur.





# Brilliant results

As a result of getting connected, the Pune facility now has a single visualization of their integrated machine data as well as a machine downtime notation system for operators, and established a unified user interface to provide technical, production and quality data. This has driven significant gains in effectiveness for the Pune facility.

Pune has experienced \$4 million in cost avoidance for three of their CNCs and a 45% to over 70% increase in overall equipment effectiveness (OEE) across their connected machines. Operating costs per hour are down significantly.

With over 20 machines connected across multiple critical processes and over 150 sensors being tracked real time, the Pune facility expects a return on investment within 1.2 years of implementation. In addition, they expect a cost savings of \$170,000 in year one from improvements in both mean time between failures (MTBF) improvements and quality rejections due to breakdowns.

*Today, the Pune facility is ready to undertake the next phase of its evolution. As part of this phase, the facility will integrate their ERP, PLM, and MES systems to pull in quality, labor, and supply chain data to provide visibility for labor hours, task time, and work in progress. These aspects of this phase will decrease maintenance costs with predictive analytics and leverage Proficy Platform for advanced analytics.*

## MIXED MANUFACTURING

# PUNE INDIA

▲  
**18%** Equipment effectiveness

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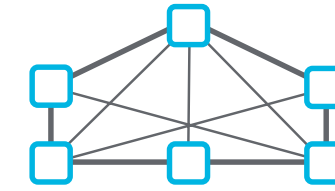
**76%** → **45%**  
Operating cost per hour  
**+3** inventory turns



## Can you improve your mixed-manufacturing operations?

Consider these five questions when evaluating your mixed manufacturing environment.

- Are you managing more than one MES across your enterprise?
- Do you have real-time access to all of the manufacturing data required for optimization?
- Do you have hidden factories within your operations?
- How are you increasing efficiency across all of your production?
- How are you empowering teams for continuous improvement?



*To learn more about how Proficy Smart Factory can help you manage mixed production complexity and improve manufacturing efficiencies, visit our [Proficy Manufacturing Execution Systems](#) page.*

FIND OUT MORE







# A Digital Approach to On-Demand Production





# Data is king

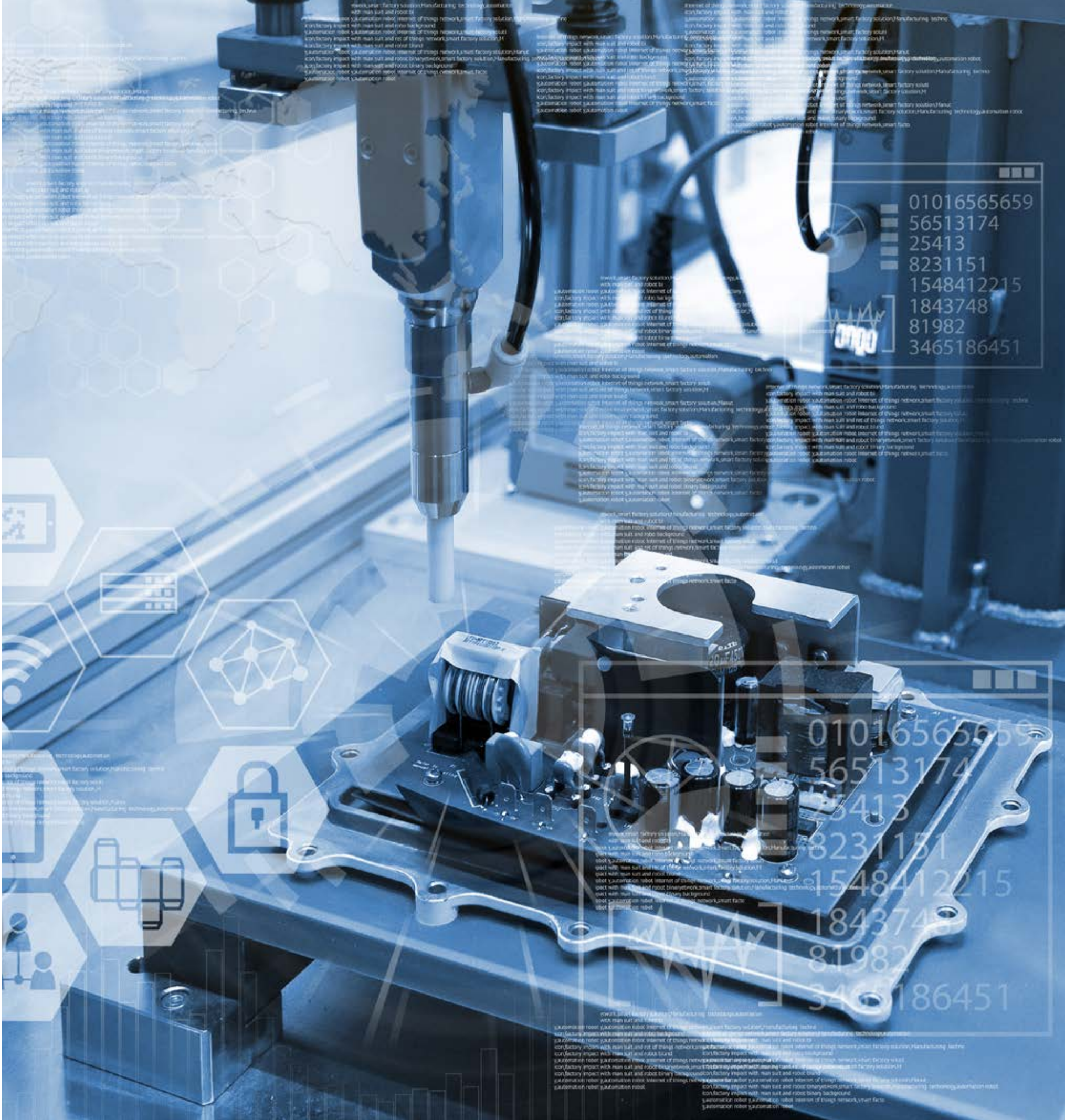
Traditionally, successful production has relied heavily on skilled personnel. Experienced employees installed equipment and implemented processes. Then they relied on their expertise and intuition to keep everything running at peak efficiency.

But times have changed. Today, data is king. Over 80% of companies say data analytics is one of the top three priorities for their company.<sup>1</sup>

And the failure to implement robust digital capabilities into your production facilities puts you at a distinct competitive disadvantage. In a recent study, 84% of industrial companies said they believe data analytics have the power to shift the competitive landscape.<sup>2</sup> In fact, the number one fear of companies being unable to implement a data-driven strategy is that competitors will gain market share at their expense.<sup>3</sup>

Today, it's the refined collection, analysis, and application of data that optimizes efficiency and productivity. Data-driven predictive asset maintenance can save up to 12% of scheduled repairs, reducing overall maintenance costs up to 30%, and breakdowns up to 70%.<sup>4</sup>

The Aberdeen Group reported that 68% of manufacturers suffer from excessive costs related to materials, labor, packaging, and shipping.<sup>5</sup> For the most part, these added expenses are due to waste resulting from rework, unscheduled asset downtime, maintenance, and late shipments. Predictive analytics have the power to help reduce all of these issues. In fact, one performance chemical company reports increasing capacity by nearly 20% after adopting a predictive analytics model.<sup>6</sup>





# The bottom line: You can't afford to delay implementing a digital strategy

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

## Fickle demand

The demand for change is increasingly common as consumer preferences shift almost daily. The result is a rapidly eroding time buffer between market demand and your production lines. In the past, you likely followed a make-to-stock model, with the luxury of months or years to line up your facilities. Now, products can be conceived, developed, and sold in a matter of weeks or days, and you're forced to compete on your ability to manufacture to order.

## Aging workforce

You've always relied on the expertise of your people to achieve production targets. But, simple demographics point to the long-term attrition of operational know-how as your most experienced personnel—often your first, and only, line of defense in responding to machine failures—exit the workforce. Meanwhile, the potential for unexpected downtime builds, threatening to upend all your carefully planned schedules.

## Siloed systems

To improve operations, you have automated select activities, primarily by purchasing point-product solutions. But production data is often gathered manually— isolated in siloed systems and different formats. Some manufacturers are taking a holistic, data-driven approach, but your organization has yet to take that step.

## Growth at risk

Near-term, you risk not having the flexibility to make the goods people want to buy today. You just don't have the big-picture visibility you need with respect to equipment, people, processes, and materials. In an environment where overall manufacturing growth is stagnant, new revenues can only come from taking market share away from competitors. But, will other more nimble rivals be able to make the products that you can't?





# Key challenges of your current environment— and strategies for tackling them

## 01 **It's difficult to start and stay ahead**

If you're like most organizations, you have equipment from multiple suppliers in plants of various sizes and ages, some of which you built and some you acquired—and no two facilities are the same. To realize benefits across the enterprise, you must create a common system for gathering and analyzing data. But integrating your systems falls outside of your core competencies. And hiring an outside vendor that is unfamiliar with your processes and equipment could result in installing technology that interrupts current output. Meanwhile, as you wrestle with your options, your competitors move further ahead.

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**48%** of those surveyed said they have a talent gap for gathering and consolidating disparate data.

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### **Start with a complete foundation**

Your strength is production, not software applications and data management. Rather than spend time and resources building your own technology infrastructure, you need a trusted partner with proven skills and tools, including applications and hosting services, to make the transition to a data-driven model a practical reality.

### **Get the flow of data started quickly and efficiently**

The journey begins with standardized connectivity to track data from your plants, equipment, materials, and people. The right partner can help you establish this capability in just a few days. You can then begin to measure and compare equipment metrics and operator practices to identify the reasons for production losses—without making costly investments in additional IT equipment or staff.

