Lean manufacturing in the age of the Industrial Internet

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 discrete 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 discrete 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.

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

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

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The challenges in discrete manufacturing

Discrete 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 - hence the term Lean Six Sigma.

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.

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Building the foundation

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

Am I collecting the right data?

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

Do I have a way to visualize it in context?

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

How can I integrate analytics into my production plan?
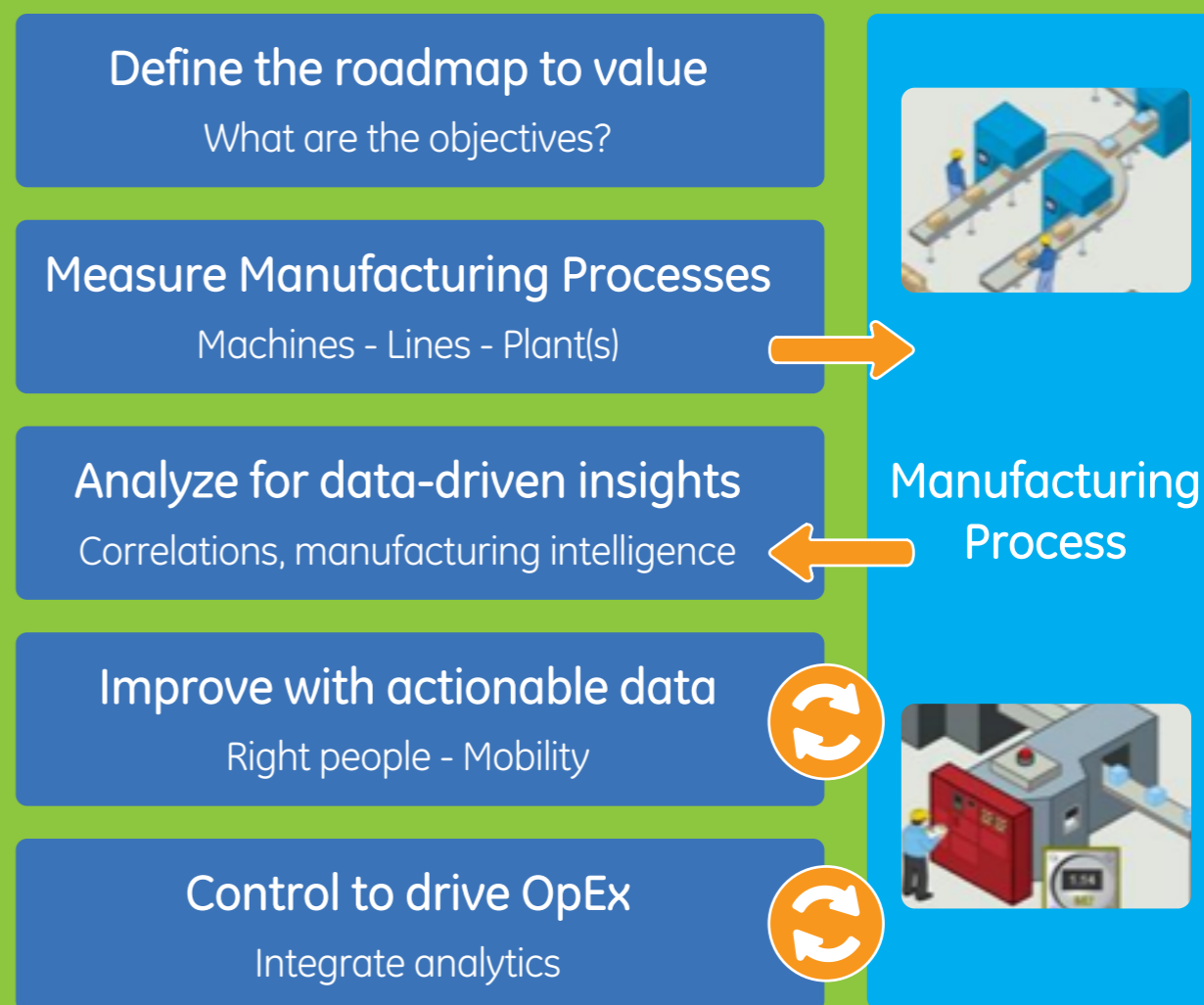
Define the roadmap to value

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

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

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

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

Maximize Lean Six Sigma with MES Digitization

Define the roadmap to value
What are the objectives?

Measure Manufacturing Processes
Machines - Lines - Plant(s)

Analyze for data-driven insights
Correlations, manufacturing intelligence

Manufacturing Process

Improve with actionable data
Right people - Mobility

Control to drive OpEx
Integrate analytics

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 may be sufficient.

If you need to get closer to a machine or production asset such as a sensor or control system that requires sub-second collection rates, you may take advantage of a different type of solution. This may be technology that allows you to embed computing power and connectivity at the point of control, creating 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.

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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.

For example, a large scale discrete 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
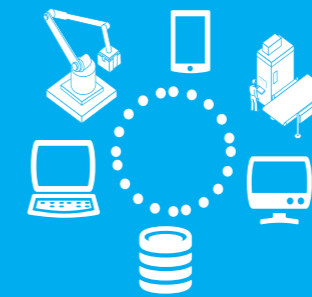
1 Collect data from your systems
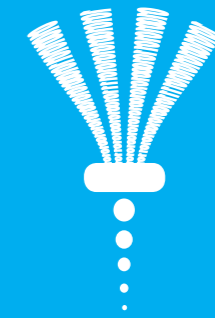
2 Transform the data into intelligent insights

3 Deliver relevant information to the right people

4 Drive Operational Excellence with lean production

Advanced MES capabilities helped an industrial motor manufacturer 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.

The results:

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.

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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
→ Leverage full product genealogy for fast traceability and exposure containment
→ Optimize production based on energy constraints
→ Integrate energy and water consumption into material management and consumption metrics

A global appliance manufacturer was bringing 10 new ground-up appliances 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 costs 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 discrete 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.

About GE Intelligent Platforms

GE Intelligent Platforms provides industrial software, control systems and embedded computing platforms to optimize our customers' assets and equipment. Our goal is to help our customers grow the profitability of their businesses through high performance solutions for today's connected world. We work across industries including power, manufacturing, water, mining, oil & gas, defense and aerospace. A division of GE, we are headquartered in Charlottesville, VA.

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