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Lean Manufacturing: The new manufacturing strategy

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Abstract
The Lean Manufacturing system aims at eliminating the major equipment losses, manpower losses, material losses and several time losses. These losses are structured to enable everyone to easily identify and agree on the opportunities for improvement. Hence in manpower losses, MURI (Strain)and MURA (inconsistent or imbalance) are the main sources of loss where the application of lean manufacturing tools result in minimizing such losses and reflected through productivity improvement and efficiency maximization.
The lean manufacturing tools can be advantageously made use of a situation where similarity in terms of some characteristics exists for productivity improvement and area of continual change. Models assisting Lean Manufacturing model such as kaizen, six sigma, poka-yoka, Tqm, Tpm, Jit, Doe, FMea, oee etc. have been most frequently used for industrial application.

Keywords: lean manufacturing, productivity, loss, profit, quality, scheduling

1. Introduction

Today the customer is the on the driving seat of the virtual manufacturing vehicle. It is realized that their whole approach to the manufacturing system should be customer oriented. So to satisfy the customer, quality of the product should be high at low cost. Hence to achieve this one should apply the basic concepts to reduce the cost systematically throughout the product design and production process by means of series of engineering reviews.
One has to reduce or eliminate the waste or scraps and added costs generated due to over-production, change or set-up time, higher inventory, waiting time, equipment breakdown, poor vendor and quality/distribution, error and defect of the machines or products / materials, process and human resource problem. So, to become lean, the organization should take the following steps.

- Re-Examine the value of the product/services with respect to customers.
- Examine the value stream by critically evaluating each part of plant and machinery, and process system, which are created to produce value for the customer. This ensures continuous flow of processing by using the following techniques.
  1. Single piece flow.
  2. Poka- yoka (mistake proofing).
  3. Visual Management/ Control.
  4. Total employee involvement.

Principles of Lean Enterprise

- Zero waiting time.
- Zero Inventories (WIP).
- Scheduling – Internal customer pull instead of push system.
- Batch-and-queue manufacturing to one-piece flow – cut batch sizes.
- Line balancing.
- Cut actual processing time.

Benefits of lean manufacturing

- Reduction in waste generation - Uncover any defect early in the process before large amount of defective parts are manufactured.
- Reduction in amount of floor space.
- Reduction in Inventory (WIP).
- Improvement in Quality.
- Reduction in Manufacturing Lead Time.
- Reduction in New Product Development Time.
- Improvement in Delivery Performance.

Wastages in production industries

- **Overproduction**

Overproduction is considered as the worst waste of all because it leads to nearly all the other wastes. Overproduction causes excess inventory, and it can hide defects and hinder the search for their root causes. Overproduction can create a need for additional processing, such as defect protection and rework. Overproduction also leads to more conveyance effort because the excess material must be moved, stored, and otherwise handled many times. Waiting time of the material, the largest component of cycle time, is increased by overproduction since the material is produced before it is needed.

- **Waiting time**

Waiting Time, the time during which value is not added to the product, arises in the industry due to unsynchronized workflow, uneven distribution of load, breakdowns or lack of material or component to process. Waiting time also include the time spent by operators watching to ensure that the machine is working properly and that product is perfect. Long setup/ changeover time is also one very important constituent of waiting related wastes; some of the most dramatic improvements in productivity have come from reductions in set-up time.

- **Transportation**

Transportation waste includes wastes like multiple handling, delay in material handling, unnecessary handling, and loss of material due to poor handling, spills, leaks or contamination etc. Every time a component is moved from one place to another, it creates delay. The solution lies in improving the transportation system so that the components that have to be moved arrive at the next machine in the minimum time possible, and in redesigning the both components and manufacturing processes so that more activities can be carried out within the same production cell.