### **Access a single source of expertise**

Point products only provide a view into a single production step or technology area. To become a truly digital company you need the enterprise-wide ability to deliver data from the source equipment to the cloud where it can be shared and analyzed. The resulting insights enable you to reduce production losses and drive additional efficiency.



## 02 **My current system doesn't provide the visibility I need to take action**

Over the years, you've installed separate best-of-breed systems for inventory, production, downtime, and quality—and systems vary from plant to plant. Often, data is relayed from one system to another manually, with corresponding delays and the potential for transposition errors. Some data isn't captured at all. As a result, no one can get a single, up-to-date view of the entire manufacturing process or view the situation from a historical context. When a problem arises, it's difficult to identify the cause. You're forced to rely on the intuition of your most experienced staff—a resource you are steadily losing to retirement. Unable to optimize, you're experiencing too much downtime and scrap produced at your busiest plants, while excess capacity sits idle elsewhere.

### **Deliver insights to the right people at the right time**

When core operational knowledge is isolated in the minds of a few key people, a vital resource is lost. You need to extract the right equipment and quality data from your operations and share it with the right people across your organization in an easy-to-consume format.

### **Have the information you need**

Without complete, uniform performance data from equipment, it's impossible to make valid comparisons. Your partner should be able to help you determine exactly what metrics to track across all your equipment—and how to ensure data is always consistent regardless of the equipment generating it. Standard data will allow you to easily roll up production results across all your lines and plants to give you a single source of the truth.

### **Show each person what they need to know**

No one has time to sift through mountains of raw data to locate what's relevant to them. So, you need to deliver custom information to meet each user's individual needs. You need to be able to provide an operator with real-time performance data on a single machine, material availability levels, and instructions in case of equipment failure. Plant managers need to know which lines need their attention and the likelihood of meeting production targets. Meanwhile, executives need a perspective that spans multiple facilities to spot common problems and initiate programs to resolve them holistically. And all of that information needs to come from the same data stream to eliminate errors and conflicting perspectives.

### **Understand all the implications of a change**

No single operator, process, or piece of equipment lives in isolation—nor should the data they generate. When you can define the relationships between each element of your manufacturing process, you can create a digital representation of your plants. The next time a machine goes down, you can quickly spot the other equipment, operators, and processes that are impacted and quickly redeploy resources. Or, you can use unexpected downtime as an opportunity to perform much-needed maintenance. With real-time data and analysis, your workforce can make informed decisions on the fly.

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**For 23% of executives, quality and cost of collecting machine data are a top-three barrier to implementing Big Data initiatives.<sup>7</sup>**

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## 03 My plants can't keep pace with changing customer demands

Using sophisticated data analytics, world-class companies have developed finely-tuned market-sensing capabilities to stay on top of changing purchase patterns. Your company is introducing new products more rapidly than ever, with a direct impact on your daily production schedule. It can take weeks or months—and require a huge capital investment—to make plant changes. And often, before you can switch over to a new product, market demands shift yet again. But, if you can't meet the cycle time of today's market, your customers will take their business elsewhere.

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Only **40%** of companies surveyed can predict based on existing data and only **36%** can optimize operations.<sup>8</sup>

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### Operate adaptable facilities

Differentiation now depends on reading demand signals from the market and synchronizing your output accordingly. And using information is the most efficient and successful way to adjust production and account for issues related to materials, equipment, people, and processes. You can track each component as it moves through each stage of the manufacturing process, regardless of how many mid-stream changes you make. By being able to quickly and efficiently switch production, you maintain margins even as your run sizes diminish, profiting from the new market model.

### Quickly identify the steps needed to change production

Your existing facilities were not originally intended for today's small runs and rapid change-overs. Complete visibility into all your plant's operations makes rapid output shifts possible. Plus, you will have the information necessary to generate new bill of materials, reroute components, change equipment schedules, and re-assign employees—allowing you to keep pace with today's shorter demand cycles.

### Make quality a fixed point of excellence

Your ability to monitor the production process ensures you are making each component correctly. Any deviations from the engineering specifications surface in time to adjust equipment before you create unusable products. And you can monitor the quality of individual products as they are made and identify areas of rework so only the highest caliber goods are shipped. You consistently meet your goals for superior products and delight your customers.

### Know the entire history of a product

Rapid changes to your product mix make step-by-step process tracking difficult. But you need the ability to track how each batch of material or components is used—even if a batch is split between different manufacturing pathways. When you make a change at the master level you need to be able to see the impact across all affected lines.



Let us help you find the right digital solutions for your business. To learn more, contact GE Digital for an assessment.

[CONTACT US](#)

# References

<sup>1</sup> Industrial Internet Industry Report, GE and Accenture

<sup>2</sup> Ibid

<sup>3</sup> Ibid

<sup>4</sup> Operations & Maintenance Best Practices: A Guide to Achieving Operational Efficiency, Release 3.0, Sullivan, Pugh, Melendez and Hunt, Pacific Northwest National Laboratory—U.S. Department of Energy

<sup>5</sup> The Aberdeen Group

<sup>6</sup> GE Digital website,

<https://www.ge.com/digital/customers/food-beverage-cpg>

<sup>7</sup> Industrial Internet Industry Report, GE and Accenture,

<sup>8</sup> Ibid







# Manufacturing Operational Intelligence

Using data and analytics to achieve operational insights





# Breaking Siloed Manufacturing Information Systems

Imagine recovering up to 20% of production capacity, reducing finished goods inventories by 30%, while validating supplier quality to reduce operational variability, risk, and rework.

Now more than ever, manufacturing leaders are challenged to balance a multitude of competing priorities. Raw materials and energy costs are rising; customers increasingly demand just-in-time order fulfillment; and lower-cost competitors are entering the market with lean, direct-to-consumer production capabilities.

Although many manufacturers have invested significantly in automation solutions—HMI/SCADA control networks, MES/MOM and ERP/ MRP applications, and database historians—most manufacturing information systems exist as disparate data silos. Production managers must frequently employ a piecemeal combination of spreadsheets and paper reports to derive basic manufacturing performance metrics.

Hand-crafted systems integrations are extremely brittle (e.g., simple process changes can cause critical data flows to fail), and their manually-intensive nature severely limits business agility and scale.

The goal of this paper is to discuss Manufacturing Operational Intelligence (MOI) as an enabling solution for modern manufacturing companies. The sections below identify outcome-driven MOI benefits and identify key requirements of an effective implementation.





# Enabling Operational Excellence

## Imagine—

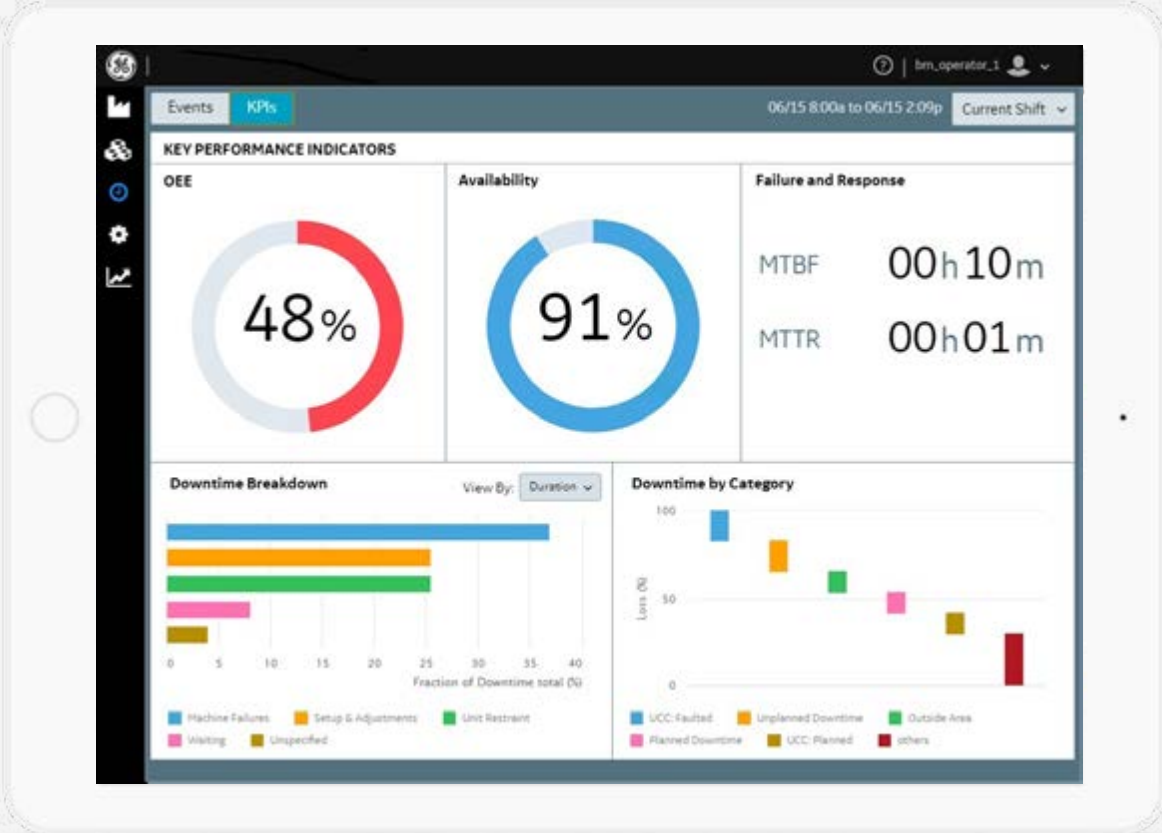
All of your machines and processes working together, with vast amounts of performance data easily feeding into a single integrated dashboard.

## Imagine—

Key performance metrics visible throughout your operations, delivering actionable insights to your plant managers, production supervisors, and operators. These insights can be used to tune equipment and production lines, as well as add visibility into production performance to allow for changes to be made “on the fly,” based upon demand.

