MATERIAL MANAGEMENT BY USING LEAN MANUFACTURING PRINCIPLES A CASE STUDY
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ABSTRACT: Material management and inventory control, or more precisely controlling flow of material is considered as last frontier of profit in profit making manufacturing organization. But in order to reduce the cost burden and make the organization more cost effective, even non profit organization such as government agencies, public utilities, hospitals and educational institutions have begun to realize its importance. Material management and inventory control therefore are primarily concerned with the flow of material within and from an organization and in manufacturing industries. This paper reviews how flow of material is managed by using some lean manufacturing techniques. The focus in lean manufacturing is to reduce the wastes and make the system more efficient. Managing the flow of material with lean principles leads to saving in time, inventory and cost.

Keywords: Material management, Lean manufacturing, Inventory control,

INTRODUCTION:

The primary goal of any business is to make a profit. In order to achieve more profits either to increase the revenue or decrease the costs involved in manufacturing. Decreasing the cost is the better option than increasing revenue because capacity of plant is fixed and price has to be increase, but due to the competitor in the market it may not be possible. Decreasing the cost in manufacturing is possible through lean approach. Lean manufacturing is the philosophy to reduce the wastes in manufacturing.

The first time that lean concept was shown to the world was in the book "the machine that changed the world" which is a benchmark among craft production, mass production and lean production. The lean manufacturing technique was built in between 1945 and 1970. The lean system helped to sustain Toyota in 1975, 1976, 1977 more than at other Japanese companies. The origin of lean thinking came from the shop floor of Toyota motor corporation where a set of tool kit is developed such as JIT, pull production, one piece flow, visual control, KAIZEN, Cellular manufacturing, Inventory control(1).

MATERIAL MANAGEMENT:

In majority of the organizations, the cost of material forms a substantial part of the selling price pf the product. The interval between receiving the purchased parts and transforming them in to final products varies from industries to industries depending upon the cycle time of manufacture. Materials are procured and held in the form of inventories. It is therefore necessary to hold inventories of various kinds to act as a buffer between supply and demand for efficient operation of the system. Thus, an effective control becomes a must for smooth and efficient running of the production cycle with least interruptions. The stocking of anything that is tangible in order to meet the future demand is the subject matter of the inventory theory(2).

The material management expert like Dean Ammer claim rightly that efforts for saving rupee in materials cost is almost equal to the efforts made for additional sale of Rs. 10.

Materials form an important part of current assets in any organization. The return on investment depends on great deal on the manner of utilization of material. The relationship is as represented bellow.

Profit

\[ \text{ROI} = \frac{\text{Profit}}{\text{Fixed asset} \times \text{Current asset}} \]

The fixed asset constitute capital already sunk and the only scope for improving the return on investment lies therefore in efficient management of materials which constitute the bulk of the current assets. Therefore in this context, the
control of materials assumes great importance(3).

LEAN PRINCIPLES:

Ever since Henry Ford invented the assembly line, industrial innovators have constantly focused on improvement through a variety of different manufacturing strategies. Lean manufacturing is a manufacturing strategy that seeks to produce a high level of throughput with a minimum of inventory.

Originally a Japanese methodology known as the Toyota Production System designed by Sakichi Toyoda, lean manufacturing centers around placing small stockpiles of inventory in strategic locations around the assembly line, instead of in centralized warehouses. These small stockpiles are known as kanban, and the use of the kanban significantly lowers waste and enhances productivity on the factory floor.

In addition to eliminating waste, lean manufacturing seeks to provide optimum quality by building in a method whereby each part is examined immediately after manufacture, and if there is a defect, the production line stops so that the problem can be detected at the earliest possible time.

One of the primary focuses of lean manufacturing is to eliminate waste; that is, anything that does not add value to the final product gets eliminated. In this respect, large inventories are seen as a type of waste that carries with it a high cost. A second major focus is to empower workers, and make production decisions at the lowest level possible.

Lean manufacturing is defined as "a systematic approach to identifying and eliminating waste (non-value-added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection".

