



Expand Lean Manufacturing with MES

DELMIA

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Executive Summary

While Lean manufacturing has been in vogue now for some 40 years, it continues to grow in importance, especially as new requirements and competitive pressures surface in the manufacturing arena. In the early years of Lean initiatives, companies made headway fixing shop floor and human-centric issues without ever touching IT systems. In today's world of globally distributed manufacturing organizations, rapidly escalating energy costs and diverse supply chain networks, the business landscape has radically changed. And, with these changes, manufacturers must now recognize that software has become virtually a requirement for successful Lean manufacturing.

This white paper will draw upon third party research and actual customer feedback to demonstrate the role a Manufacturing Execution System, or MES can perform, complementing and supporting the quest to drive waste out of operations processes. The integration of software into a Lean program has been identified and validated as a best practice enabler across a systematic framework for change management and continuous improvement. An overwhelming majority of top performing manufacturers use an MES system to support their Lean initiatives by implementing best practices, measuring performance and improving processes to continue the cycle of removing waste from operations processes.

An Introduction to Lean

Lean Manufacturing started as the Toyota Production System (TPS), developed by the Toyota (now Toyota) Motor Car Company. Toyota's engineers looked to Henry Ford (inventor of the assembly line), Taylor (inventor of Modern Management techniques and Industrial Engineering), and Dr. W. Edwards Deming (Father of Modern Quality Management) to see how they could improve productivity, increase quality and achieve worldwide ranking within the global automotive market.

It worked. Japanese productivity and quality surpassed that of North American plants, causing a scramble by the Americans to remedy the situation. Dr. Womack and his International Motor Vehicle Program (IMVP) group at MIT identified the key differences between Toyota's TPS, European auto industry and North America's traditional systems, coining the phrase "Lean Manufacturing" to encourage the adoption of TPS methods. This term has since been expanded to "Lean thinking" to encompass improving productivity within service organizations.

Until recently, most of the foundations of the Lean movement were based on manufacturing and process improvements from the 1970's, a time when automation and software applications were in their early, nascent years. The past 20 years has witnessed tremendous leaps and advancements within these disciplines. Until recently, the thought of using software in support of a Lean project was simply unheard of, having no place within the collective Lean circles.

That thinking has now changed.

Software as a Requirement for Distributed Lean Manufacturing

A recent survey of manufacturers conducted by industry analyst firm ARC Advisory Group found the adoption of Lean manufacturing increased by two-fold over a recent 15-month period comprising the 2006 calendar year. In and around this same time period, ARC's market research on the adoption of Manufacturing Execution Systems (MES) has also showed a steep uptick, with a growth rate of 27 percent.¹

Based on these trends, ARC set out to identify best practices among leaders for Lean manufacturing adoption and implementation. An objective was to investigate the correlation among companies deploying MES to achieve these best practices. It was theorized that in today's complex, dynamic and global manufacturing supply chains, manufacturing software solutions such as MES can play an essential role in the success of Lean manufacturing efforts.

¹ "Best Practices for the Intersection of Lean Manufacturing and MES," Ralph Rio, ARC Advisory Group, November 2007

Defining Leadership in Lean

The ARC study reports that industry leaders have improved first pass yield, inventory turns, delivery promises kept, scrap and rework and overall equipment effectiveness (OEE) – fairly standard metrics used to gauge overall success from a Lean perspective. The report then goes more in depth as to the various behaviors – or best practices – leaders engage in to attain these results. ARC defined Lean Leaders as having established best practices across four main parameters: people, processes, technology and metrics. See Table 1 for the summary of these practices.

But perhaps most importantly, the report identified the sole defining characteristic Leaders share that manifests these best practices – Leaders successfully use technology to support their Continuous Improvement programs, with Lean and Six Sigma chief among the programs specified by respondents. More specifically, **77 percent of those surveyed reported their use of MES “accelerates” their Continuous Improvement program.**

The balance of this paper will discuss in further detail on how Lean Leaders leverage MES to support and enhance Lean initiatives.

MES: A System to Enable Change

One key to success in deploying and sustaining Lean can be found in a manufacturer’s ease and ability to actually change a process. Static processes can’t support the implementation of new best practices to remove waste as part of a Lean program. Processes are implemented at one plant but not across multiple departments and geographical locations will at best have limited benefit in reducing waste across the organization.