## Imagine—

Outcomes such as improving labor efficiencies by 5% or reducing overtime costs by 10%.



**“If your company isn’t on the path towards using manufacturing performance dashboards, 61% of your competitors will be using them to drive continuous improvements in performance more accurately and rapidly.”**

**LNS Research**

LNS Research, a leading industrial analyst firm, recently found that 21% of companies LNS surveyed are currently using MOI software solutions, and an additional 26% are planning to do so in the next year.\*\* Research shows that MOI adoption is accelerating as companies look to utilize real-time information as a strategic tool to improve business.

# Key MOI business outcomes

Although priorities vary among manufacturing leaders, most agree that MOI can have a profound impact on production operations by improving visibility, streamlining decisions, and replacing guesswork with fact-based decisions. Important business outcomes are highlighted below.

## Increase labor efficiencies

To optimize workforce productivity, MOI dashboards often visualize operator productivity and downtime metrics. Armed with these critical insights, management can optimize resource allocations based on personnel productivity and identify additional capacity within the existing workforce instead of hiring new labor or allocating overtime.

## Reduce downtime costs

MOI enables equipment maintenance to be performed predictively, in many cases dramatically reducing repair and costs associated with unplanned downtime. Maintenance departments can order the replacement parts in advance to get better pricing, and managers can allocate repair personnel at the most cost-effective times—when production demand is lower or when inventory and raw materials are exhausted.

## Reduce defects and related costs

By tracking context-rich quality data, MOI allows production managers to identify defect root causes and eliminate costs associated with waste. Improving the focus on quality at every stage of production also reduces warranty costs.

## Achieve automation efficiencies

MOI enables the shop floor to go paperless. Typically, plant managers and line supervisors spend an enormous amount of time collecting, analyzing, and reporting downtime information. MOI eliminates human-intensive data collection by capturing and reporting downtime sources automatically—allowing skilled workers to focus on high-value activities.

## Increased yield

The net effect of reduced machine downtime, higher productivity of operators, and reduced defects is the achievement of higher production yields with the same resources.

# P&G sees time savings and data customization with Proficy Smart Factory

Procter & Gamble (P&G), a global CPG company, was challenged with technicians having to manually enter data across systems. This led to a lack of customizable data, which limited the data's contextual value. The company realized there was a strong need for system integration.

P&G looked to GE Digital and GrayMatter, a GE Digital partner, to implement the scorecard application, part of the Proficy Smart Factory (MES) suite of solutions, to provide panoramic views of production performance for continuous improvement. Now, operators use tablets to receive critical process data in real-time on the factory floors, without needing to return to a desk for reactive analysis. P&G has also been able to replace manual data interpretation processes with touchscreen technology in team rooms, further enabling customization of data. P&G has been able to save 45 minutes per shift, per line, per business unit with this technology. This GE Digital solution has offered operators flexibility to customize data relevant to their specific aspect of the manufacturing process.

[WATCH NOW](#)

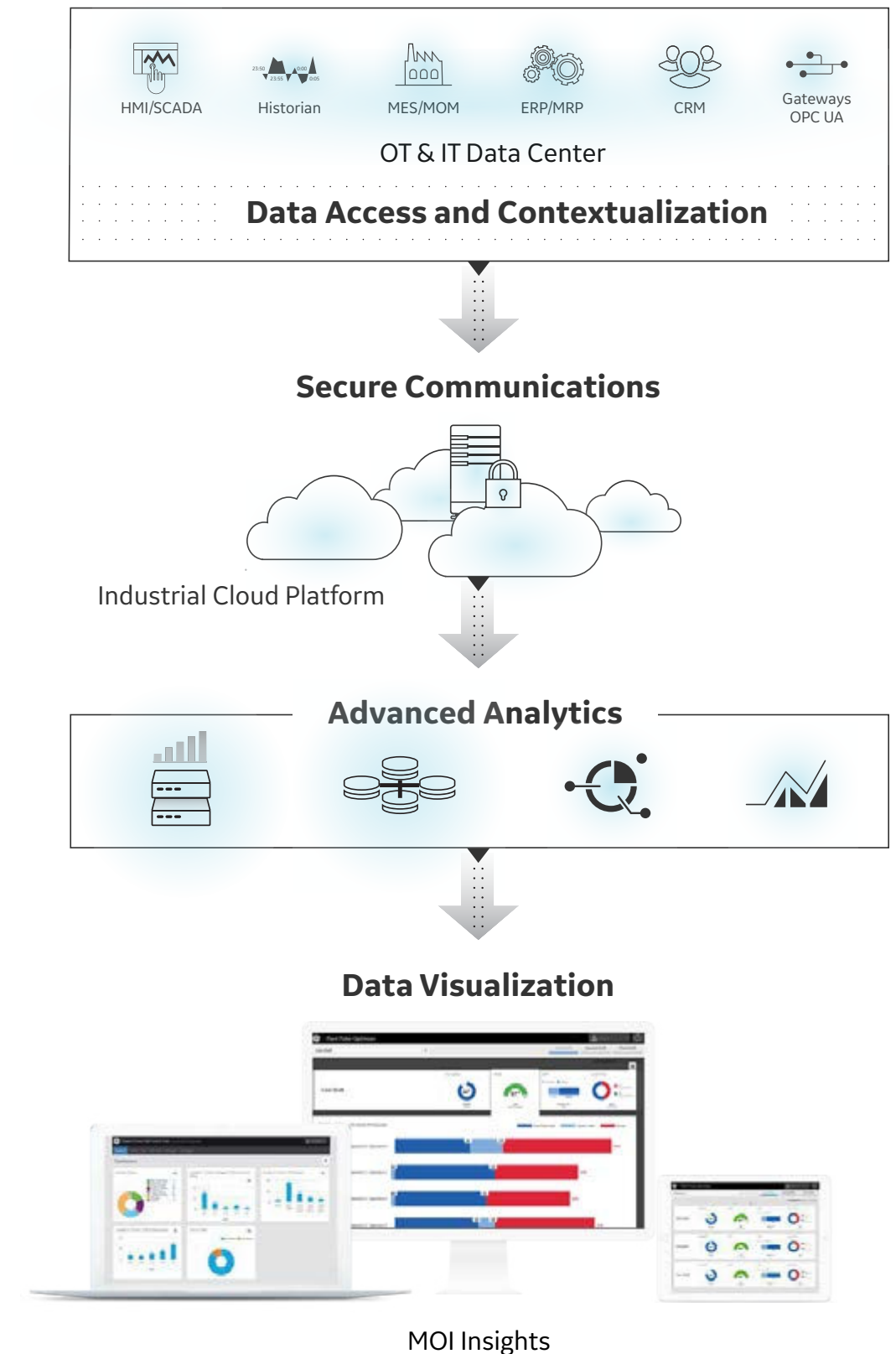


# MOI technology foundation

Although information architectures vary, most manufacturers have systems in place for real-time process control (HMI/SCADA), manufacturing management (MES/MOM), resource planning (ERP/MRP), and customer relationship management (CRM). Many organizations are also implementing historians to hold time-based machine and process data histories. Combined, these systems form the information backbone needed to drive MOI analytics and insights.

Core capabilities of effective MOI infrastructures include:

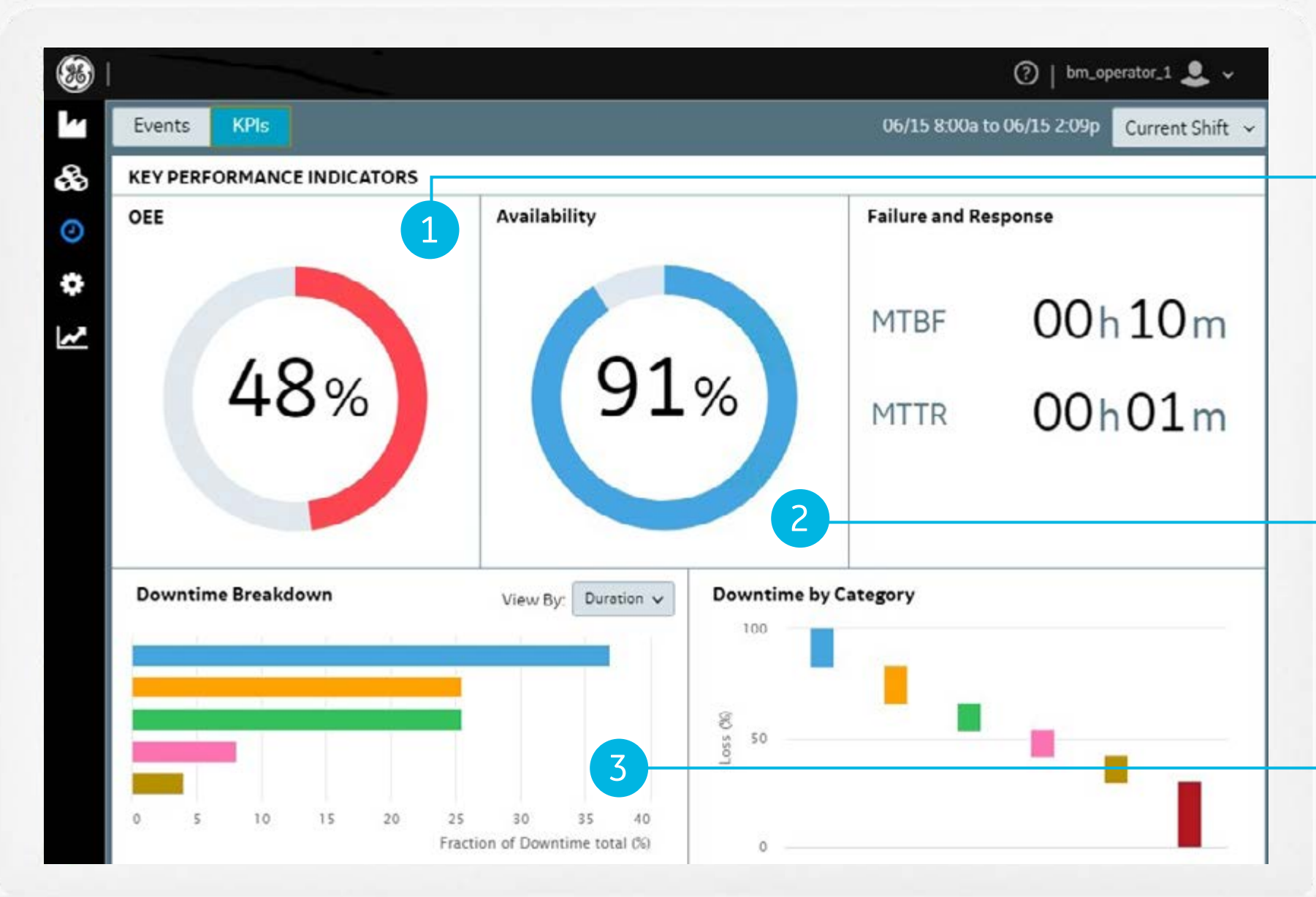
- **Data access and contextualization:** The MOI data access tier must be capable of retrieving and integrating data across critical back-end systems in OT and IT data centers, using whatever APIs and semantics those systems expose (ODBC, OPC UA, REST, etc.).
- **Secure communications:** Regardless of whether an MOI solution is deployed entirely on premise or on a cloud platform, security is paramount. Data must be protected while at rest and in flight, and MOI communications must not expose critical control systems to attack from malicious intruders.
- **Advanced analytics:** Some manufacturing insights can be achieved by simply providing visibility into machine, inventory, and process states. Other insights—e.g., for machine and equipment health—require predictive models and advanced analytics. An effective MOI provides ready access to a continuum of analytic horsepower needed to drive meaningful operating improvements.
- **Data visualization:** Leading MOIs use advanced visualization patterns to bring manufacturing data to life. Users gain immediate visibility and insight into key operating performance metrics, and dashboards are easily customized to accommodate new analytic requirements.



