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A Review of Assembly Line Changes for Lean Manufacturing

Awasare Anant Dattatray [1], M.V.Kavade [2]
[1] *(Mechanical Engineering Department, Rajarambapu institute of Technology India)*
[2] *(Head Mechanical Engineering Department, Rajarambapu institute of Technology, India)*

ABSTRACT: *The orientation towards an efficient mass customization confronts most companies with two opposing requirements: While the applied mass production system should be able to produce a huge product variety, the cost must be kept low. Therefore assembly lines have to be planned in a much more flexible way. The more complex the product, the more extensive the product mix—the more difficult the task. Shorter product life cycles also complicate the situation. Due to the volatile nature of market, companies cannot afford to manufacture same type of product for long period of time and neither can maintain high inventory level; to tackle this problem we propose a Continuous improvement tools and techniques are introduced to address these issues, allowing the manufacturing of superior quality products with efficient processes. The Lean tools and techniques is one of them.*

Keywords *- production planning, Mixed-model assembly line balancing, Just-in-time scheduling, Lean tools, Product life cycle*

I. INTRODUCTION

Assembly is an important manufacturing process for cost effective product variety. Significant research has been done in the Design and operations of assembly systems in support of high product variety, but many opportunities exist for future research. Assembly is the capstone process for product realization where component parts and subassemblies are integrated together to form the final products. As product variety increases due to the shift from mass production to mass customization, assembly systems must be designed and operated to handle such high type variety. The concept of manufacturing assembly line (AL) was first introduced by Henry Ford in the early 1900's. It was designed to be an efficient, highly productive way of manufacturing a particular product.

1.1 What is Lean manufacturing?

Lean Manufacturing, also called Lean Production, is a set of tools and methodologies that aims for the continuous elimination of all waste in the production process. The main benefits of this are lower production costs; increased output and shorter production lead times. More specifically, some of the goals include:

1.1.1. Defects and wastage: Reduce defects and unnecessary physical wastage, including excess use of raw material inputs, preventable defects, and costs associated with reprocessing defective items and unnecessary product characteristics which are not required by customers.

1.1.2. Cycle Times: Reduce manufacturing lead times and production cycle times by reducing waiting times between processing stages, as well as process preparation times and product/model conversion times.

1.1.3. Inventory levels: Minimize inventory levels at all stages of production, particularly works-in-progress between production stages. Lower inventories also mean lower working capital requirement.

1.1.4. Labor productivity: Improve labor productivity, both by reducing the idle time of workers and ensuring that when workers are working, they are using their effort as productively as possible (including not doing unnecessary tasks or unnecessary motions).

1.1.5. Utilization of equipment and space: Use equipment and manufacturing space more efficiently by eliminating bottlenecks and maximizing the rate of production though existing equipment, while minimizing machine downtime.

1.1.6. Flexibility: Have the ability to produce a more flexible range of products with minimum changeover costs and changeover time.

1.1.7. Output: Insofar as reduced cycle times, increased labour productivity and elimination of bottlenecks and machine downtime can be achieved, companies can generally significantly increased output from their existing facilities.

1.2 Key Principles of Lean Manufacturing

1.2.1. Recognition of waste: The first step is to recognize what does and does not create value from the

customer's perspective. Any material, process or feature which is not required for creating value from the customer's perspective is waste and should be eliminated. For example, transporting materials between workstations is waste because it can potentially be eliminated.
1.2.2. Standard processes: Lean requires an the implementation of very detailed production guidelines, called Standard Work, which clearly state the content, sequence, timing and outcome of all actions by workers. This eliminates variation in the way that workers perform their tasks.
1.2.3. Continuous flow: Lean usually aims for the implementation of a continuous production flow free of bottlenecks, interruption, detours, backflows or waiting. When this is successfully implemented, the production cycle time can be reduced by as much as 90%.
1.2.4. Pull-production: Also called Just-in-Time (JIT), Pull-production aims to produce only what is needed, when it is needed. Production is pulled by the downstream workstation so that each workstation should only produce what is requested by the next workstation.
1.2.5. Quality at the Source: Lean aims for defects to be eliminated at the source and for quality inspection to be done by the workers as part of the in-line production process.
1.2.6. Continuous improvement: Lean requires striving for perfection by continually removing layers of waste as they are uncovered. This in turn requires a high level of worker involvement in the continuous improvement process.