“Despite attempts, most businesses have not been able to capture or sustain the benefits of a Lean transformation,” says Paul Swift, a Lean consultant with BeyondLean.com in his introduction to his Step by Step Lean Guide. “Lean manufacturing represents a fundamental change and most businesses have pursued change in tactical, rather than a strategic manner ... the methodology of many companies is to rely on a series of quick-hit approaches that deliver short term benefits, but aren’t sustainable in the longer term. Add to this the reluctance of many companies to consider the business as a whole rather than just concentrating on operations or manufacturing, and you have a recipe for failure.”²

Stated differently, the challenge to overcome is not what processes **should** be changed, but which **can** be changed, and **stay** changed. When evaluating possible process improvements, it is easy to write them down on a white board and achieve agreement to implement. And, with some effort, it is often possible to initially run these process improvements manually, testing the new process and evaluating if benefits can be achieved, at least in the short-term. The challenge is getting people to embrace and adopt a change after the Lean implementation

² “Introduction to Lean Guide” by Paul Swift; <http://www.beyondlean.com/lean-guide.html>; May 11, 2008

What is MES?

MES is an abbreviation of the term “Manufacturing Execution System,” which refers to a computer system that manages plant production. Often this system will be used to integrate shop floor operations with Enterprise Resource Planning (ERP) applications.

Today, as manufacturers continue to expand their global presence, a solution with a wider scope is now being sought, now referred to as a “MOM” or Manufacturing Operations Management solution. This approach references a broader set of functionalities beyond just production, to also include Quality, Warehouse, Maintenance and Labor operations across multiple locations.

Apriso solutions can be used as just an MES, or as a complete MOM solution, depending upon how many application modules are deployed. For the purpose of this paper, only the term MES has been used to avoid confusion. However, each of the concepts discussed also apply to MOM solutions.

project manager or outside consultant has left, after the Lean project focus has passed. Add to this challenge a manual process, and it is easy to see why so many Lean initiatives fail.

Try to implement a process change across different locations, and the complexity and challenge increases exponentially. A change in process impacting multiple plants – beyond the visibility of a plant manager’s daily routine – might never ‘stick,’ especially if the responsible party for success can’t see that the process has not been permanently implemented. It quickly becomes obvious that manual process improvements don’t work effectively, even more so when implemented across a global operations environment. The solution is to automate a process improvement, removing the ‘friction’ of human reluctance to change.

If the complexity, programming or other skill required to change a business process is difficult, then the impediment to change is the process management system. Often this process may involve multiple systems, equipment vendor user interfaces or even complex XML or other web-based programming. Alternatively, manufacturers who embrace the need for change recognize that the investment in a Business Process Management (BPM) system can pay a handsome reward, capable of supporting frequent changes or updates. This system must be easy to use (or else it offers no benefit over existing static system), without the need for complicated programming by outside consultants or IT personnel, which may not be available at a moment’s notice.

MES + BPM = Sustainable Process Improvement

A winning approach to Lean is one that spans all dimensions of the manufacturing enterprise, encompassing the entire value stream, from ordering through manufacturing to cash received. MES systems ‘touch’ every area where a Lean program might impact an operations process, so therefore have the capability of being an ideal solution. But, the MES system must be capable of easily supporting process change and execution, while automating Lean process improvements.

Leaders select MES systems that span the entire suite of operations processes, amplifying the potential benefit of such a program. The ability to infuse an organization with embedded, automated business processes enables MES to address one of the most challenging aspects of manufacturing operations management and Lean – the enforcement and continued adherence to defined processes. See Table 1.

MES systems utilizing an effective Business Process Management (BPM) framework best support the implementation of new Lean processes, providing control and monitoring of existing and new processes to ensure timely execution and conformance. Phrased differently, while Lean techniques provide the methodology to optimize business processes, MES systems that leverage BPM provide a highly competent “systems infrastructure” to implement Lean efficiencies, sustaining them on an ongoing basis.