# MOI Insights Example

This simple dashboard illustrates useful MOI insights in a dairy plant. Data used in the dashboard is collected from multiple back-end datastores and applications. Analytics are represented simply and visually to make it easy to understand quickly.

MOI gives all team members instant access to defined plant KPIs – across sites – eliminating data clutter, exposing key insights, and improving operational agility.



1 Overall Equipment Effectiveness (OEE) for my shift. The OEE is a combination of

2 Focus on “My equipment” availability for my shift, one of the 3 OEE components.

3 Downtime analysis, by reason and category. The purpose is to identify the key reason for low efficiency and the bad actors.



# Key MOI Capabilities: Tools vs. Applications

One of the first decisions an MOI implementation team must make is whether to acquire point-level technology tools and build the MOI from scratch or install and configure a unified application. Although a build-from-scratch strategy offers flexibility, it also assumes the implementation team has all of the requisite knowledge and skill to build an MOI application correctly—the first time.

Commercial MOI applications offer significantly shorter-time-to-implementation and reduced project risks—because they are designed to deliver advanced capabilities out of the box. Further, leading applications offer the flexibility to begin with on-premises implementations and expand to secure cloud deployments over time.

Key capabilities of a world-class MOI solution—whether built from scratch or deployed as a commercial application—are summarized here.

- **Aggregation:** Making available data from many sources, mostly shop floor systems, including custom databases, MESs, LIMs, quality systems, and increasingly combined with financial and business data from ERP systems.
- **Contextualization:** Providing a structure—or model—for the data that will help users find what they need. Usually a folder tree utilizing a hierarchy such as the [ISA-95](#) standard.
- **Analysis:** Enabling users to analyze data across sources and especially across production sites. This often includes the ability for true ad-hoc reporting.
- **Visualization:** Providing tools to create visual summaries (often ad-hoc) of the data to alert decision makers and call attention to the most important information of the moment. The most common visualization tool is the dashboard.
- **Propagation:** Automating the transfer of data and transactions from the plant floor up to enterprise-level systems or vice versa.

## MOI Transaction Propagation Scenario

A heavy equipment manufacturer implemented a commercial MOI application with the goal of reducing line downtime and improving dealer service levels. Under production load, a key piece of equipment begins to report vibration in its main bearing assembly. Analytics predict the bearing will fail within 72 hours.

In addition to alerting operators about the possible problem condition, the MOI alerts the maintenance team by automatically triggering an urgent inspection work order based on upper and lower control limits on vibration settings for the asset. The MOI enables the supervisor to adjust anticipated production throughput in the MES solution, and issue a fulfillment delay notification in the supply chain application. The manufacturer's CRM system is also notified to keep the sales team updated on product availability status.

# A Checklist for Getting Started on the Path to MOI

Although some organizations are staffed to roll their own MOI infrastructures, the discussion above reveals that implementations require a diversity of technical skills – including data integration, security, analytics, and advanced visualization. LNS Research suggests a five-step roadmap for implementing an MOI pilot, and expanding to a larger vision once the pilot has been successfully completed.\*\*

## 01 Don't go it alone

Start by building a small, easily manageable cross-functional team that includes members from the impacted areas of manufacturing, production operations, and IT.

## 02 Clearly define the objectives of an MOI pilot solution

The initial expectations should be set that the first proof of concept will collect, aggregate, and contextualize a certain set of data into new information that can “bring to life” some new or faster performance insights. These new insights need to be associated with one or more current challenges that exist within the manufacturing/production operations.

## 03 Scope the MOI pilot solution to be small (one to three months)

The pilot project will need to address issues like where and how will automated data collection occur. Will the MOI solution collect data from data historians, through API calls to enterprise applications, through OPC UA gateways? Involve end users (and customers) in the pilot design phase to determine what metrics are most meaningful to provide, and what actions can be taken based on the new information insights.

## 04 Once successful, expand the pilot to other areas

As the pilot implementation team gains experience and confidence, and the larger organization becomes convinced that MOI can act as a performance visualizer and accelerator, companies are ready to define a long-term vision (one to five years). This vision should be transformative in the way in which your organization can work and collaborate in the future.

## 05 Accelerate the MOI journey by choosing the right partners

A chosen software vendor should have a technology tool set that can address both the quick project cycles in the short-term pilot, as well as possess the capabilities to scale to the sophistication of a long-term vision.



# Summary

Manufacturing leaders are increasingly challenged to balance a multitude of competing priorities—improved customer service levels, reduced costs and cycle times, and build-to-order production capabilities. Although many companies have invested in manufacturing automation systems, most manufacturing data remains locked in disparate data silos.

MOI solutions provide the software infrastructure needed to access and aggregate critical industrial data, thereby providing context for advanced analytics and visualization. Adopters have reported significant gains in productivity and efficiency in comparison to outdated spreadsheet models and paper reports. Importantly, MOI also provides a path for business optimization, as newly automated processes can drive further automation in all adjacent systems.

Organizations can choose to implement hand-crafted MOI solutions by selecting from a variety of available tools and building from scratch. Although a "tools-centric" strategy offers flexibility, it is accompanied by significant costs, risks, and time-to-implementation factors that may not be acceptable.

Many manufacturers are choosing instead to acquire and install a commercial MOI. Commercial applications offer a compelling alternative when time-to-implementation and risk management are driving criteria.

## GE Digital: Solutions and Services for Manufacturing

GE Digital is a leading provider of technology solutions for manufacturing organizations worldwide. Our [Proficiency Smart Factory \(MES\)](#) suite is the synthesis of two decades of working with the world's most recognized brands in manufacturing, including our own GE plants.

In addition to providing world-class manufacturing solutions, GE Digital offers the flexibility to deploy our software in three different ways: on premises, in the cloud, and in hybrid configurations. We also provide a wide range of professional services—including design and mentoring workshops, implementation Starter Kits, and remote management—to put your digital industrial initiatives on the fast track. Contact us today to learn how we can help you get started on your MOI journey.

*\*\*Getting Started with Enterprise Manufacturing Intelligence – LNS Research*





# Enabling Rapid Line Changeovers

Using electronic work instructions to improve changeover processes—paving the way for manufacturers to recover valuable production time, accelerate margin, and control product quality





# Introduction

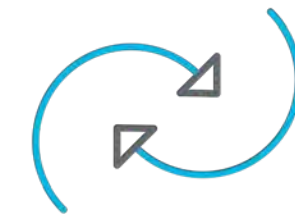
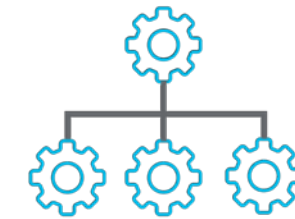
In today's fiercely competitive economy, manufacturers face intense pressures to boost production efficiency and meet increasing consumer demands. Now more than ever before, consumers expect a constantly changing breadth of diverse, innovative products, and inventory managers everywhere have had to adapt to smaller, more targeted runs to meet demand and minimize excess inventory.

Most plants are running multiple products per line per day, including varieties of the same products as well as entirely different ones. All these different products being produced on the same line have resulted in many more production line changeovers in the factory compared to even just a few years ago—requiring processes, people and equipment to adapt. With capitalization of new equipment out of the question in

this current “hold your cash” world, manufacturers need to look at improved changeover procedures.

A critical enabler is speed because the amount of changeovers a plant can perform is limited by the amount of time it spends on each changeover. Most plants today spend a significant amount of time on them between runs—translating into non-production time and higher costs per unit. Key obstacles include manual processes, which are more time consuming and prone to increased quality risk, and the time required to train operators to constantly perform new changeovers.