1.3 Problem Description
It has identified several wastes in the internal material supply chain to latest assembly line and suspect that There are more to be found. In upcoming assembly line the company wishes to reduce or eliminate these wastes. Which capacity the assembly should have can only be forecasted and will most likely vary from week to week. Previous assembly lines have all had the same cycle time, increased demand has been solved with extra night and weekend shifts. So aims for the minimum amount of transportation and handling between stations. Likewise, works-in-progress should be stored as close as physically possible to the place where they will next be used. This is to reduce material handling requirements, reduce misplaced or inaccessible inventory, reduce damage to materials in transit, and to require the discipline of adhering to a pull based production system.

II. TYPES OF LAYOUTS

2.1There are 4 basic types of layouts:

2.1.1. Process Layout: Process layouts (also known as functional layouts) are a layout that groups similar activities together in departments of work centers according to the process or function that they perform. The advantage of process layout is flexibility whereas the disadvantage is inefficiency.

2.1.2. Product Layout: Product layout is also called flow-shop layout or straight line layout. It involves the arrangement of equipment's according to the progressive steps by which a product is made. Raw materials are fed continuously into the first machine and there after it passes through the subsequent operations rapidly while the finished products are coming out from the last one.

2.1.3. Fixed-position layout: Layout in which the product or project remains stationary, and workers, materials and equipment are moved as needed, for example: ships, houses and aircraft. In such a process the fixed costs would be low and variable costs would be high.

2.1.4. Service Layout: Most service organizations use process layouts because of the variability in customer requests for service. Service organizations look to maximize profits per unit of display space, rather than minimize customer flow. The layout must be aesthetically pleasing as well as functional.

2.1.5. Cellular Layout: Cellular layouts attempt to combine the flexibility of a process layout with the efficiency of a product layout. Based on the concept of group technology (GT), dissimilar machines are grouped into work in centers, called cells, to process parts with similar shapes or processing requirements. The layout of machines within each cell resembles a small assembly line.

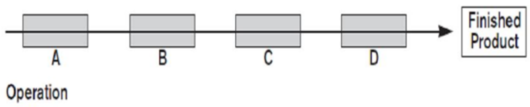
2.2 Types of Assembly Line: An assembly line can be classed into three categories based on numbers of models assembled on the line and according to the line pace which are:

2.2.1. Single Model Line: A single – model line can be described as a line that assembles a single model. This line produces many units of one product with no variation. The tasks performed at each station are same for all units. Products with high demand are intended to this line**.**

2.2.2. Mixed –Model Line: Mixed – model line is producing more than one model. They are made simultaneously on the same line. Once one model is worked at one stations, the other product are made at the other stations. Thus, every station is equipped to perform various tasks needed to produce any model that moves through it. Many consumers product are assembled on mixed – model line.

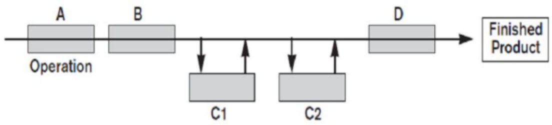
2.2.3. Batch Model Line: This line produces each model in batches. Usually workstations are set up to produce required quantity of the first model then the stations are reconstructed to produce other model. Products are often assembled in batches when medium demand. It's more economical to use one assembly line to produce several products in batches than build a separate line for each model. The research will be carried out in industry which applied a mixed model line.