Table 1

| | People | Process | Technology | Metrics |
|--------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------------------------|
| Leaders | Involve people in all segments of the business including suppliers | Broad and deep application of methodologies with wide access to real-time data | Business processes are embedded in MES ensuring consistency | Metrics are calculated frequently by IT systems with high credibility & use |
| Competitors | Focus mainly on manufacturing areas and include a portion of those in aligned areas | Broad application of Lean tools with good access to manufacturing data | Apply MES systems and complement continuous improvement prog. | Broad use of metrics, but mixed results. Some automated and many manual |
| Followers | Focus on the plant floor with weak support | Shallow application of Lean tools with limited access to mfg. data | Manual BPM using tribal knowledge; technology skepticism | Few metrics which are manually calculated and not actionable |

Leveraging IT systems with embedded business processes ensures operations consistency – across multiple functions and locations – for actions performed by personnel, equipment and facilities; reduced variation is a key tenet of Continuous Improvement programs. Figure 1 graphically depicts the performance benefits over time when business processes can be embedded within IT systems, when compared to the manual execution of the same tasks.

Streamlining the process of instituting change and refinement lets manufacturers achieve greater success. More improvements can be implemented – rather than merely theorized – helping drive an efficient, successful Lean program. There is no longer an acceptance of ad hoc business processes.

Processes are deliberately planned and standardized to reduce waste, save money and create quality products and services. Processes are immediately, consistently implemented, and most importantly, these processes are sustained over time.

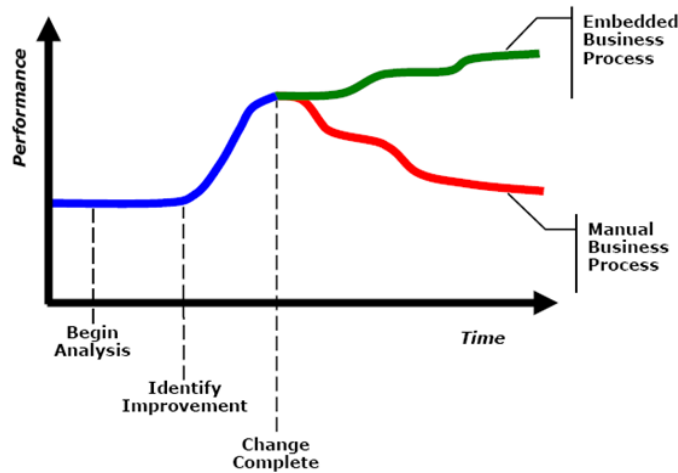


Figure 1: Embed BPM in your MES and IT Systems for Sustained Process Improvement

Extending Lean across the Global Manufacturing Enterprise

Back in the 1970s, the concept of 'global' was much different than today. Packaging a product and shipping it for sale in Europe was global in 1970; today, it requires sophisticated product differentiation, new packaging and adherence to localized regulations.

In search of lower costs, faster times to market, heightened product innovation and local market acceptance, manufacturers set up operations overseas, adopting global outsourcing strategies. However, integrating operations from plant to plant across borders can be tricky. Aside from the obvious language and localization issues, global manufacturing adds an exponential layer of complexity and the need to navigate and adapt to ever-changing global market dynamics.

Today's emphasis on global sourcing, distributed production and just in time production that is synchronized to be in sequence with supplier shipments is pushing manufacturing to a whole new level of Lean. For companies that have operations spread far and wide, optimal performance requires frequent adjustments and relocations of operating capacity, as markets and supply sources shift. Manufacturing operations that are Lean shift more readily.

In today's global economy, Lean Leaders understand it is shortsighted to consider a Lean program within the silo of a single location. Waste must be removed from as many processes as possible; these processes now extend across the supply chain, throughout operations as well as across distributed production sites.

Visionary Lean organizations think "outside the box," extending and integrating processes to drive Lean practices enterprise-wide, across operations – sales, engineering, product development, procurement, customer service and human resources – and across the globe.

MES plays a critical role when implementing Lean across the distributed global enterprise by facilitating and streamlining information flows among plants, suppliers, distribution centers and customers. It can provide a system to identify, capture and replicate best practices across the enterprise, with support for diverse manufacturing methodologies, geographies, cultures and markets, enabling implementation of Continuous Improvement programs.

This information flow across the global manufacturing enterprise enables companies to address the strategic imperatives of governance, risk management and compliance as they optimize business processes.