The goal of lean manufacturing is "to eliminate the eight wastes of lean-overproduction, motion, inventory, waiting, transportation, defects, underutilized people, and extra processing. Lean targets non-value-added activities. These are the same activities that contribute to poor product quality"(5).

Lean thinking exposes these root causes that will need to be solved in order to eliminate the problems that they cause. The manufacturing process will become for efficient and consistent as these problems are solved. Table 1 shows the difference between lean organization and traditional organization.

Lean manufacturing leads to the standardization of processes that can insure that improvements are consistently maintained. Of course these standards are not set in stone, but constantly challenged to see if further improvements can be made.

The key lean manufacturing principles::

1) One piece flow/ Cellular manufacturing:

One-piece flow is defined as moving/making only what is needed, when it is needed thus minimizing WIP inventory enhances efficiency, eliminates quick response time, eliminates build-up of defects and facilitates standardized work. To implement one piece flow Line should be properly balanced. In cellular manufacturing, production work stations and equipment are arranged in a product-aligned sequence that supports a smooth flow of materials and components through the production process with minimal transport or delay.

2) Batch Size Reduction:

Historically, manufacturing companies have operated with large batch sizes in order to maximize machine utilization, assuming that changeover times were "fixed" and could not be reduced. Because Lean calls for the production of parts to customer demand, the ideal batch size is ONE. However, a batch size of one is not always practical, so the goal is to practice continuous improvement to reduce the batch size as low as possible.

Reducing batch sizes reduces the amount of work-in-process inventory (WIP). Not only does this reduce inventory-carrying costs, but also production lead-time or cycle time is approximately directly proportional to the amount of WIP(6).
Table 1: Comparison between traditional organization and lean organization

<table>
<thead>
<tr>
<th>Concept</th>
<th>Traditional Organization</th>
<th>Lean Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inventory</strong></td>
<td>An asset, as defined by accounting terminology</td>
<td>A waste – ties up capital and increases processing lead-time</td>
</tr>
<tr>
<td><strong>Ideal Economic Order Quantity &amp; Batch Size</strong></td>
<td>Very large – run large batch sizes to make up for process downtime</td>
<td>ONE – continuous efforts are made to reduce downtime to zero</td>
</tr>
<tr>
<td><strong>Process Utilization</strong></td>
<td>Use high-speed processes and run them all the time</td>
<td>Processes need to only be designed to keep up with demand</td>
</tr>
<tr>
<td><strong>Work Scheduling</strong></td>
<td>Build products to forecast</td>
<td>Build products to demand</td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>Inspect/sort work at end of process to make sure we find all errors</td>
<td>Processes, products, and services are designed to eliminate errors</td>
</tr>
</tbody>
</table>

3) Takt time:  
"Takt time" refers to the rate at which customers are buying products from the production line, i.e. the unit production rate that is needed to match customer requirements. It is calculated by dividing the total available time per day by the daily customer demand (7).

4) Standard work:  
The goal of TPS (Toyota Production System) is to create an efficient production sequence that emphasizes human motion and the elimination of waste. Focused around human movements, standardized work outlines efficient, safe work methods and helps eliminate waste while maintaining quality. Standardized work is the foundation for Kaizen, or process improvement, in production. It organizes and defines worker movements. This is important because, when the work sequence is different each time and/or if the motions are disorganized, there is no base line for evaluation. The first step in kaizen is standardization (8).

5) Jidoka:  
Jidoka is defined as a system of ensuring that defect-free product is passed from one operation to the next. Quality is designed into the operation beginning at the product/equipment design phase utilizing prevention techniques. Standard work supports tasks that involve exercising human judgement. Two common prevention techniques are Pokayoke and Andon(9).

A Pokayoke is an element of the process that senses a defect or non-conformance and will not allow the process to proceed. Examples of Pokayoke include fixture features that will not accept an out-of-spec part, sensoring that checks for parts or features from previous operations, or sensoring/clamping in the process that will not release the part if it is not properly processed. Andons are visual displays such as lights, flags, etc. which indicate the operating status of a work centre. For example, a green light may indicate a cell is on schedule and is meeting takt time, a yellow light may indicate a cell is behind schedule or that an operator is calling for help with a problem, and a red light may indicate a cell has been stopped(10).