2.3. Assembly conveyor systems are generally classified into two basic types, each with distinct characteristics:
2.3.1. Synchronous conveyor systems: Utilize indexed movement of parts from station to station, along a fixed path and at a fixed cycle rate. Examples include rotary dial machines and cam-operated, in-line machines. Short cycle rates, standardized production, and a high level of automation are features of the synchronous system. But synchronous systems also have their shortcomings. System throughput, for example, must be geared to the slowest operation on the assembly line. And there is no provision for cycle independence; all parts of the production line move in "lock step."



2.3.1. Synchronous conveyor systems

2.3.2. Non-synchronous conveyor systems: Provide independent movement of parts from station to station on an as needed basis, as they become ready for the next operation. Work can be routed independently along a flexible path providing the option of batch manufacturing or custom processing all on the same line. Non-synchronous systems can accommodate the full range of product sizes and weights. Moreover, there are virtually no limitations on the number or complexity of assembly steps with non-synchronous systems. Manual tasks can be readily integrated with automated operations because the system allows for varying station cycle rate. In addition, you can easily add buffers as needed to balance assembly line work flow.



2.3.2 Non -synchronous conveyor systems

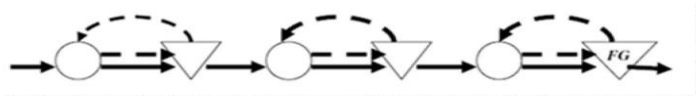
III. Tools of Lean Manufacturing Applied for Assembly line

There are numerous variables involved in designing the best assembly methods to move products through a manufacturing operation. The more complex the product, the more extensive the product mix—the more difficult the task. Shorter product life cycles also complicate the situation. As product mix or volume increases, traditional material handling methods (i.e., the use of plywood pallets and/or roller conveyor for staging and transferring WIP) may prove inadequate or counter-productive. Adding more of the same is clearly not a long-term solution. Additional common assembly challenges include: Numerous parts, components, and/or subassemblies, Assembly operations requiring precise, repeatable positioning, and Special environmental provisions such as clean rooms, ESD (electrostatic discharge) protection, temperature control, Operations to accommodate model variations with differing lot sizes, Products requiring up to 100% inspection Companies successfully managing the demands of continued, profitable growth have recognized the need for a mechanized solution, i.e., conveyor systems designed specifically for assembly flexibility. Often, the best product assembly strategy requires the right mix Companies successfully managing the demands of continued, profitable growth have recognized the need for a mechanized solution, i.e., conveyor systems designed specifically for assembly flexibility. Often, the best product assembly strategy requires the right mix of automated and manual operations and the ability to adjust that mix as necessary. Flexible assembly conveyors, seamlessly integrated into the assembly processes they support, provide the best solution for today's complex assembly conditions. There are different types of lean manufacturing tools are:

3.1. Kaizen: Kaizen is a Japanese word for continuous improvement. JIT improves the manufacturing system gradually rather than drastically. This gradual continuous improvement is defined by APICS Dictionary as "one less at a time": a process of gradually reducing the lot size of the number of items in the manufacturing pipeline to expose, prioritize, and eliminate waste. The Japanese refer to continuous improvement as kaizen. To the Japanese, kaizen means to strive relentlessly to increase quality, efficiency and effectiveness in all areas of life. Although this concept definition may sound somewhat individualistic, the Japanese emphasize small incremental, but cumulative holistic improvements. Kaizen is the process of identifying and eliminating waste as quickly as possible at the lowest possible cost. Kaizen requires continuous, gradual, persistent improvement by all employees and management. Here for lean type assembly line; modified the assembly line fixture, material storage rack as well as material moving trolleys for proper integration.

3.2. Teams: Process improvement teams are trained and responsible for detecting waste. Departmental barriers are eliminated and replaced with cross-functional teams that study a process and then immediately implement improvements.