- **Waste of process**

A process may be wasteful; or it may be totally unnecessary and capable of being completely eliminated. The reason, it is wasteful may be that it does not add value or because there are alternative, better ways of producing the same results. For example, a heat treatment process may be eliminated by the selection of materials that do not require heat treatment. This focus on the waste of the process is particularly useful when applied to service processes. Improving the efficiency of a production process can significantly reduce waste generation at the source of generation.

- **Holding or purchasing**

Holding or purchasing unnecessary raw material, work in process and finished goods are considered as inventory waste. Excess inventory is rated as colossal waste. Inventory is often used to insulate the factory from problems, such as long setup time, poor maintenance practices, unreliable suppliers, and improper production control policies. Therefore, it can be viewed as an indicator of problem rather than as a problem itself. The ultimate in inventory control procedures is embedded in the just-in-time manufacturing philosophy, since this method estimates the need for inventory.

- **Unnecessary human movements**

Unnecessary human movement is a waste of time and energy; it is tiring and stressful, and disrespectful to the workers. It is found that in some of the western factories, operators are seen waiting near work stations to receive the parts from the conveyor belt. Productive time of workers is unutilized and this situation can be improved by redesigning the wok, reallocations of work stations and synchronizing the flow, as being suggested by the TPS (Toyota Production System).

- **Defects**

Frequent error in paperwork or material / product quality problems resulting in scrap and/or rework, as well as poor customer service are defined as defects. Defects waste time which constitute of time to detect, time to repair or replace, time to sort, and the time it takes to produce the defective products in the first place. Defects also waste material and create scrap. Defects are also realized in the performance of human potential and worker effort. Furthermore, defects directly contribute to high variability. This in turn it causes more congestion, longer cycle time, longer lead times, higher WIP, higher production costs, and the entire battery of problems related to high variability.

- **Others**

Waste is present in the product design in the form of unnecessary complexities and non standardized component fits, interfaces and over specifications like high tolerance limits and high quality surface finish. Having unnecessary components, material variety, requiring complex and unnecessary manufacturing and assembly process increases waste in the form of inventory, material waste, labour waste, time waste and energy waste resulting in increase in the tooling and process costs, effecting quality, reliability, lifecycle cost, and new product development cycle time.

The waste of unrealized human potential disregards the most significant asset of a factory: the cumulative wealth of employee experience and creativity. Human beings have the ability to learning, inventing, adapting, teaching, solving problems, creating new products, and improving processes. In fact, they are one of the best competitive advantages which cannot be duplicated by the competitors.

Implementation of Lean Manufacturing (LM)

- Research, evaluate, support implementation and report on designing and development processes within an industrial context.
- Research and evaluate applications for problem solving, implementation and improvement processes, philosophies and techniques including Problem solving, Brain Storming, decision-tree, trade-off tables, Kaizen, TQM and Tools of TQM. Support implementation and report on engineering projects incorporating problem solving, improvement processes, philosophies and techniques.
- Research, evaluate and report on case studies involving continuous, mass, batch, jobbing or prototype production processes, competitive (lean) manufacturing including sequential and cellular manufacture and assembly, Just In Time (JIT), design for reliability, optimum maintenance, computer managed maintenance.
- Identify resources, skills, knowledge and techniques required by engineering applications.
- Identify resources, skills, knowledge and techniques for engineering applications. With the help of others, identify control and supervisory systems if required by particular applications.
- Identify functional attributes of components and systems of engineering projects.
- Identify and use sources of information on resources, skills and knowledge for engineering projects.
- Appropriate sources of information on resources, skills, knowledge and techniques for engineering projects were identified and used. Trade language and descriptions of resources and techniques are used as appropriate.
- Appropriate computing techniques have been implemented in the process of sourcing, categorising, cataloguing and reporting on resources search results for engineering applications.
- Apply engineering fundamentals in support of selection of resources for engineering applications based on functional or performance specification of system and components.
- Appropriate basic scientific principles and techniques are applied in support of selection of resources for engineering applications.
- Appropriate calculations and assumptions are used to enable choices of resources for engineering applications.
- Appropriate materials properties, methods and processes knowledge is applied in support of selection of resources for engineering applications.
- Appropriate resources have been chosen for the engineering application. Selections should be based on functional or performance specification of system and components of application.
- Specify resources, and technical support for engineering applications sufficient to facilitate their identification and supply.