This white paper discusses how real companies have successfully enabled rapid changeovers through the use of electronic work instructions, also referred to as electronic standard operating procedures (eSOPs), to effectively guide operators through the process. Electronic work instructions help manufacturers gain the agility and speed needed to efficiently produce many different products on the same line without changeover delays—enabling the recovery of valuable manufacturing time, consistent product quality, and reduced excess inventory, all of which are critical to a better bottom line.



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*Changeover costs are seldom measured, but can total as much as tens of thousands of dollars per hour. It is estimated that for a one-hour daily changeover on a fairly significant packaging project with the line running 240 days per year, the annual cost is \$1.8 million.*

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## Guiding operators through changeover processes

It is no secret that line changeovers cost money. In the past, most companies built this into the base cost because it was not performed frequently enough to track during their large production runs. But today, manufacturers find this formerly “hidden cost” growing exponentially as the number of changeovers increases and production run lengths are cut to reduce inventories.

In a survey of *Food Manufacturing* readers, the majority of plants (57%) reported that they run two or three different products per line per day; 30% of respondents reported that line changes involved a change to an entirely different product; and 17% run more than ten packaging changes per day.

Line changeovers equate to non-production time with many labor hours spent cleaning, adjusting, and verifying machine setup. They also introduce greater risks because issues not addressed properly during changeovers can cause longer startup cycles, more rejected product, and increased machine malfunctions. It stands to reason that the more often changeovers occur, the higher the likelihood of negative effects.

For example, one manufacturer adjusted its production run to half the amount of product, allowing it to change flavors and sizes on the line to gain a more flexible production inventory level. But when it changed from a one line

changeover per week to six line changeovers per week, the plant’s equipment failure rate doubled, which slowed down production, increased product rejects, and also resulted in extremely high operator overtime.

The company decided to take a step back and examine what happened; at the top of the list were ineffective changeovers. As it moved from one changeover to six changeovers per week, many new operators were brought into the process, but there was a lack of changeover procedures to guide them. Additionally, the new operators did not have the tribal knowledge or expertise of the original operators, opening the lines to more errors and lost time during line changeovers.

To address this challenge, the manufacturer implemented new electronic work instructions for changeovers to guide each worker through the tasks required to get the line ready for the next product or size change. These workflows captured the tribal knowledge of the company’s most experienced operators to help make every worker “the best worker” and incorporated best practices into the work processes for faster and better production setup. As a result, the company reduced its line changeover time by 25% and line start issues by 50% for significant time and cost savings.



*GE Digital software guide operators through electronic Standard Operating Procedures (eSOPs).*

**With the implementation of new electronic work instructions to effectively guide its new operators through changeover processes with increased accuracy and speed, a mid-sized consumer products manufacturer saved 25% of its line changeover time and cut its line start issues by 50%.**



# Enabling Rapid Line Changeovers

## Speeding up the most costly part of a production line.

When asked about the time required to change over a production line, many companies will give general answers like, “We do that off shift” or “half a shift” or “a whole shift depending on the type of changeover we are performing.” The unfortunate issue is that they do not understand or know how long changeovers—a costly, nonsalable action—really take, particularly because in the past when changeovers were completed less frequently, the impact was minimal.

In today’s environment where there are constant changeovers, manufacturers that view line changeovers as a production run can leverage the power of information to quicken changeovers, hence driving increased productivity for a better bottom line. The use of eSOPs help systematize best practices and provide valuable information and critical visibility into changeover processes, including how long each actually takes and where and why issues occur—enabling improvements for effective production planning.

For example, one food manufacturer implemented an eSOP solution and turned its process improvement team onto

the data. The team discovered that the same tasks were taking different amounts of time to perform, depending on the operator shift, which pointed to the need for better training. Additionally, it discovered that moving through the production mix worked better in one direction than others; for example, reducing bottle size was faster and easier than increasing bottle size.

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*The valuable insight gained from the use of electronic work instructions enabled a food producer to uncover a significant improvement opportunity that led to the reduction of the overall time for line changeovers by 35%.*

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Using the information from electronic work instructions to gain better insight about its changeovers, the company incorporated training and also changed its production to go from largest bottle size to smallest bottle size, reducing the overall time of a line changeover by 35%. The significant improvement resulted in less operator overtime, fewer product rejects, and reduced equipment failures—driving speed and production efficiency.

## Ensuring high product quality with accurate setup

Quality as explained by one manufacturer’s Vice President of Quality is “a game of trust but verify.” Generations of companies have taken on different mantras to ensure quality, including “do it right,” “continuously improve,” and “Lean/Six Sigma.” Furthermore, many of these companies have realized that the operator is the first line of defense and have moved toward having the operator perform many of the quality verification steps.

For instance, one company realized that changeovers were impacting its product quality and implemented eSOPs to ensure that its operators would not miss any changeover steps, which if omitted, resulted in setup errors and rejected product. The use of electronic operating procedures prevented its operators from inadvertently skipping a step, ensuring production compliance with defined processes and minimizing errors that can lead to quality issues.

The workflows also enforced operators to enter critical parameters along the way, which could be verified against quality standards automatically—helping to ensure that the line was set up correctly and ready to run. With valuable information on product quality, operators could quickly respond to issues, allowing them to gain tighter control without additional headcount and reducing the reject rate.



## Electronic Standard Operating Procedures (eSOPs) vs. Paper-Based SOPs

### The significant advantages of eSOPs include:

- Strong adherence to standard operating procedures as eSOPs can be used to ensure that lessons learned actually stick.
- Improved accuracy and repeatability as eSOPs are much less open to interpretation and abuse, either intentional or unintentional.
- A direct link to the plant to ensure that safety interlocks remain uncompromised and changeovers are followed in exact sequence.
- The ability to do what people are poor at doing—routinely collecting and collating masses of data.
- Powerful reporting tools that transform data into meaningful information, which is consumable by stakeholders across the organization for better decision making.

## Winning the excess inventory battle

Companies with high volumes and low margins know that razor-thin inventories are paramount to their success. Reducing excess inventory can mean millions of dollars added back to the bottom line, which is why companies continue to push their supply chains to be more agile and drive toward a “make-to-order” nirvana.

To achieve this, companies must stop treating their manufacturing sites as black boxes that only report the finished product, and instead gain more information about the build process as it is happening. Real-time production information helps companies drive out unpredictability, which can then help them to reduce their safety stock to new lows—freeing up cash that would otherwise be tied up in product.

The advantage of successful line changeovers enabled by electronic work instructions expands beyond product quality and speed to improved predictability. Reliable changeovers allow companies to gain better insight into real-time production and the impact on inventory to enable proactive scheduling and planning of resources and materials. Therefore, companies do not have to hold unnecessary inventory levels—tying up real money that could be invested for growth or other strategic initiatives.

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*Electronic work instructions enabled one of the world's largest CPG manufacturers to reduce excess inventory, saving millions of dollars per year in rental warehouse space while enabling better planning of resources.*

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As a case in point, a warehouse manager for one of the world's largest CPG companies previously had to rent three separate warehouses to hold excess inventory because the company could not accurately predict expected production. After implementing eSOPs, his production became much more reliable, whereby safety stock could be better aligned with actual production levels.

As a result, the company was able to reduce its excess inventory across its product lines, eliminating the need to rent three warehouses and saving the company millions of dollars per year in rental space.





# Conclusion

With increasing consumer demands for an endless variety of new products, manufacturers have had to keep up with smaller, more targeted runs and multiple products per line per day. In turn, a growing area of concern for manufacturers in today's fast-paced environment is the increased frequency of line changeovers, which results in significant non-production time, in addition to increased quality issues and costs.

As some leading companies have begun to discover, the key to quickening line changeovers without compromising quality relies upon guiding operators through changeover processes with electronic work instructions. The faster operators can set up machines and recipes correctly, the more efficiently manufacturers can produce many different products on the same line without changeover delays and errors—recovering valuable production time and delivering consistent product quality.

Furthermore, rapid and reliable changeovers enabled by electronic work instructions help manufacturers leverage improved predictability to drive proactive planning of resources, including the reduction of excess inventory. The critical insight manufacturers gain into real-time production helps drive increased agility across the plant—accelerating profit margins for a stronger bottom line.







## Case Studies



# Delivering Real Results to Manufacturers



- \$5M annual quality improvement savings
- >\$10M energy savings over 5 years
- \$500K annual waste savings
- \$200K/yr SKU cost reduction
- \$0.01/case SKU formula cost savings
- \$850K/yr production efficiency savings
- 3-month payback on MES investment
- 39% decrease in downtime events
- 10% operating costs reduction
- 10-15% energy savings improvements YOY
- 30% faster new product introductions
- 25% defect reduction
- 25% plant downtime reduction
- 80% reduced furnace emission
- 50% waste reduction
- 20% OEE improvement
- 90% waste reduction
- 35% reduction in product waste
- 90% decrease in finished goods holds & packaging waste
- 9% increased production efficiency







# Digitization Step Change at Procter & Gamble Improves Performance

Diverse Consumer Products: shampoo, paper towels, electric personal devices, OTC medicines, and much more





# Digitization is a journey, whether in a large or small organization.

Learn how P&G, one of the largest consumer packaged goods companies in the world, has deployed Proficy Plant Applications at an enterprise scale to accomplish digitization step changes and achieve critical outcomes.

## Mixed Manufacturing Environment

With diverse manufacturing requirements, P&G leverages a hybrid MES for both process and discrete capabilities in one solution.

## Hybrid On-Prem / Cloud Approach

Furthermore, discover how P&G has employed GE's Manufacturing Data Cloud for an on-prem / cloud approach that improves performance, reduces costs, and provides a foundation for analytics and optimization.

