Support lean manufacturing principles with IBM Maximo Asset Management

Improve efficiency while optimizing maintenance processes and reducing operational costs across all critical assets

IBM

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Introduction

The debate about *industrial innovation* is often limited to product innovation. Yet the area of process innovation—the act of developing and adjusting the production process to reduce costs and increase speed—should not only focus on the business processes around the production itself, but also on the business processes linked to all critical assets necessary for production.

This is lean manufacturing. Process innovation using lean manufacturing techniques focuses on the efficient design of all relevant production processes. The term "lean" was adopted by three researchers from the Massachusetts Institute of Technology in Cambridge, Massachusetts, to describe the successful production system developed and rigorously applied by Toyota Motor Corporation. In the book *The Machine That Changed the World*, Toyota's system is described as being centered on continuous improvement and zero-tolerance levels for all forms of waste in the manufacturing process, including poor equipment reliability and downtime.[1]

This white paper investigates the impact of lean manufacturing principles on one of the support functions of the manufacturing process: the maintenance department. By removing waste from the value stream, dependency on the reliable performance of assets (people, tools and machines) dramatically increases. Reliable and well-performing assets become an absolute prerequisite for running the business. There simply is less room for error. Companies that implement lean manufacturing principles should consider an asset management solution to help improve reliability while optimizing the cost of maintenance and operations across a wide range of asset classes.

Bottom-line results from lean manufacturing

In the search for world-class performance levels, many companies have adopted lean approaches to production with varying degrees of success. For many, the promised benefits of lean have not been realized, and some have even moved backwards rather than progressing toward their goals.

Companies have adopted lean approaches to production with varying degrees of success.

This is demonstrated in a study done by The Aberdeen Group that uncovered a large performance gap between those companies that are simply using lean techniques on the shop floor versus those that have built a culture based on lean thinking.[2] A more recent study by The Aberdeen Group describes how different companies are striving to achieve superior performance and competitive advantage, but the majority of manufacturers at all maturity levels have centered on lean initiatives to help deliver that edge in performance. Now they are wondering what other action or capability can provide an extra edge to keep moving in a positive direction to gain or maintain that level of advantage and stay best-in-class compared with other companies.[3]

Shortfalls in expected benefits delivered by lean manufacturing initiatives can often be traced to the actual performance delivered by new process equipment operating within the stringent demand-driven lean production environment. For example, a company in the pharmaceutical industry was proposing to purchase an additional gel-dipping line to meet demand. But a further evaluation found that the company's actual utilization for the current equipment was less than 60 percent and operational equipment effectiveness (OEE) was less than 55 percent. Using data taken from the plant history held in the asset management system, a Reliability Centered Maintenance (RCM) analysis identified the main sources of loss and typical failure rates. By eliminating the recurrent failure stops and reducing changeover times, the OEE increased to such an extent that the need for an additional line disappeared, saving the company US$6 million in unnecessary capital costs.[4]

But with Toyota's application of Total Productive Maintenance (TPM), the use of techniques such as the "Five Whys" approach (asking five "why" questions) to root cause analysis—together with the targeting and once-and-for-all elimination of all causes of equipment-related manufacturing defects and delays—enabled and empowered delivery of lean goals.

Toyota succeeded with lean production because it was able to implement the principles against the background of a zero-breakdown approach delivered by a strong focus on equipment performance and asset lifecycle management.

In *The Machine That Changed the World*, researchers describe how Japanese companies gained a competitive advantage over North American and European companies by pioneering new ideas in manufacturing.[1] In the book *Lean Six Sigma*, Michael L. George states that a majority of manufacturing companies are looking at their financial data to determine evidence for manufacturing performance improvements measured by increased inventory turnover. Measured in terms of their achievement of lean goals, only half of the companies studied had moved forward, while the remainder had gotten worse. For those who improved, gains were relatively small when measured in terms of the expectations of lean benefits. However, a small population demonstrated the true potential of lean by delivering improvements of up to 300 percent.[5]

Shortfalls in effectiveness originate primarily from the actual performance delivered by new process equipment operating within the stringent demands imposed by the lean production

environment. While lean manufacturing issues have received considerable publicity and attention, the book that introduced lean has no chapter devoted to the subject of equipment performance and asset management. It perhaps did not emphasize sufficiently how fundamental to Toyota's success was the critical recognition that highly automated and integrated manufacturing systems can only fully enable and empower the potential benefits of lean by achieving zero breakdown.[1]

To achieve results by focusing on equipment performance, it is essential to use a proven software solution that supports all relevant business processes: to monitor, support and manage all critical and strategic assets and asset management-related services within the enterprise.