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- Suppliers of resources and technical support are identified.
- Assist with design specifications and development procedures for engineering applications.
- Contribute significantly to the creation of design, implementation, installation, commissioning and maintenance procedures and documents for specific engineering applications.
- Implement appropriate computing and programming techniques in the process of development of design specifications and documentation for specific engineering applications.
- Create and file design graphics and documentation suitable to the design and development process of the application or project in accordance with organisational and contractual requirements.
- Assist with implementation of design and development in accordance with specifications and documentation for engineering applications.
- Assist significantly with implementation of design, development, installation, commissioning and maintenance in accordance with specifications and documentation for specific mechanical and manufacturing engineering applications.
- Review design implementation. Report on and record results of the outcomes of the implementation of the design and development.

Literature Review

Dennis P. Hobbs Lean manufacturing has been the buzzword in the area of manufacturing for the past few years. The concept originated in Japan after the Second World War when Japanese manufacturers realized they could not afford the massive investment required to build facilities similar to those in the them A. The Japanese, particularly Toyota, began the long process of developing and rifling manufacturing processes to minimize waste in all aspects of operations.

Feld William: Five primary principle elements are required to support the manufacturing component of Lean Manufacturing. They are as discussed below.

1. **Manufacturing Flow:** It concerns the physical charges and design standards deployed as part of each work cell.
2. **Organization:** It establishes people's roles, functions and trains them in new way of working and communicating.
3. **Process Control:** It includes efforts to monitor, control, stabilize and improve desecrate manufacturing.
4. **Matrices:** It establishes visible results based performance, measures, and determines targets for improvement and recognizes work teams for their process improvement.
5. **Logistic:** It defines the operating rules and mechanism for planning and controlling the flow of material.

Hines, P., Taylore, D Lean manufacturing originally known as the Toyota Production System (TPS), was originated by Taiichi Ohno and Shigeo Shingo at Toyota. It is now widely recognized that organizations that have mastered lean manufacturing methods have substantial cost and quality advantages over those still practising traditional mass production.

Lean Enterprise Institute Lean Manufacturing leads to integration of various culture and strategy to serve the customer with quality, low cost, and shorter lead time. Lean manufacturing implies that all the activities not adding value to the product are waste. In lean manufacturing, the value of a product is defined solely based on what the customer actually required and willing to pay for.

Ohno, T In Lean Manufacturing, the value of a product is defined solely based on what the customer actually requires and is willing to pay for. Keeping in view the finer details of the manufacturing operations, various activities can be grouped into three main segments.

1. Value adding (VA)
2. Necessary but non value adding (NNVA) and
3. Non-value adding (NVA)

Activities involved in the conversion or processing of products are termed as value adding activities. Necessary but non value adding operations are defined as activities that may be wasteful in nature but are necessary under present operating conditions. These types of operations are difficult to remove in the short run and hence, should be targeted in the longer term by making major changes in the present operating system. This includes creating a new layout, vendor selection for delivering the goods etc. Non value adding activities do not make a product or service more valuable. These are termed pure waste and involve unnecessary actions which should be eliminated completely. Some of the examples are increased waiting time, double handling, unnecessary inventory, inspection etc.

Research at the Lean Enterprise Research Centre in the United Kingdom (Hines and Taylor identify the ratio of various activities for physical product environment and same for information environment, outline diagram in Figure 1.2 is properly interpreted. This figure shows that as per the information environment (e.g. office, distribution or retail) value stream time is distributed as 1% value adding, 49% non value adding, and 50% necessary but non value adding.