## P&G Plant Statistics

- 2 GBS Supported MES Platforms: Proficy (94), Maple (17)
- 10 Category's (Clients: 10 BU VPs and 120+ Plant Managers)
- 39 Manufacturing Solutions
- 68 Sites archiving data in the Mfg Data Cloud (MDC)
- 101 plants
- 2000+ manufacturing lines
- 45,000+ (Users: people working in manufacturing discipline)

# P&G

## Products

- Proficy Plant Applications
- Proficy Manufacturing Data Cloud
- Proficy Historian
- iFIX HMI/SCADA
- Proficy Workflow

## Results

- Improved performance
- Reduced costs
- Data analytics

WATCH P&G VIDEO #1



# Delivering Manufacturing of the Future

## Background

Procter & Gamble (P&G) is a fast-moving consumer goods company that's made up of several different business units that touch the entire spectrum of a person's life stages.

## Challenges

### Keeping up with consumer demand

The company's technicians were often tasked with re-entering the same data across multiple systems, causing improper utilization of time and frustration among its operation teams. P&G needed an integrated system that would allow technicians to interact with data in real-time and at scale.

## Results

### Unlocking real-time operational visibility

P&G was able to visualize its operations to achieve improved process reliability, production efficiency, and operational safety.

- Improved process reliability
- Increased productivity
- Improved operational safety

[WATCH P&G VIDEO #2](#)







# 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

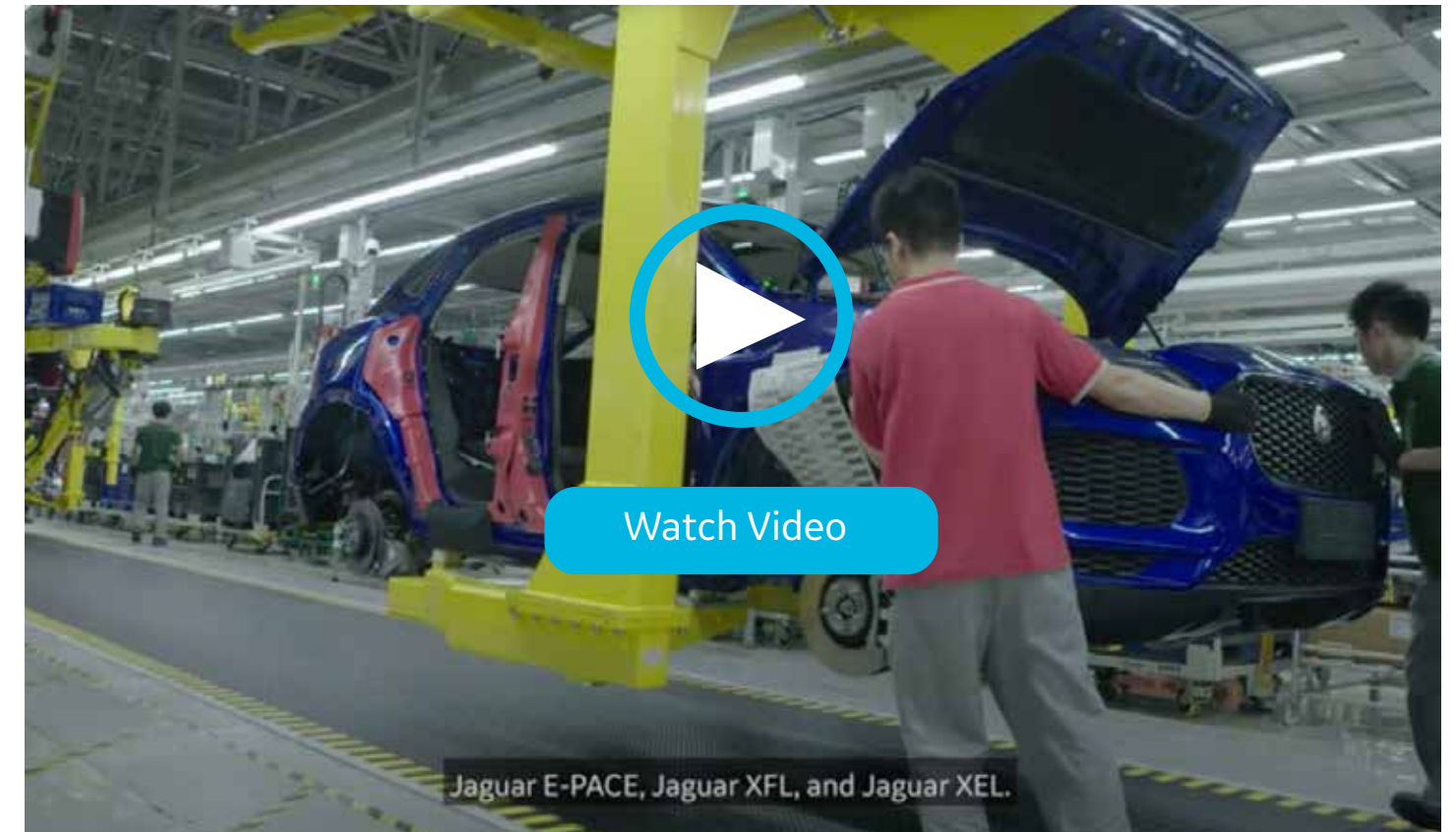
Proficy Plant Applications

Proficy Historian

Proficy Webspaces

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.



## 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.

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*"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**

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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.

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*"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**

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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

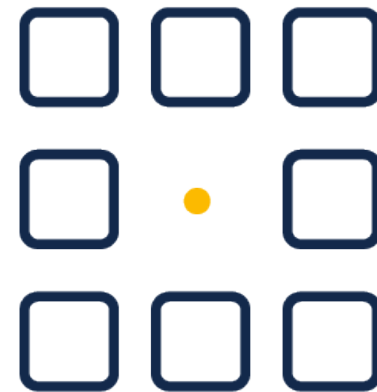
Innovation is key to help Chery Jaguar Land Rover overcome the technology disruptor coming out of the automotive industry and drive values to the business. Using GE Digital's MES and Holo-Lens mixed reality has helped them not only reduce time to market and reduce costs for launch, but also helped improve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

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*"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**

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# The J.M. Smucker Company

Harvests value from data to drive process & people changes





# Summary

## J.M. Smucker Company

### Solutions

- Production Management: efficiency, quality, traceability, and more
- Enterprise- and plant-wide monitoring, visibility, and control
- Industrial data management with enterprise-/plant-wide historian

### Products from GE Digital

- Proficy Plant Applications
- iFIX HMI/SCADA
- Proficy Historian
- Proficy Workflow



## Big Wins

- Saved \$500,000 a year by reducing product overfill at pet food facilities
- Expanded Uncrustables production capacity through error recognition & reduction
- Data flowing to senior-level leaders is highly relevant; no longer outdated

The J.M. Smucker Company was founded in 1897 when Jerome Monroe (J.M.) Smucker created his first product, apple butter, in Orrville, Ohio.

Guided by a vision to engage, delight, and inspire consumers through trusted food and beverage brands that bring joy throughout their lives, Smucker has grown to be a well-respected North American marketer and manufacturer.

The Fortune 500 company's brands spans pet food and pet snacks, coffee, and consumer food and natural beverage.

**Two years ago, Smucker's didn't have a data analytics group.**

Now it has a team of four focused on how to harvest value from all the data consolidated from its production facilities. What changed? Smucker's leadership recognized the huge potential of harnessing big data to dig into production challenges such as product overfill, hidden plant capacity and equipment downtime. Plus, IS Operations colleagues John Baier and Kevin Briggs were willing to "pick a fight" by suggesting data analytics and visuals could produce real savings for Smucker's.

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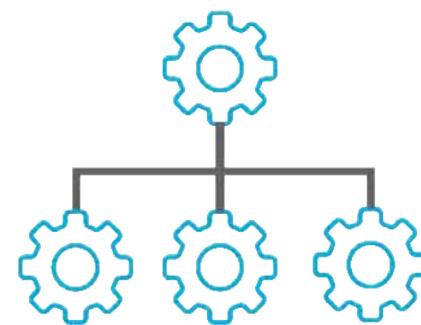
*"We have the largest data set in the entire company, our operations data. How do you leverage that information so you can take action?" said Baier, the Senior Manager of IS Operations at Smucker's.*

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### The Challenges

Smucker's wanted to enable a near real-time flow of information to facility operators to optimize production and spread the opportunity to make strategic adjustments from senior leaders to plant floor professionals.

Some adjustments require hours to flow through a production system. Other processes occur in batches, meaning the sooner a negative data trend is spotted, the fewer batches get rejected. Fine-tuning Smucker's ability to target hot spots and act quickly has been a focus for Baier's team. Baier said Smucker's has made huge strides in making that data available, but it still contends with messy data—data that doesn't accurately reflect production realities or is incomplete.



*"We dabbled in a small portion of the business and saved \$500,000. If we keep getting organized around that, we can save even more."*

**— Baier, the Senior Manager of IS Operations at Smucker's.**

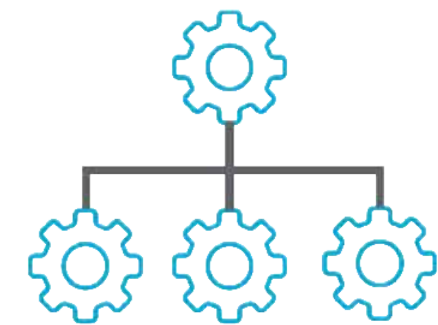




## The Solutions

“GrayMatter was one of our key partners,” Baier said. “Our leadership trusted the IS organization enough to say, ‘You guys have a right to be at the table and speak,’” Baier said. “And we’re now into a phase where the business is saying, I want to do reliability acceleration for fiscal 2020.” Baier said Smucker’s has been able to build out its capabilities to spot issues and address them. Company leaders have also asked for those capabilities to be ready on Day 1 of a new facility that’s opening soon.