Figure 1 shows how choices of manufacturing approaches impose performance constraint ceilings on manufacturing companies.

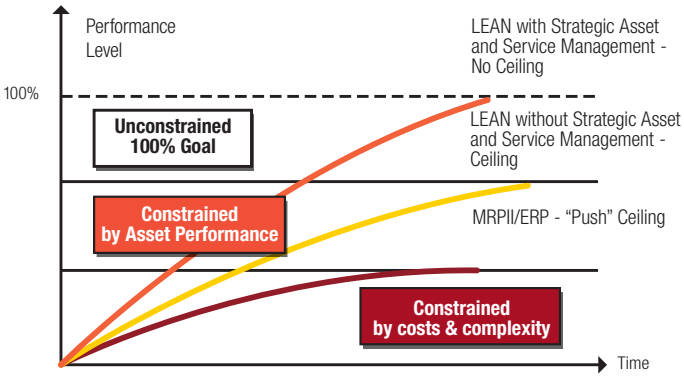

Figure 1: Results of manufacturing approach choices

Lean and pull manufacturing have enabled manufacturers to break through cost and performance levels imposed by push manufacturing driven by traditional enterprise resource planning (ERP). However, their achievements remain constrained by the performance of their manufacturing equipment assets. Asset management, together with a powerful enabling IT framework, allows manufacturers to remove these constraints and set new, world-class performance standards for cost, delivery and quality.

As part of the IBM® Tivoli® software portfolio, IBM Maximo® Asset Management supports and executes successful lean manufacturing principles by pulling information from ERP and plant information systems into asset management software. Maximo Asset Management can help maximize the performance of fixed, physical or other capital assets as facilities that have direct and significant impact on achieving corporate objectives and which strive to maximize performance for the lowest total cost of ownership.

IBM Maximo Asset Management supports successful lean thinking principles by optimizing asset performance and asset management processes.

Since 1985, Maximo software for asset and maintenance management has been at the forefront of optimizing available functionality to support major manufacturing concepts such as RCM, TPM and Good Manufacturing Practice (GMP). Today, companies use Maximo Asset Management to help support these concepts—to manage, monitor and document their efforts to meet regulatory requirements and to help utilize lean manufacturing to its fullest potential.

Lean manufacturing principles

Lean thinking is about the removal of waste from the value chain. "Waste" is defined as any human activity that absorbs resources but creates no real value. This definition includes mistakes that require rectification, production of items no one wants and processing steps that aren't actually needed.

Lean thinking provides a way to specify value, line up value-creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more effectively. In short, lean thinking is "lean" because it provides a way to do more with less—while coming closer to providing customers with exactly what they want.

Manufacturing companies are traditionally organized into "functions" and "departments." The grouping of workers and assets along functional lines appears to be a logical choice to manage tasks as efficiently as possible. However, the movement of goods and services from one function to the next and the coordination and planning required to do so often introduces delays and other forms of waste.

Implementing a lean enterprise can help companies realize significant gains.

Today, companies can realize significant gains by implementing a lean enterprise. The lean alternative is to reorganize the work of functions and departments along the lines of the value stream with work cells and assets that are dedicated to performing certain tasks. By using this approach, unnecessary and non-value-adding activities can be removed from the system, leading to a more efficient process.

The principles of lean thinking can be defined in five key concepts: *value*, *value stream*, *flow*, *pull* and *perfection.*

Value

The critical starting point for lean thinking is value. Value can only be defined by the customer, and it is only meaningful when expressed in terms of a specific product that meets the customer's need at a specific price.