6) 5S(House keeping):  
5S is a system to reduce waste and optimize productivity through maintaining an orderly workplace and using visual cues to achieve more consistent operational results. The 5S pillars, Sort (Seiri), Set in Order...
(Seiton), Shine (Seiso), Standardize (Seiketsu), and Sustain (Shitsuke), provide a methodology for organizing, cleaning, developing, and sustaining a productive work environment. 5S encourages workers to improve the physical setting of their work and teaches them to reduce waste, unplanned downtime, and in-process inventory.

7) Continuous improvement (kaizen):
Continuous improvement in a management context means a never-ending effort to expose and eliminate root causes of problems. Usually, it involves many incremental or small-step improvements rather than one overwhelming innovation. From a Japanese perspective continuous improvement is the basis for their business culture. Continuous improvement is a philosophy, permeating the Japanese culture, which seeks to improve all factors related to the transformation process (converting inputs into outputs) on an ongoing basis. It involves everyone, management and labor in finding and eliminating waste in machinery, labor, materials and production methods. The Japanese word for continuous improvement, kaizen, is often used interchangeably with the term continuous improvement. From the Japanese character kai, meaning change, and the character zen, meaning good, it means improvement (11, 12).

CASE STUDY
This case study is conducted at Siemens Ltd. Kalwa. The plant comes under energy distribution group which mainly produces switchgear, switch board, motor and transformer. This case study is conducted at switch board plant.

A switchboard forms an important link in the distribution chain of power, from its source of generation to its end user. It controls the flow & distribution of power from a central place.

Depending upon the type of application, vacuum circuit breakers are classified as:
- Indoor Vacuum Circuit Breaker (IVCB)
- Outdoor Vacuum Circuit Breaker (OVCB)

Introduction to product:

The Indoor Vacuum Circuit Breaker (IVCB) as shown in fig. 1 are mounted on panels & hence the name as Indoor Vacuum Circuit Breaker (IVCB). The unique merits of these breakers are less weight of moving parts & have a very long life of the order of several thousand operations at rated normal current. These breakers are designed to handle all the switching duties that occur in primary distribution systems.

Need to implement lean manufacturing
The todays annual demand of IVCB’s is 8800 that means near about 32 breakers required to produce daily in todays condition. But according to the forecast this demand is going to increase to 22,000 up to 2011-12 i.e. nearly 80 breakers are required to produce daily. To cope with that demand SIEMENS is going to implement LEAN manufacturing which is the best tool for improving the productivity by reducing the waste.

In the current system the material is primarily stored in the racks of the stores and then it is stored at commissioning area where space is provided for the secondary storage. Current commissioning area can not be directly integrated with the new lean assembly line since it is having following problems:
- Current commissioning area layout is not as per the lean principles. While doing commissioning lots of backtracking motions are required to do by the material feeder since material is not grouped as per breaker type.
- No any proper indication system for refilling the material from store to commissioning area; So if material becomes zero at commissioning area material feeder has to wait till store keeper fills the material.
- No proper material handling system for moving the VI
- housings from unloading station to commissioning area location.
- Vendor managed products are very less

**Reducing unnecessary motion by changing lay out**

Arrangement of drawers of components location at the tray filling area is as shown in Fig. 2. Each color indicates components from a particular type of breaker.

Old arrangement of materials

![Fig 2. Old arrangement of all parts (Front View)](image)

Table 2: color coding of all material

<table>
<thead>
<tr>
<th>Breaker Type</th>
<th>Old Lay Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>3AH5 &amp; 3AH0</td>
<td></td>
</tr>
<tr>
<td>3AH5</td>
<td></td>
</tr>
<tr>
<td>3AH0</td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td></td>
</tr>
<tr>
<td>3AH3</td>
<td></td>
</tr>
<tr>
<td>Verities in that type</td>
<td></td>
</tr>
</tbody>
</table>

Verities in that type

According to the OIS (order instruction sheet) jacket, worker identifies the breaker type and he fills a tray by picking required components from drawers. Thus, worker has to move at different drawers of components. Thus, it is seen that because of complex arrangement of components, worker has to do backtracking movement, which takes more time.

