

LEAN MANUFACTURING PRINCIPLES AND ITS APPLICATION IN PLASTICS MANUFACTURING

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ABSTRACT

The objective of this study is to present a brief history of Lean Manufacturing and to discuss the different facets that are components of an effective lean culture and programs. We then examine the specific impact of each of the lean manufacturing tools on the bottom line and performance of a company. Crandon company, and specifically Elcho division, is actively engaged in the implementation of lean tools and we will complete the study with a discussion of our strategy and plans for Elcho division. It is also important to note that while we will tend to focus on the applications of lean principles in a manufacturing environment, the fundamentals apply to businesses of all nature.

Key Words: Lean Manufacturing, Productivity, Business process engineering, quality

INTRODUCTION

The main tools of a lean manufacturing program are Value Stream Mapping, 5S, Total Productive Maintenance (TPM), Single Minute Exchange of Dies (SMED), and 6 σ . Each of these tools focuses on certain aspects and areas of the manufacturing process in order to help improve costs and efficiencies in a company.

The lean manufacturing and a lean enterprise or business mean that the company is focused on supplying exactly what the customer wants, in the form they want it in, free of defects, at the exact time that they want it, with minimal waste in the process.

The objective of this study is to present a brief history of Lean Manufacturing and then discuss the different facets or tools that are components of an effective lean culture and programs. We then examine the specific impact of each of the lean manufacturing tools on the bottom line and performance of a company. Crandon company (name changed for confidentiality purposes), and specifically Elcho division, is actively engaged in the implementation of lean tools and we will complete the study with a discussion of our strategy and plans for Elcho division. It is also important to note that while we will tend to focus on the applications of lean principles in a manufacturing environment, the fundamentals apply to businesses of all nature.

Many of the ideas that lean enterprise talks about and are based upon are ideas that have been around for a while. Also, many of them are common sense when you step back and look at

processes from a different perspective. Once a company begins implementing lean ideas in their manufacturing processes and seeing results, it will typically precede with the application of lean principles virtually every aspect of their business.

Lean Manufacturing

The origins of lean manufacturing dates back to Henry Ford and his first production line in 1913 (Lean Enterprise Institute 2007). Ford was the first person to consider the flow of production. In today's teachings though, Ford's first assembly line is used as an example of mass production that goes contrary to many lean principles. The problems are not with the flow or even inventories, which he was able to turn entire inventories every few days. The problems were with his ability to make only one variety of cars.

There has been so much focus on lean teachings in recent years that some additional facets, tools, or methodologies have been pulled under the lean umbrella with the Toyota Production System based on how each company takes the lessons and applies them. Regardless of the name or the origins of the methodology, lean enterprise is all about serving the customer more efficiently and effectively. Impacts on the bottom line are in elimination of wastes and growth of customer base. We will now begin to break down and look at the specific tools of a lean manufacturing operation.

Value Stream Mapping (VSM)

Value Stream Mapping at Elcho helps management to visualize the flow on information and product, helps to see waste, shows the relationship between information and material flow, and forms the basis for prioritizing lean actions. The seven wastes in processes that VSM helps to identify are (Elcho 2007): 1) Over Production 2) Transportation 3) Inventory 4) Motion 5) Waiting 6) Defects 7) Over Processing.

These wastes are readily apparent in every manufacturing facility in the business world. Some of them are unavoidable. It is those companies who identify, manage, and minimize these wastes that are able to succeed the best in this very competitive marketplace.

The first step in creating a Value Stream Map is to group and identify product families.

The next step is to walk the process and document inventory levels and process cycle times, along with changeover times.

VSM in itself does not have a direct affect on the bottom line of a company. But, it is a method of visually representing where wastes occur in your process. This then creates the map pointing to the places where you go utilize the lean tools that do directly affect the bottom line. The wastes and the reduction of them are what directly impact the bottom line.

5S

While value stream mapping is considered by many to be the basic tool for management to start towards a lean operation, a 5S methodology is absolutely necessary on the plant floor as a foundation for later improvements.

In application at Elcho, and other companies that we are aware of, we actually refer to it as 6S, adding Safety into the mix. Safety must be at the forefront of everything we do and is an important benefit of 5S.

The greatest benefit from a 5S program is the discipline that is learned. But, there are others as well. Standardization of work areas and documentation can lead to reduced cycle times, greater cost efficiency, and reduced motion which directly affect the wastes of transportation and inventory. An ideal plant layout is raw material in one side and finished goods out the other with one piece pull flow through the plant in between. Also, less money will be tied up in inventories, fewer defects will be produced because everyone performs things the same way, and fewer things will be overlooked with the use of visual cues. Finally, equipment upkeep will be easier because with clean equipment some types of problems, such as oil leaks, will be readily apparent.

Total Productive Maintenance

As a company begins working towards a lean enterprise and synchronous flow of batches of parts across machines, machine availability and uptime becomes a major issue. It is estimated that the cost of unscheduled equipment downtime in lean manufacturing environments without excessive inventory buffers is 5 to 30 times what it is in other manufacturing environments (Cooper 2004). This is because it results directly and immediately in lost opportunity, failed shipping schedules, and lost sales. Total Productive Maintenance or TPM is the methodology used to attack issues with machine uptime.

The entire focus of a TPM program to keep equipment effectiveness on levels that allows for smooth flow with minimal inventories through production. Waiting, or downtime on machines, is much more costly in a lean environment. Also, reliability in machines allows management to know what capacity levels are and more accurately plan and react to variations in sales. Improved impacts on the bottom line come from on-time deliveries to customers, reduced inventory costs, and lower scrap numbers.