Value stream

The value stream is the set of all the specific actions required to bring a product through the three critical management tasks of any business:

- The problem-solving task runs from concept through detailed design and engineering to production launch.
- The information management task runs from order taking through detailed scheduling to delivery.
- The physical transformation task proceeds from raw materials to a finished product in the hands of the customer.

Flow

Once value has been specified, the value stream for a product has been fully mapped and obviously wasteful steps have been eliminated, it's time for the next step: to make the remaining value-creating steps flow. Instead of having activities performed by distinct departments, all of the activities pertaining to the completion of a product or service should be organized in a single, uninterrupted flow.

Pull

Once a company has placed its revenue-generating assets in a flow concept, the next step is to make the product only when there is actual demand from a customer, instead of working against a forecast. This concept, called pull, ensures that no waste in the form of unwanted products is being created.

Perfection

Once companies have implemented the above lean principles, those involved often realize that there is no end to the process of reducing effort, time, space, cost and mistakes while offering a product that is ever closer to what the customer actually wants. Striving for perfection can drive additional rounds of improvement.

The book *Lean Thinking*, by J. Womack and D. Jones, uses an example of bicycle manufacturing to explain the transformation to a lean enterprise.[6] In traditional bicycle manufacturing, for instance, the key functional activities in the bicycle manufacturing process are tube cutting, tube bending and tube mitering; the welding, washing and painting of the frame and handlebars; and final assembly of the complete bike. Most traditional manufacturing companies have organized their production layout along the lines of these functional groupings.

For each stage of the manufacturing process, machine automation has been introduced to remove manual labor from the process. Because changeover times on these machines are lengthy, parts are usually produced in large batches.

In order to manage the process, a planning system is used to generate work orders based on a forecast, taking into account the inventories of parts and subassemblies. Due to the batch sizes for part production, the total lead times for the bikes are usually long. In addition, batch sizes also lead to high inventories of subassemblies and parts that put pressure on the working capital.

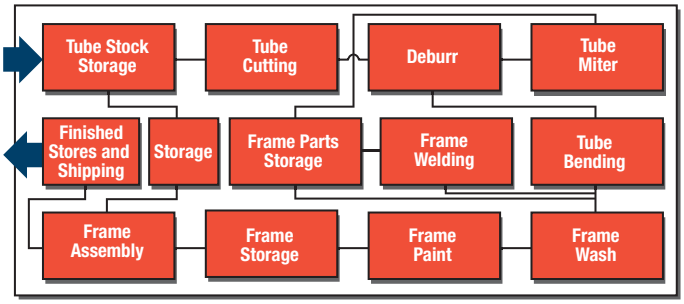

Figure 2: Layout of traditional bike manufacturing plant

In lean bicycle manufacturing, however, the continuous flow layout allows the production process to be laid out in a series of process steps required to assemble the bike, removing all non-value-added steps between functional departments.

In this layout, single machines have been replaced or broken into multiple smaller machines so that bikes can proceed continuously, one at a time, from tube cutting, bending and mitering to frame welding, washing and painting, to the final assembly, without stopping. In order to capitalize on this flow, changeover times have been reduced using Single Minute Exchange of Die (SMED) or like approaches. The inventory between stations has been reduced and moved from stage to stage using a pull-based system such as "Kanban"—a signaling system that uses cards to

signal the need for an item. The size of the work teams can now be geared to the production volume of the cell. The benefits of this approach are lower working capital due to the reduction of work in process inventories, the ability to respond to shifts in customer demands and, in some cases, lower capital requirements (such as space or machines).