![Old lay out](image)

![New lay out](image)

Fig 3. New arrangement of all parts (Front View)

Grouping of components according to breaker type in new Commissioning area is as shown in Fig.3. Because of grouping of components for particular breaker, worker has to do movement in a limited area of that particular breaker components. Thus, backtracking movements are eliminated and time required to fill a tray is less. Also it is easy to identify a location of particular item of a particular breaker.

Time study taken with both layouts shows the benefits with new lay out as shown in table 3.

<table>
<thead>
<tr>
<th></th>
<th>Old lay out</th>
<th>New lay out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time required to fill 6 trays</td>
<td>36 min.</td>
<td>25.2 min.</td>
</tr>
</tbody>
</table>

Table 3 : Comparison in Time study

Total time saving=36-25.2=10.4 min/6tray

As we are planning to feed 80 trays/day so we are saving 138 min daily

**Reducing material handling by providing trolleys**

Material handling is concerned with moving the right quantity of materials-raw material, machinery spares, work in progress and finished goods at the right time in given space. It deals with art and science involving the movement packing and sorting of materials mechanically and manually. The movement of materials can be vertical, horizontal, in batches or as a single unit. Materials handling function includes every operation except the actual processing. Handling materials increases only the cost of the product and not the value of the item.

Materials handling represents about 50 percent of production, cycle time, an equal amount of the conversion cost and
about 25 percent of production cost. It is one of the few areas where cost can be substantially reduced.

While doing study we came to know for VI housings the current material handling system is not quite well. VI housings are required for 3AH0 pole assembly. Daily we receive near about 40 VI housing on an average as per the production plan so at any time there should be space for 80 VI housing including the stock. Currently as the VI housing are unloaded on pallets and kept at the 3AH0 pole assembly workstation. This system is having following disadvantages.

- Maximum 14 VI housings can be stored on pallet
- Every time hand pallet truck is required to move VI housing from one location to another which is inconvenient since that required a person and hand pallet truck free at that time
- Since space at workstation is less so other pallets required to kept at other location in store that cause for multiple storing locations.

For this we provided a solution by making a trolley as shown in fig. 4.

Fig 4. Improved material handling for VI housing

This alteration provides following advantages

- Trolley can carry 36 VI housing at a time which is equivalent to the space of two pallets. So 8 more VI housings can stored in same space as compared to previous storage system.

- Same trolley can be used for unloading and then moved to workstation so no requirement of any other material handling system

by providing 2 trolleys we made space for 72 VI housing that satisfies all requirement of storage so no secondary location is required for VI housings.

Reducing waiting time by implementing Kanban system

In Commissioning area material is stored mainly in cage boxes and in table drawer. Previously for refilling the material store keeper has to check the all containers and refill it whenever required that leads to following problems

- Store keeper required to check each and every location at Commissioning area which consumes lot of time.
- Some time if by mistake if some locations are not checked that may lead to stock out condition at kitting area.
- There is no any concept of safety stock or reorder level at commissioning area
- Store keeper must keep information that where the material is kept in store

With the introduction of KANBAN card system all above problems are recovered as discussed bellow.

We placed a KANBAN board at new commissioning area. So store keeper required to check only that board in the span of every one hour. Some modifications are made in table drawer and cage boxes so as to make intimation when material reaches at reorder level. Previously table drawer’s arrangement was such that they can move in one direction. We done some modifications such that table drawer can move in both forward and backward direction as well as C channel is provided so as to place a partition plate to identify the reorder level.
So the table drawer is divided in two parts that is front half and back half when material becomes zero at front half the kitting person has to place the kanban card in the kanban board as shown in fig.5. As store keeper makes round at one hour span and he finds card at the kanban board he takes that card and refills material as per the information mentioned on the card. Since material is refilled from back side of table drawer he required to move material from back half to front half by removing the partition and required to place the kanban card at the front half as shown in fig.6.