GrayMatter, a GE Digital partner, collaborated with Smucker’s to enhance its MES capabilities and equip it with powerful operations management tools that analyze data and manage fast-moving processes. Baier said Smucker’s is working to further enhance traceability of raw material that enters a facility, is transformed into a product and then leaves a facility. “It’s been an interesting two-year journey,” Baier said. This year, Smucker’s IS Operations team—the one that didn’t exist two years ago—earned an Innovation Award for its business operation analytics.







# Somfy Increases Efficiency and Capacity Using GE Digital's MES

An industry leader in home automation





[Somfy](#) operates in 58 countries and is the world leader in automatic controls for openings and closures in homes and buildings. It offers a range of motorized solutions and control points, and is a key player in smart home systems. The company, founded more than 50 years ago, takes its industry leadership seriously with a commitment to:

- Customer satisfaction through quality and on-time delivery
- Consistent, efficient manufacturing
- Sustainability with a focus on the eco-design lifecycle

To better serve customers, Somfy developed a digital strategy to meet increasing capacity needs and drive consistency across its eight main manufacturing sites, each with 100-200 production lines. This strategy is part of its global “[2030 Ambition](#)” plan, which in terms of digital transformation focuses on the successful implementation of MES and ERP across [Somfy Group](#).

The company partnered with GE Digital representative [CP Solutions](#) and integrator [Premier Tech Digital](#) to deliver a [Manufacturing Execution System \(MES\) solution](#) based on industry-leading [Proficy Plant Applications](#) and [Proficy Historian](#) software.

**The company expects to see gains of:**

- Increasing efficiency
- Decreasing breakdown rate by at least 2%
- Increasing capacity with better productivity
- Supporting on-time delivery with real-time overview planning
- Improving quality and reducing waste through improved reactivity and faster analysis
- Enabling improved decision making with real-time data
- Supporting time-to-market goals with product creation/modification workflows integrated into MES
- Achieving a modern technology infrastructure that appeals to a changing workforce

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*Piloted at the company's headquarters manufacturing plant in Cluses, France, the MES solution is providing value toward meeting goals in Somfy's assembly manufacturing environment.*

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## Supporting Sustainable Growth and Customer Expectations

While Somfy has long enjoyed high growth and market leadership, the company saw acceleration in home renovation and demand that started during the COVID pandemic. Home automation including motorization systems for smarter homes are in high demand, offering greater comfort, safety and energy efficiency.

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“To meet the growing demand of our customers, we need to better use our existing equipment,” explained Yannick Mace, Vice President of Manufacturing for Somfy. “Through real-time management, MES helps us to reduce our production cost and improve product traceability and reaction rules in case of failure. With this tool, we will also standardize manufacturing processes across our eight main manufacturing sites.”

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Somfy also looked to an MES solution as, with growth and increased internationalization of sales, the company saw more complex product flows and the requirement for monitoring and traceability. Additionally, international competition drove a need for a way to further ensure Somfy could continue to meet its unique brand commitments of highest quality, innovation and reliability. Lastly, like most companies around the world, Somfy faced a changing workforce, which underscored the need for robust, simplified and automated processes based on modern technologies.





## Commitment to Digitization

According to Stanislas Dupouyet, program manager for Somfy's Digital Manufacturing, Somfy's Digital Roadmap helps to tackle all of these issues with the MES as a critical component. **The roadmap features three axes including:**

- **Axis 1:** The Lean Factory > Standards, fundamentals, modernization of production tools
- **Axis 2:** The Smart Factory > Digitization of processes and procedures
- **Axis 3:** The Intelligent Factory > Dynamic and predictive analysis of industrial data

"With the MES, we can improve the performance and efficiency of our operations, removing non-value added tasks and increasing reactivity with real-time data," Stanislas Dupouyet said. "We can standardize and digitalize our production processes around one unique manufacturing tool. Also, MES is one key to the overall data management challenge to meet our business goals such as customer delivery and stock optimization."

## MES Selection and Pilot Deployment

Emmanuel Carmier, lean and change director at Somfy, explained, "We had experience with Proficy and the flexibility and capabilities of the software. Every production environment, every factory is different, and we needed a solution that could adapt to our requirements but also provide reliability and sustainability for long-term use. It is the right balance of software capabilities and company strength."

*In selecting a partner for the MES, Somfy benchmarked software solutions available in the industry. The company chose GE Digital's MES based on previous experience with Proficy manufacturing software as well as GE's reputation, product reliability, and company sustainability.*

Unlike other companies that implement MES line by line, Somfy implemented Proficy at its Cluses plant across several lines at one time, as the lines are interconnected. This methodology has worked at Somfy in conjunction with carefully managing the project step by step. The team created an "MES school" with simulation of production using the MES, which has supported training workers in the software and how to react. The pilot site is proving that the MES offers a tool to help measure and implement a performance approach.

The software solution provides data management, facilitates real-time reactivity to deviations and faster intervention, and allows the Somfy team to spend less time collecting and formatting data and more time analyzing and managing improvement actions.





# From Product Creation to Performance Management

Somfy's manufacturing is an assembly process, bringing together subassemblies. The Proficy solution provides Somfy with functionality in four main areas: product creation and modification, scheduling, production, and performance management.

*"We were able to take a specific solution and configure it to our needs and cover a wide range of MES functionalities," Stanislas Dupouyet said. "It's provided a solution capability for our entire complex assembly process. It encompasses our operators, line management, maintenance, quality, and supply."*

**The Proficy solution supports Somfy's manufacturing with:**

- **Product creation and modification**

- Workflow: control and validation by department until production validation + test mode management
- Manufacturing data management: Product and process recipes

- **Scheduling**

- Available production time management and planned activities management (quality control, self maintenance, meetings, etc.)
- Production order list management
- Scheduling of work orders (automatic scheduling, manual optimization, send to production, real-time follow up, issues management)

- **Production**

- Gantt visualization / start-end production / declare production to ERP (SAP)
- BOM check for component and subassemblies
- Declare downtimes / manage planned activity
- Declare defects
- Component replenishment
- Modus operandi display
- KPI display
- Maintenance / quality alert

- **Performance management**

- Real-time production dashboard and alerts
- Data transfer to data lake for business intelligence(BI) reports





## Visualization for Supervisors and Operators

Somfy's solution features two types of graphical user interfaces on the production lines, visualizing real-time information:

- Supervisor screens to manage production activity
- Operator screens at workstations with work instructions, data entry, alarms, notifications, etc.

The easy-to-use Proficy screens enable the team to manage production and visualize KPIs, capturing production start and end, planned and unplanned downtime events, quality controls, defects, and more. The team can track reasons for downtime such as breakdowns or part/component inventory issues. Proficy Historian captures all of the OT data, making it available for real-time and historical analysis.

## Real-Time Intelligence for the Right Actions

Real-time data and reporting available through Proficy are critical to driving the right actions. As an example, the team has improved quality management and reduced scrap rates using the software for better root cause analysis. However, as Yannick Mace notes, "people won't react because of the information. We have to train them to use the system and to react."

Stanislas Dupouyet agreed, stating, "The challenge is not to use the tool. We needed to reorganize and change the processes to use the tool and drive improvements."

Fortunately, operators are quickly learning the changes and new processes as well as the software solution. According to Stanislas Dupouyet, they have found the new processes and system easy to use and have reduced non-value added tasks – with less paper and manual input and tracking. Operators and supervisors also like the availability of real-time data including KPIs in dashboards such as OEE, yield, defect rates, and changeovers.

With many innovative product specifications, Somfy's manufacturing has frequent line changeovers. Operators perform a changeover every 30-60 minutes. Rapid line changeovers are critical to improved productivity, and the MES solution tracks and reports on changeover times and reasons for delays, providing an opportunity for performance improvement.

## Helping to Support Sustainability

In addition to improving production, Somfy expects to use the MES to help support the [company's sustainability efforts](#). Somfy has a deep commitment to eco-design as an overarching process that impacts each stage in the lifecycle of a product – reducing the product's impact on the environment, from the extraction of raw materials to manufacturing, shipping, usage, and even its destruction.

"Somfy is by far the leader in its market, and we have a strong belief that we should transform our industry," Emmanuel Carmier said. "As a whole, the building industry represents one-third of global CO2 emissions. Being a leader, we have a role to play in driving our sustainable development transformation, not only with our product offering but also with our own footprint."

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*"Digitalization should help," Emmanuel Carmier continued. "For example, the MES solution is designed to reduce waste, as one benefit. As of today, we are investigating and assessing all of the ways that digitalization can help bring us in the right direction related to sustainability."*

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# Next Steps



What's next for the team at Somfy? Overall, the team is looking to drive performance and create more value with data. Following a successful first deployment, the team is gathering experience feedback from the Cluses deployment and starting to deploy at its next sites. Somfy will integrate the MES seamlessly into its businesses and processes. Stanislas Dupouyet said the project will ramp up from an MES scale to a Manufacturing Operations Management (MOM) level, integrated with the production ecosystem. Also, the team will better define ISA-95 levels.