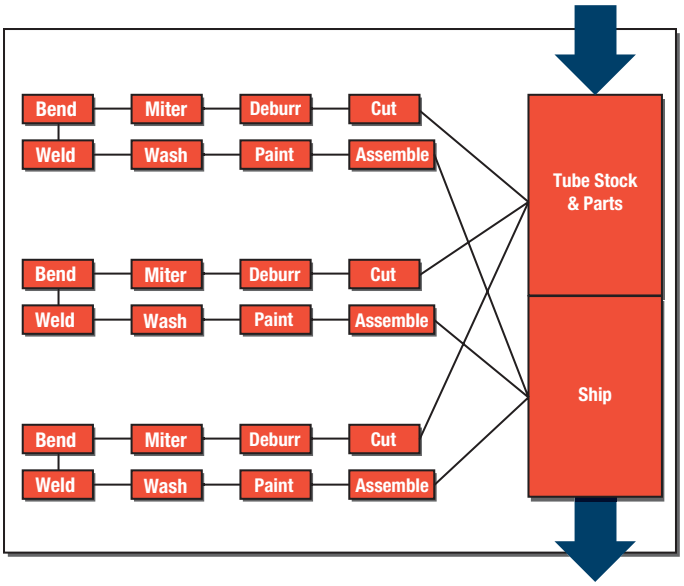

Figure 3: Layout of lean bicycle manufacturing plant

Why is asset performance so critical in lean manufacturing?

In traditional manufacturing, machine setup and product changeover times are lengthy and the conventional wisdom is to manufacture products in large batches to minimize the incidence of changeovers and associated lost production time. It is also conventional to operate with large buffer stocks of raw materials, semi-finished and finished goods.

A typical traditional manufacturing operation might resemble the following figures. In Figure 4, Buffer A contains raw materials, Buffer D contains finished goods, and Buffers B and C contain semi-finished, inter-stage sub-assemblies. Units 1, 2 and 3 are process equipment, each operating at 90 percent. The effect of the buffers is to effectively disconnect the units from each other until there is availability for the complete manufacturing system at the lowest performing stage—90 percent, in this case.

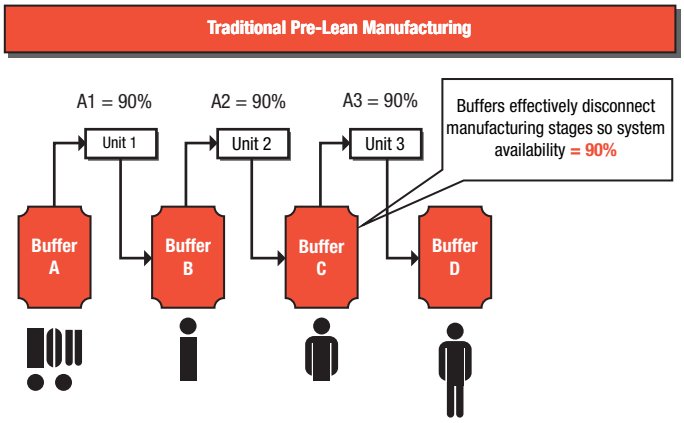

Figure 4: Constraints and performance ceilings in traditional manufacturing

Now consider what happens when a lean approach is applied to the same figure. In Figure 5, entry and exit buffers are minimized and inter-stage buffers are eliminated. The manufacturing process now looks rather different.

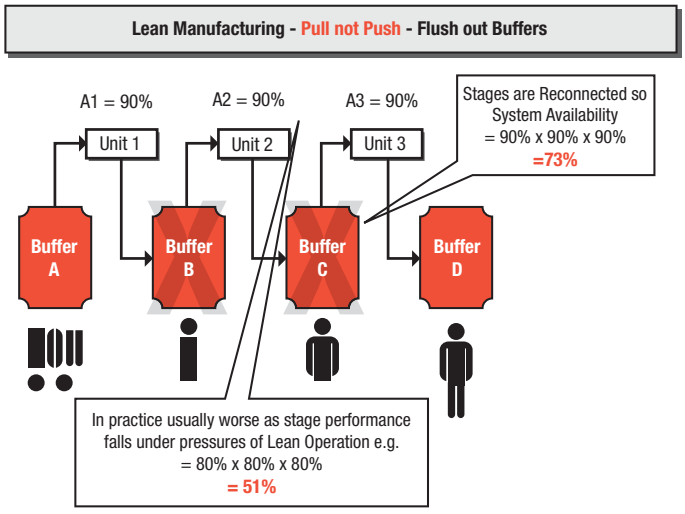

Figure 5: Constraints and performance ceilings in lean manufacturing

With the inter-stage buffers removed, units 1, 2 and 3 are reconnected so that failure of any one will immediately impact the others. If the individual unit availability remains the same at 90 percent, the availability of the complete manufacturing process becomes:

90% x 90% x 90% = 73%

In practice, manufacturers often overestimate the availability of individual process stages, while they are shielded by buffers and not really tested.