Single Minute Exchange of Dies (SMED)

It was in response to the emerging needs of increasingly smaller production lot sizes required to meet the needed flexibility for customer demand. It was originally developed through the study of a die change process, thus the name. The die changeover was monitored and evaluated to determine what could be done to increase the speed and accuracy of the changeover. SMED also seeks to standardize and simplify so that the need for especially skilled workers is minimized. SMED has now been expanded to virtually any changeover of equipment.

Today's SMED practices target changeovers of 10 minutes or less. Some companies who have fully embraced lean teachings are targeting "Zero Changeover", which is considered 3 minutes

or less. As a company becomes more sensitive to the customers needs and thus more flexible, the need for an effective SMED program increases due to smaller and smaller production lot sizes. VSM helps to point the way to areas in the plant where SMED needs to be applied for increased overall throughput.

The benefits to the bottom line of SMED are similar to that of TPM: improved flow, lower inventories, and better quality. Whereas TPM focuses on reducing unplanned downtime, SMED focuses on reducing planned downtime due to changeovers. The less time that it takes to change a machine from one product to another, the more time there is for production resulting in greater capacity for throughput.

Kaizen Culture

Another tool of a lean enterprise is the cultural tool of Kaizen. It is the ongoing attitude that continuous improvement can be made.

At Elcho the Kaizen culture is based on 5 elements shown in Exhibit 6 (Elcho 2007): 1) Quality Circle 2) Improve Moral 3) Team Work 4) Personal Discipline 5) Suggestions for improvement

Kaizen is more an attitude of the work force than it is a specific tool of lean manufacturing. The benefits of a Kaizen culture to a company's bottom line are clear. When a workforce is focused and thinking of improvement opportunities every day, the problem is not initiating continuous improvement, but prioritizing and allocating resources to affect the most important improvements. Reduction of costs is an area hugely affected by a Kaizen culture.

Hoshin Kanri Planning

Hoshin planning is more a methodology for management to set forth a plan for the future. At Elcho, each staff member with responsibilities in every plant has annual goals. Each of these goals can be tied directly to the goals of the superior that he or she reports too and the same holds true for the level above that. This is the case all the way through the chain of command up to the Chief Executive Officer of Elcho PLC. All goals should directly support the company's vision as set forth by the CEO and the board.

Summary

As presented here there are several aspects to a lean enterprise. When utilized together they are powerful tools that can make or break businesses. Even applications of some of the tools can produce positive effects, but true results are only realized with an entire lean transformation.

The insider perspective at Elcho demonstrates a promising picture for Lean implementation, despite the lack of understanding with other manufacturing corporations in the industry. From the experiences we have had with visiting various Elcho plants throughout the US, there is definite effort and accomplishment seen in the benefits that 5S methods have delivered to the facility layouts. Tools are visible and in order, supplies are organized and assigned locations in the work areas, and 5S is reiterated through the facility with signage that readily explains the

sort, set in order, sweep, standardize, and sustain steps. Elcho has invested a lot of time and resources to training their Lean managers internally to continue deployment of Lean thinking in the management teams of every facility. In 2007, selected Lean facilitators attended Black Belt training and studied the auditing process for scoring facilities in their Lean progress. The financial perspective is positive, too, as Elcho Closure & Containers facility has identified \$300K in operational savings that stem from investment in machinery. The intent is for the investments to yield positive gains in overall equipment effectiveness, by tracking and continuing to modify processes as identified through value stream mapping and investigation of poor performance with equipment. Yet there is still more evidence necessary to support Elcho's incorporation of Lean activity in its overall corporate business model

The Elcho Closure & Containers facility would still probably be considered in the relatively early stages of our lean transformation. Some tools such as 5S have been effectively implemented and they are in the planning phase of others such as TPM processes. Through this entire time it is management's responsibility to teach the workforce and to promote the Kaizen continuous improvement culture. There comes a point in the cultural transition where the change is like rolling a snowball downhill. In the initial stages, it takes continuous pushing and prodding from management to move it and make things happen. But, once a little momentum is achieved and results begin to happen it starts to roll downhill and build on itself.

We are not to that self-sustaining stage at the Elcho's Closure & Containers facility plant yet, but are working diligently on getting there. The following graphical representation, Exhibit 8, is a plan of lean implementation for us at Princeton and a constant reminder of the bottom line results of our efforts (Elcho 2007).

Conclusion

Lean manufacturing and more generally lean enterprise work principles are widely taught throughout most industries now, and yet there are still companies that persistently refuse to embrace the ideas. With the prevalence of lean ideas and books it is amazing to see that as recently as 2005, polls among manufacturing managers showed that 41% of them admitted to little understanding of what lean was. Another 34% were familiar with the term but did not really know how to achieve it. 22% replied that their companies were "on the lean path" but not getting the desired results, and only 3% were undergoing lean transformations with great results (Koenigsaecker 2005).

Perhaps some of the reluctance to embrace lean ideas stems from the terminology and that the ideas are coming from outside of US. As mention here that many of the ideas are in fact American in origin and were only pulled together and refined as part of the Toyota Production. Regardless, the common sense workable ideas behind lean manufacturing are here to stay. With the success of hundreds of manufacturing companies, the numbers do not lie. Another indicator of this is the recent acquisition of a lean scheduling and kanban execution vendor by the business enterprise system giant SAP (Gordon 2007).

When taken in the simplest form, lean is all about streamlining the flow of value through an organization. If it does not create value in the customer's eyes, it is a waste. What are the

effects of eliminating waste and focusing on value? Improved bottom line performance, greater productivity, increased quality, cost reduction, customer satisfaction, and greater market share are some of the results. But most importantly, all of these tie into an increase in shareholder wealth in the companies.

Note: "References available upon request from Mehmet C. Kocakulâh at mkocakul@usi.edu.