The Kanban card is designed as shown in fig.8. which contains photograph of that part, its part number, its location in store, its location in Commissioning area and quantity to bring.

Reducing inventory through VMI concept

Just in time inventory system arranges the purchase of raw material and sub assemblies as they are needed, thus holding of material and finished goods at zero or minimal. The management of manufacturing companies should ascertain the items which can be procured when they are needed. When there is continuous flow of material and parts the necessity of inventory build up for such material and parts would be largely eliminated. (3)

Vendor-managed inventory (VMI) is a supply-chain initiative where the supplier is authorized to manage inventories of agreed-upon stock-keeping units at retail locations. The benefits of VMI are well recognized by successful retail. In VMI
- Distortion of demand information (known as bullwhip effect) transferred from the downstream supply-chain member (e.g., retailer) to the upstream member (e.g., supplier) is minimized.
- Stock out situations are less frequent.
- Inventory-carrying costs are reduced.

Furthermore, a VMI supplier has the liberty of controlling the downstream resupply decisions rather than filling orders as they are placed. Thus, the approach offers a framework for synchronizing inventory and transportation decisions.

In production management system the material planner has to start planning before three months. So on his requisition when purchase engineer gives the open order for next three months to vendors they supply the material as early as possible for them. Many times unnecessarily material is kept in our store regardless of when it is going to be used. Which ultimately cause for increase in inventory at our side with this new system the batch quantity and visiting time is defined for each material and vendor so vendor come at his respective visiting day and check the inventory if that is bellow the minimum stock level he fills that in next visit. It is explained as bellow.

Let’s take example of shafts. One breaker requires one qty. of shaft in drive assembly. We are producing 800 breakers per month. So our monthly requirement of shaft is 800. Previous system was such that for one month the material comes in two batches one before 1st of month and second before 15th of month so at a time 400 shafts comes in store. So we require 5 cage box’s as one cage box can carry 80 shafts. That means we required 5 location in store.

In new system we provided only 3 locations for shafts that is for three cage boxes and batch quantity is decided of one cage box that is 80 shafts and visiting time is fixed of 3 days; that means vendor will come after each 3 day and if he finds any empty location he will refill it on that day.

We started this activity for some vendors from few months; for that purpose we have created first a monitoring chart includes batch quantity and visiting time for each vendor and accordingly followed it; which result in saving of 40% in inventory carrying cost of each material.

**Conclusion and Recommendations**

Lean manufacturing is a continuous improvement process it doesn’t stops at any particular point. Implementing lean manufacturing in commissioning area gives us benefit in terms of saving in time, material handling and inventory carrying costs.

In order to ensure the success of a Lean programme it is our experience that the following points are keys to success:

• Be realistic in your expectations – you are beginning a journey. It will not be completed in a few weeks. Indeed the whole process is will probably never be finished. Choose an area that will produce results quickly. This helps with motivation and people can see the results. Maybe they will get involved later.

• Cultivate an attitude of ‘it’s okay to make mistakes’. Reinforce with positive praise. Encourage ideas. Dare to be different. Abandon fixed ideas. See problems as opportunities.

• Use an external facilitator – there are no hidden agendas this way.

• Support of the management. Feedback results regularly, invite them to hear how shop floor workers have improved a process and more importantly give plenty praise to develop confidence and esteem.
References:

1) Seth D and Gupta V (2005) Application of value stream mapping for lean operation and cycle time reduction an Indian case study, production planning and control V16, Pg 44-59
2) Marten Telsang, Industrial Engineering and Production Management, V6, 2003
3) Sudhir Dawra, Material management, V1, 2004, Pg.3,7
4) Arvind Jain, Inventory Management, V1, 2004, Pg104
5) Peterman, Lean Manufacturing, V1,2001, Pg. 24
8) V. Crute,Y. Ward, S. Brown, A.Graves, ”Implementing Lean in aerospace—challenging the assumptions and understanding the challenges”, Technovation 23 (2003) 917–928