Furthermore, under the more dynamic loading conditions of make-to-order lean manufacturing, individual stage availability falls below its former pre-lean levels. When lower stage availabilities are added to the impact of reconnection and inter-stage dependency created by lean manufacturing, availability of the complete manufacturing process often falls dramatically.

These critical equipment issues were understood at Toyota. But it is rare to see such single-minded focus on equipment performance in Western manufacturing companies, which explains why investment in lean production initiatives utilizing automated manufacturing process equipment often fails to deliver anticipated return on investment.

In *Lean Six Sigma*, Michael George comments that as much as 50 percent of capital investment in new equipment is made to compensate for the under-performance of existing equipment due to low OEE.[5]

Asset management that goes beyond performance ceilings

Asset management maximizes the performance of fixed, physical or capital assets that have a direct and significant impact on achieving corporate objectives. Companies and organizations depend on vital assets to drive their business. However, they often see them as individual, standalone objects operating in the background. In reality, companies comprise a collection of strategic assets that are tightly interdependent and exist as a single system that should be managed as a unified enterprise at higher levels in the organization.

Asset reliability is critical to a successful lean manufacturing implementation.

Strategic asset maintenance management strives to maximize asset performance for the lowest total cost of ownership while taking into account risk, safety and compliance issues, and to manage those assets with a limited set of resources.

To get continuous systems to flow for more than a minute or two at a time, every asset must be completely "capable." That is, it must always be in proper condition to run when needed and every part made must be right. The reliability of the assets is the responsibility of the maintenance department. Asset management helps companies maximize asset reliability and performance for a lean manufacturing implementation.

Now, let's take the bicycle manufacturing example from *Lean Thinking*[6] and overlay the implications of a machine breakdown in either scenario. On a given morning in a traditional bicycle manufacturing setting, the operator of the tube-bending machine is scheduled to bend 100 aluminum tubes and finds that the motor of the machine doesn't start. The maintenance department was behind in their preventive maintenance program and the motor had missed a few needed revision tasks.

Luckily for the operator, all of the tube-bending machines are located in one department. The operator informs the maintenance department of the problem and moves the batch to another machine to complete the job. Furthermore, these tubes are only necessary for the production run for the week after next, so even if the machine that broke down was the only one that could perform the required task, there was ample time for the operator to get the maintenance department to perform a rush job.

In lean bicycle manufacturing, the layout of the bicycle plant has been changed to a flow-oriented layout, so the impact of the breakdown has changed significantly. The tube-bending machine is placed directly within the aluminum bike production line. A breakdown of the tube-bending machine, therefore, affects the production output of the entire line. More importantly, because the planning system has been changed from forecast-based production (with production of parts in advance) to pull-based production (based on demand signals), the impact of a breakdown is that customer demand cannot be fulfilled. The reliability of the tube-bending machine becomes a critical prerequisite for the performance of the entire production line for aluminum bikes.

Maintenance departments need to establish programs that help improve and manage the reliability of critical assets. In order to achieve this, maintenance departments must master a set of core competencies that are related to the asset-management function and put in place the required improvement programs. Asset management provides maintenance and asset managers with a framework to make decisions on improvement programs and to make the right decisions in relation to corporate objectives.

Traditional manufacturing with high inventory levels has a low performance ceiling constrained by costs and complexity. Furthermore, it masks equipment reliability and effectiveness. Although availability and downtime measures may be in place, the true extent of the impact of equipment shortcomings on work speed, product quality and inventory levels, and associated costs are not fully understood. World-class performance cannot be reached without a strong focus on equipment performance.

These lean manufacturing initiatives are currently being implemented by manufacturers: removal of wasteful processes; Kaizen (continuous improvement); 5S (efficient workplace organization); Kanban; value-stream mapping; extending lean principles into business processes; quick changeover (via SMED); just-in-time delivery from suppliers; extending lean principles into supply-chain management; Six Sigma; and Total Productive Maintenance.