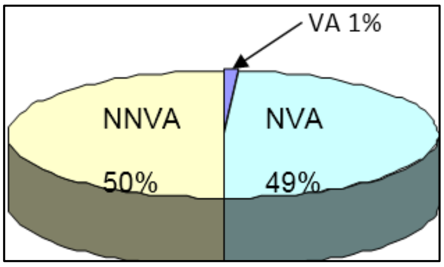

Fig 1: Information environment

Rother, M., and Shook, J [17] Waste can be termed as anything other than minimum amount of equipment, material, parts, space, and time that are essential to add value to the product. Waste uses the resource but does not add value to the products. It has many forms and can be found at any place and at any time inside the organization.

Womack and Jones [24] Screening the circumstances from an operation management view point, it presents a logical and coherent framework in implementation of the lean manufacturing philosophy to improve the productivity and quality of the organization through waste (MUDA) reduction, where 'MUDA' is the symptoms of MURI (Strain) and MURA (Inconsistent or Imbalance). Lean manufacturing technique is based on the application of five principles to guide management's actions towards success Value, The Value Stream, Flow, Pull, and Perfection.

The best Japanese manufacturer, i.e. Toyota, admitted that they still have an average above 30% waste. In the purest sense of interpretation the division of activities in physical flow environment and information flow environment are assessed properly.

Lean manufacturing is based on five principles proposed by Womack and Jones [20]. These principles provide a simple structure to build a detailed route map of lean implementation. The five lean principles are described as follows:

1. Specify what does/doesn't create value from the customer perspective and not from the perspective of individual firms, functions and departments.
2. Identify all the steps necessary to design, order and produce the goods across the whole value stream to highlight non value adding waste.
3. Make the actions that create value flow without interruption, detour, backflows, waiting or scrap.
4. Only make what is pulled by the customer.
5. Strive for perfection by continually removing successive layers of waste as they are uncovered.

Based on the above principles a road map to implement lean can be drawn. The objectives of the above principles and methods of achieving are given in Figure 1.3.

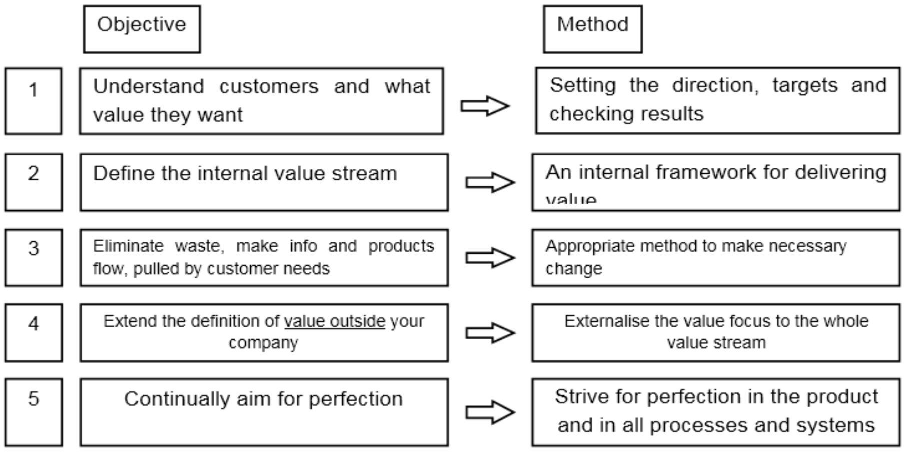

Fig 1.3: How to go lean

Conclusion

It is generally agreed that for a lean manufacturing programme to be effective, it should include a set of tools and techniques or provisions to ensure management commitment, employee involvement, identification of wastes, development of controls for wastes and training and education for employees

These tools and techniques are said to be typical of any comprehensive lean manufacturing implementation programme. The implementation of lean manufacturing reduced the waste in the industry and enhances the profit and production.

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