"Traditionally, compliance and lean initiatives have actually been at odds with each other because of the heavy burden of compliance," said Mike Auerbach, editor-in-chief of trade magazine Pharmaceutical Processing, in a transcript of a webinar he hosted on Lean

Manufacturing, Gaining Efficiencies and Maintaining Compliance on the Plant Floor. *“But with IT solutions, the way they’re designed with the ability to automate much of that workflow, you can now take that burden off of the floor and automate it as part of your process, thereby giving you the assurance that you’re not only meeting compliance, but that compliance is now part of your workflow.”*³

Paper Kanban vs. e-Kanban

Kanban Cards are a standard component of traditional Lean programs, as a signaling system that utilizes cards to signal the need to move materials within a manufacturing or production facility, or signal the movement of materials from an outside supplier to the production facility.

Traditional ‘paper-based’ Kanban programs typically operate within a single facility, so the use of ‘on-site’ ordering queues makes perfect sense. Distribute your operations across several different locations – coupled with the use of third party outsourcing vendors – and the use of a paper-based Kanban system starts to fall short.

Once again, the implementation of an MES system can quite effectively address this shortcoming, providing an e-Kanban signal when inventory levels should be restocked, or when a production process is ready for the next raw material. An advanced IT system can be integrated across all areas of operations, from production to warehouse to quality assurance, ensuring idle inventory levels are minimized, or even eliminated, adding yet more functionality to an integrated MES system.

Measuring Performance Improvement

You don’t have to be a Lean guru to know that some sort of tracking and reporting system is necessary to help identify where a best practice might exist, as well as what quantitative benefits might be obtained from implementing a process change.

Performing quantitative measurements on operations performance can be an excellent way to locate future performance improvements. A comprehensive reporting system can be established to summarize operations results and highlight areas for improvements, such as comparing one plant’s performance to another, or to the entire industry average.

Once again, a well-conceived and implemented MES system can accomplish this task, providing a platform for consistent performance measurement, tracking the operations statistics most relevant to your achieving the highest possible performance. As was true of implementing new global best-practice processes, a global system for measuring Key Performance Indicators (KPIs) can amplify visibility to enterprise operations performance, quickly highlighting those business processes not delivering the desired results, as well as those setting a new standard for operations excellence.

³ *“Lean Pharmaceutical Manufacturing: Gaining Efficiencies and Maintaining Compliance on the Plant Floor” – Webcast Transcript; April 27, 2006; Pharmaceutical Processing on May 18, 2008*
<http://www.pharmpro.com/ShowPR.aspx?PUBCODE=021&ACCT=0000100&ISSUE=0607&RELTYPE=PR&ORIGRELTYPE=ATO&PRODCODE=0000&PRODLETT=M&CommonCount=0>

MES: Fueling the Quality Control Machine

Traditionally, quality management applications were implemented separately from ERP and MES, but today manufacturers have adopted a more holistic approach that considers quality an integral element of core business processes versus a bolt-on strategy.

Management of quality control in a Lean manufacturing system is critical. In a Lean environment, the management of quality control shifts from an inspection-oriented approach to defect-prevention. This means inspection at every phase of the production process, from material purchase, delivery, inventory and supply to processing, as opposed to the conventional inspection process conducted at the beginning, during, and end of the production process.

In order to best support quality control, data collection and reporting processes are needed to identify a starting point for improvement and track progress as processes are refined. Many companies conduct data collection and reporting manually in an off-line system (typically Excel) which generates waste in terms of time and effort, and also introduces opportunity for error.

According to ARC, Leaders empower their people with access to real-time data to improve decision-making and their ability to evaluate changes identified through Lean methodologies. For example, nearly 50 percent of Leaders leverage MES systems to calculate metrics related to first pass yield. A high first pass yield metric measures an organization's success at removing manufacturing wastes and defects – or the ability to “get it right the first time.”

MES offers employees, supervisors and plant management visual real-time dashboards focused on Key Performance Indicators (KPIs) that can be used to monitor the whole corporation, lines of businesses, functions or processes, with the ability to drill-down on any data point for the details.

These systems can also notify users immediately when out-of-control conditions occur, so process owners and process specialists can capture the root cause for corrective action or for best practices implementation. This empowers the people who do the work with the right information to identify problems and take appropriate corrective action.

Lean = Green

Over the past 20 years, there has been growing pressure on businesses to pay more attention to the environmental and resource consequences of the products and services they offer and the processes they deploy. The rise in energy costs has now made this initiative mandatory. To achieve sustainable operations – conserving natural resources and reducing their environmental footprint – manufacturers are looking to get more out of their Lean programs to remove wasted energy use, improve quality ('get it right the first time') and defer capital expenditures and expansion by running operations more optimally.