Lean manufacturing and risk

The impact of lean thinking on the risk profile of a company can be explained in terms of insurance. If you consider buffer stock as a type of insurance policy that can reduce the risk that a customer order cannot be shipped, and the implementation of the lean principles drives the company to remove these buffer stocks, then the risk of non-delivery increases.

The company needs to take out another insurance policy in the form of more reliable assets that help to mitigate this risk. Asset management systems help companies to implement better asset management programs that help to increase asset reliability.

How Maximo Asset Management supports lean manufacturing

Within the IBM Maximo set of functional capabilities, as well as in its implementation methodology, companies can deploy individual techniques such as RCM and TPM to increase asset reliability, Just-in-time (JIT) or Vendor Managed Inventories (VMI) to manage their parts inventories, or Activity-Based Costing (ABC) or Zero-based Budgeting (ZBB) to improve their understanding of costs. Maximo Asset Management also provides a natural alignment with the current PAS 55 asset management or future ISO 55000 standard.

The implementation of an enterprise asset management program directly affects the ability of a company to achieve its corporate objectives, including:

- Revenue protection and enhancements through higher asset reliability
- Cost control and reduction through enterprise visibility of maintenance activities across sites and asset classes
- Risk mitigation and legal compliance through the implementation of standards-based work processes and common standards for safety and health-related processes
- Competitive advantage through better execution and lower cost for maximum performance

Software solutions for asset management can support enterprise-wide cost and compliance objectives.

While implementing an asset management program requires people who have the right skills and experience, investing in a software solution to support the program can provide significant benefits, including:

- Reduction of the number of systems required
- Reduction of total cost of ownership
- Reduction of the number of integration points
- Visibility of asset and workforce performance using a common set of standards for benchmarking
- Flexibility to adjust the solution to changing requirements and work processes
- Embedded best practices leading to easy adoption by the users

The implications of asset management for manufacturing companies goes far beyond improved planning and reduced maintenance costs. Without this initiative, companies will not break through the performance ceiling imposed by low levels of OEE. While the true impact of low equipment performance levels is not fully appreciated in traditional manufacturing, lean production places a sharp focus on it.

The IBM vision is to provide an asset management solution to support all business processes around all strategic or critical assets within the enterprise. Maximo Asset Management is based on the latest software technology, standards and architecture, providing the capability to configure structures and data to increase agility, responsiveness and reconfigurability.

Integration with other, external operational systems can be achieved through its service-oriented architecture (SOA) approach, which optimizes application-to-application integration. SOA provides a more robust, scalable and secure integration infrastructure, leveraging industry best practices such as XML, web services and portals to standardize interoperability.

Asset management systems, like Maximo Asset Management, can help companies mitigate the risks inherent in lean manufacturing.

With Maximo Asset Management, clients can maximize asset retention, lower labor and resource costs, deliver higher asset reliability and better align asset and service management to changing business goals. This also helps asset management service providers achieve their most important business objectives: to run a profitable business by operating efficient service delivery processes that drive down service delivery cost, meet customer commitments through close management of service-level agreements and manage risk through better control and visibility.

Companies worldwide are using Maximo Asset Management as their solution to support asset and facility maintenance and manufacturing concepts such as RCM, TPM and GMP, and to manage, monitor and document their efforts to comply with regulatory requirements. The implementation methodology that supports Maximo Asset Management incorporates lean principles to help companies identify value, map out the value stream, compress the value stream and strive for perfection. Instead of focusing only on the removal of waste, the implementation methodology provides guidelines for improving asset reliability and performance.

By combining lean and value thinking with a robust, risk-based project management approach, Maximo Asset Management provides companies with a solid foundation on which to implement efficiency improvement programs.

Conclusion

When a company fully embraces lean manufacturing thinking, waste is removed from the value chain and leaves reliable assets as an absolute necessity for business success. Asset management provides a framework for improving the reliability of assets while working in this type of resource-constrained environment. Asset management also provides lower cost of ownership alternatives by supporting the implementation of a single platform across multiple asset classes. This provides management with better visibility of asset performance and standardized work processes across the organization.

For more information

To learn more about IBM Maximo Asset Management, please contact your IBM representative or IBM Business Partner, or visit: **ibm.com**/software/products/us/en/category/SW222?lnk=msoST-aman

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