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*“What we have seen is that it’s not only an MES project. It’s really a transformation project of the company,” Stanislas Dupouyet concluded. “It impacts a lot of the organization, connecting the IT and OT worlds. It’s an opportunity to define a new way of working and new responsibilities. It touches all professionals in the company, quality, maintenance, and so on. It truly is digital transformation.”*

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## Stanislas Dupouyet's Recipe for Successful MES

- Start small and learn as you go. Be Agile, there are too many parameters to anticipate and control everything.
- Teamwork and field mindset are the key to solve problems. The devil is in the details, and you will face issues every day.
- Have excellent knowledge of the business/operations within the project team. It's a production transformation not an IT tool.
- But ... do not neglect the IT part of the project – in particular the architecture, cybersecurity, alerting, and high availability of the solution.
- Spend time in anticipation on overall data structure of the company to plan for the future. Define the data governance between systems.
- Then anticipate work by building standards (Golden rules) and guaranteeing the accuracy of data (data cleansing workshops).
- Testing the process is long but necessary. Invest time on it! Dedicated environment, data set, test definitions, automated tests, test campaigns with key users, non-regression tests, performance tests, crash tests, release tests, etc.
- Plan in detail the data migration organization and data freeze to not impact your product development and production business.
- Do not underestimate change management – especially at the company level. MES is a bridge between systems and interconnects different worlds / departments which implies new roles and responsibilities (new RACI).
- Plant key users (the doers) are the critical factor for a successful deployment. Onboard them, integrate them into project decisions, create a community.
- “MES school” is a powerful tool. Change presentation, POC demonstrator, use case validation, users training. It is our deployment basecamp.
- It is a terrifying project in its scope, but know that by your action you will fundamentally and profoundly change your company. Don't be afraid one step at a time, it's going to happen!





# Toray Plastics (America), Inc. Optimizes Manufacturing Operational Performance with Big Data Analytics

*World leader in high-performance films and other products*





# Background

If you've ever indulged in a bag of chips or munched on a breakfast cereal bar, then you're probably more familiar with Toray Industries than you think. Toray Industries, Inc. is behind the manufacturing of many of the shiny metallized packages that protect a variety of food products, from snack food to cookies, prepared meals, candy, crackers, and granola bars. Toray Industries—headquartered in Tokyo, Japan—is the world leader in high-performance films, synthetic fibers and textiles, carbon fibers, plastics, chemicals, and pharmaceuticals. Today, the organization operates 254 facilities in 26 countries with more than 45,000 employees—with annual sales exceeding \$19 billion.

Toray Plastics (America), Inc., an American based subsidiary of Toray Industries, is responsible for manufacturing the Torayfan Polypropylene Film, Lumirror Polyester Film, and Toraypef Olefin Foams across its Rhode Island and Virginia facilities. Within its facilities, Toray Plastics operates through a bi-modal approach—a combination of standard operations mixed with agile and cutting-edge techniques—that is fueled by technology. With a keen focus on lean activities, the company's strategy goes beyond the standard "mode one" of keeping a business up and running. Instead, Toray Plastics consistently strives to integrate innovation, creativity, and experimentation into all of its processes.



# Keeping it fresh

The diversification of today's "food-on-demand" culture has led to an increasing need for keeping food products safe and fresh for extended periods of time—all while preserving its original flavor. Consumers expect their food products to maintain a relatively long shelf life without compromising quality. And as a result of this growing demand, Toray Plastics was faced with producing better food packaging film than ever before.

Food packaging film is composed of very unique components for protecting against oxygen and water, and producing these films is no easy task. It requires very tight production processes that are examined with the utmost scrutiny to ensure the highest quality. So, in order for Toray Plastics to meet its vision to remove waste across the organization and remain competitive, the company implemented a new integrated system that allowed it to monitor its film manufacturing much more closely to ensure exact quality standards in every unit.

## Results from GE Digital Solution

- Over \$7 million in cost avoidance per year
- 37 siloed systems eliminated
- Best practices driven across divisions
- Removed costly manual processes and limitations – example, product traceability in seconds versus hours





# Undergoing a digital transformation

Don M. Cormier, Vice President of U.S. Information Systems and Quality Assurance for Toray Plastics, knew that the company needed to change its processes in order to remain an industry leader. By embracing its bi-modal approach, Cormier geared up to accelerate innovative "mode two" through digitization. He sat down with his fellow executives to establish a holistic vision for Toray Plastics. The vision was simple—to drive extreme efficiencies out of its assets by becoming standardized, simplified, integrated, and secure. In order to make this vision possible, Cormier teamed up with various business groups within the company to conduct a robust discovery. This discovery phase was intended to reveal current hurdles each business group was facing, and to identify the gaps in information or operational siloes that caused these problems to exist.

Once these problems were identified, the hunt for the right data-driven solution began. Cormier and his team developed a criteria list to evaluate various commercial off-the-shelf MES solutions. And after performing various in-depth assessments amongst 20 vendors, GE Digital and AutomaTech, a GE partner, were chosen as the right organizations to meet Toray Plastics' needs—with Manveco providing support and implementation services during this transition.

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*We found that as the years went on, we were collecting more and more big data. And we were able to utilize a lot of tools from GE Digital to analyze that data and turn ourselves into an algorithmic-type organization.*

**Don M. Cormier, Vice President, U.S. Information Systems and Quality**

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# Data-driven operations

Keeping high-quality film production at the heart of its operations, Toray Plastics started leveraging Proficy Plant Applications from GE Digital, part of the Proficy Smart Factory suite. As an on-premises solution, Proficy Plant Applications allowed Toray Plastics to collect real-time data directly from edge devices and assets for critical key performance indicators, as well as perform batch analyses to optimize operations. Proficy Plant Applications enabled operators to oversee manufacturing on a more granular level and reduce the production of defective film (first pass quality), which improved overall equipment effectiveness, quality, and reduced material waste, thus helping to increase efficiencies and decrease costs.

Toray Plastics also tightly integrated Proficy Plant Applications with its SAP software, which made it extremely cost effective and scalable globally. The two systems continuously pass about 30,000 pieces of information a day between one another—covering everything from inventory status to bill of materials, customer specifications, and production order status. This alignment between GE Digital and SAP allowed both systems to utilize the same number of assets and labor while significantly increasing productivity.

In addition, Toray Plastics began managing production with a “by-the-numbers” philosophy. This philosophy focuses on having accurate and visible measurements across operations to mitigate issues and allow better decision-making.

By implementing other edge solutions—such as iFIX from GE Digital and Proficy Workflow from GE Digital, Toray Plastics utilized data-driven information to gain visibility into potential production interruptions and downtime. Toray Plastics also leveraged Proficy Historian from GE Digital to optimize asset performance through its data archive and reporting capabilities. The company further developed its by-the-numbers approach by creating a downtime dashboard—which tracked each line by shift, downtime percentage, and cost of downtime—to better align plant floor metrics to executive level goals.

And it paid off. Toray Plastics yielded some big results, such as significant savings in film recovery, increase in film productivity, and improving uptime. Toray Plastics also drove significant quality improvements by decreasing the amount of time for product traceability as well as lowering film defective rate.

*“We further developed our by-the-numbers approach by creating a downtime dashboard—which tracks each line by shift, downtime percentage, and cost of downtime—to create friendly competition amongst factory operators and encourage production efficiency improvements”*

**Don M. Cormier, Vice President, U.S. Information Systems and Quality Assurance**





# Moving to the next level

So, what's ahead for Toray Plastics? Chris Roy, Senior Vice President and General Manager of Toray Plastic's Torayfan Division, continues to play an instrumental role in accelerating Toray Plastic's digital transformation. He believes that continuing the momentum for improving efficiency, effectiveness, and responsiveness will help sustain the company's competitive edge in the market.

Being a digital industrial company that prides itself on innovation, Toray Plastics is looking to continue its digitization journey by leveraging artificial intelligence (AI) to transform its continuous processing operations. This will enable the company to generate more predictive analytics through placing sensors on machine assets to forecast process failures.

The company is also continuing to work with GE Digital's Advisory Services to uncover which business outcomes will be the most critical to their Industrial Internet of Things (IIoT) initiatives.

By utilizing an edge-to-cloud solution with GE, the operating system for the Industrial Internet, Toray Plastics will be able to collect condition, material, quality, and machine processing data in real-time. Capturing this data will create a high probability for correlating asset, process, and product information through machine learning and algorithms—and successful execution could reap significantly more per year to the Torayfan division's bottom line.



*Proficy Plant Applications from GE Digital, part of the Proficy Smart Factory suite, has allowed Toray Plastics to maintain its high-quality control standard and keep each machine running smoothly.*

*“By implementing GE Digital’s iFIX HMI/SCADA and Workflow products, we were able to utilize data-driven information to gain visibility into potential production interruptions and downtime. This improved visibility allowed us to identify problems and their causes quickly, and prevent mistakes from happening, which ultimately led to reduced downtime and increased productivity. GE Digital’s HMI/SCADA software products provided a strong foundation for our digital transformation journey”*

**Don M. Cormier, Vice President,  
U.S. Information Systems and  
Quality Assurance**

## Toray Plastics drives production efficiencies through edge solutions within GE Digital's Proficy suite:

- iFIX provides operational visibility to enable better decision making
- Proficy Workflow drives more consistent operations with dynamic electronic formats
- Proficy Plant Applications optimizes operations and ensures product quality with real-time data
- Proficy Historian helps improve asset performance and production through data collection and aggregation

# Additional Case Studies

Ready to find out more? Explore these comprehensive resources.



## Food & Beverage Successes

Global References & Case Studies

Read



## Consumer Packaged Goods (CPG)

Global References & Case Studies for Non-Food CPG Manufacturing

Read



## Automotive OEM & Tier Supplier Successes

Global References & Case Studies

Read



## Pharmaceutical / Life Sciences Successes

Global References & Case Studies

Read





## About GE

GE (NYSE: GE) is the world's Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive and predictive. GE is organized around a global exchange of knowledge, the "GE Store," through which each business shares and accesses the same technology, markets, structure and intellect. Each invention further fuels innovation and application across our industrial sectors. With people, services, technology and scale, GE delivers better outcomes for customers by speaking the language of industry.

## Contact Information

[www.ge.com/digital](http://www.ge.com/digital)