Sustainability goes beyond “doing the right thing” and being a good steward to the environment, it's also key to competitive advantage, cost reduction and customer satisfaction. Manufacturers understand that as the cost of materials and energy continues to increase, these costs become an even larger component of total costs, currently up to 70% or more depending upon the industry. They must adopt effective sustainability strategies today.

Implementing Lean manufacturing is one way manufacturers can enable sustainability across all the various business processes. The focus of improvement programs can be expanded to include and embrace sustainability themes, including the adoption and application of Lean tools and techniques to sustainability improvement projects. Lean manufacturing can help identify overall requirements and align need to capacity, thus ensuring production lines are optimized, energy is maximized and raw product fully utilized.

As evidence of the recognized link between Lean and “green,” the Society of Manufacturing Engineers (SME) recently established the Lean to Green Sustainability Tech Group. This group helps members face the challenges of a sustainable future for global manufacturing, using the lessons of Lean to advance learning and innovation across the industry. Using Lean principles such as Continuous Improvement, SME says companies can identify what is valuable, eliminate waste and embed learning cycles that can be used every day.

This emphasis on sustainability contributes to Lean by improving overall organizational performance and efficiency. While there does exist synergistic relationships between Lean and “green” programs in general, in particular, sustainability efforts focused on waste elimination offers significant benefits for Lean manufacturing.

Sustainability programs tend to be enterprise-wide initiatives, impacting processes spread throughout the enterprise. Therefore, when selecting an MES system, criticality of support for implementing and updating global best practices should be placed in the highest importance. Lastly, as the Green movement is still in its early years, best practices for sustainable operations are still in a state of change. As a consequence, be sure your MES enables rapid process changes to keep up with the 'sea of change' currently underway within the sustainability / Green movement currently underway.

Conclusion

Today, MES is now recognized as an essential component of Lean manufacturing success in today's world of complex global supply chains, ever-changing product mix and greater demand volatility. Yielding the benefits of continuous improvements, reduced waste, improved response times as well as sustainability initiatives, MES has been adopted by Leaders in Lean, integrating the needs of the real-time plant environment with the transactional environment of business systems.

MES supports the application of Lean best practices while adding value to Lean initiatives, encompassing processes that span across multiple areas of operations. By efficiently establishing and maintaining business processes (ideally through a framework of BPM) and the collection of operations data throughout production, the supply chain, warehousing and the execution of maintenance management programs, a more cost-efficient Continuous Improvement program is possible, saving time and resources to further maintain and optimize operations performance within the business.

About Apriso Solutions

Since 1993, some of the world's largest and most successful manufacturers have leveraged Apriso software and services solutions to ease the challenges of global manufacturing operations management. With Apriso, manufacturers can improve organizational agility so as to adapt more quickly and effectively to change. This agility enables firms to take advantage of new market opportunities by delivering the right product at the right time for the lowest total cost. Manufacturers choose Apriso to help manage today's manufacturing transformation of thinking global while acting local.

Apriso software solutions have won numerous awards and accolades for their ability to tightly synchronize global manufacturing operations and supply chain networks to deliver real-time visibility, control and synchronization of business processes performed across plants and the product supply network. Leverage an Apriso solution to establish a common set of operational standards that can be managed holistically on a global scale while still being continuously improved to meet your local market and customer needs.

Apriso Corporation was acquired by Dassault Systèmes in July 2013, and is now a product portfolio within its DELMIA brand. Apriso products and solutions provide a connection between the virtual world of digital manufacturing and the real world of manufacturing production.

About Dassault Systèmes & DELMIA

Dassault Systèmes, the 3DEXPERIENCE Company, serves 170,000 customers across 140 countries, providing virtual universes for sustainable innovation. Dassault Systèmes' DELMIA brand offers products that connect the virtual and real worlds. As part of DELMIA, the Apriso product portfolio – including its suite of manufacturing operations management applications – helps manufacturers transform their global operations to achieve and sustain operational excellence. Learn more at apriso.com, visit our blog at apriso.com/blog, or follow us on Twitter at [@Apriso](https://twitter.com/Apriso).