3.3. Kanban: Kanban is an information system that is used to control the number of parts to be produced in every process as shown in "fig." the most common types of Kanban are the withdrawal Kanban, which specify the quantity that the succeeding process should pull from the preceding process, and the production Kanban, which specifies the quantity to be produced by the proceeding process. A supplier Kanban is another type of Kanban that is used between the supplier and the manufacturer under JIT. In order to achieve JIT delivery, suppliers have to adjust from the traditional run sizes to smaller lot sizes. The supplier Kanban circulates between the manufacturer and the supplier. By utilizing a Kanban system under JIT, smaller lot sizes and huge inventory reductions can be achieved. Under this production system raw material, subassemblies and finished product inventory are kept to a minimum and the JIT production principles are followed to eliminate inventory as a source of waste.



3.3 Kanban System

Key: The sold line represent movement of parts, the broken lines represents the circulation of Kanban, the circle represents the machines and the triangle represents the buffers. Another type of waste that is eliminated under JIT production is over production since every process is producing at a pace no higher than that of the subsequent process requirements, the need to produce more than what is diminished.

3.4. Standardized Work: Operations are organized in the safest, best-known sequence using the most effective combination of resources. Jobs are broken down into elements and examined to determine best and safest method for each. The standard is then established, taught, and sustained by attention and repetition. Finally the standard can be improved when better methods are found.

3.5. One Piece Flow: To minimize work-in-process, operators focused on completing one part through the process before starting on the next part.

3.6. Cells: For proper placement of machines developed a cell layout which reduced inventory, balanced work, less walking time and an improved work area. Cells include work balancing, which maximizes operator efficiency by matching work content to TAKT time. TAKT time is the rate at which the customer requires the product and is computed as:

3.7. Total Productive Maintenance (TPM): TPM consists of a companywide equipment maintenance program that covers the entire equipment life cycle and requires participation by every employee.

3.8. Value Stream Mapping: VSM serves as a starting point to help management, engineers, suppliers and customers recognize waste and identify its causes. VSM is a method of visually mapping a product's production path, including materials and information flow, from dock-to stock. It takes a holistic look at the activity required (both value added and non-value added) to move a product from raw material to the customer. Data is collected to provide the information needed to develop the current state and the eventual future state. Ideas for the future state will be identified as information is gathered on the current process. The result of VSM is a future state, which can serve as the foundation for other lean improvement strategies

3.9. 5S/Workplace Organization: Various housekeeping activities are often used first in adopting the continuous improvement way of life. Here we adopt some practice at plant are: Sort out what is unneeded; Set-In-Order what must be kept; Shine everything that remains and establish a cleaning schedule; Standardize the system throughout the facility and provide employees with training Sustain the effort with self-discipline and resources and time to improve their workplace.

3.10. Waste elimination is the ultimate goal of lean manufacturing. Seven types of non-value- adding wastes were identified by Toyota:

3.10.1. Overproduction: producing items when there is no demand, which generates more wastes such as excess inventory, overstaffing, transportation, and storage costs.

3.10.2. Waiting: workers being idle due to a lack of smoothness in production flow.

3.10.3. Unnecessary transport: transporting WIP long distances around the facility, or moving finished goods into storage areas.

3.10.4. Over processing: taking unnecessary steps to process products or parts, e.g. repairing defective products is an example of over processing.

3.10.5. Excess inventory: having excess raw material, WIP, or finished goods is a waste of space, and holds up the company's capital; also, with inventory as buffer stock, employees do not feed the immediate urge to solve problems to produce products to meet demand.

3.10.6. Unnecessary movement: employees are wasting effort to create unnecessary movement to perform operations.

3.10.7. Defects: producing defective parts not only lead to unnecessary inspection and rework, it also damages the company's relationship with the customer if they products are shipped.

IV. CONCLUSION:

In this paper the use of lean manufacturing tools and techniques in assembly system. The primary focus of this paper on the implementation of lean manufacturing is the process of all seasons and not only limited for particular industry. It was shown that value stream mapping is an ideal tool to expose waste in a value streams and identify tools for improvement also contributed to reduction in inventory and lead time.Lean Manufacturing also eliminates many of the problems associated with poor production scheduling and line balancing, Lean Manufacturing is particularly appropriate for companies that don't have ERP systems in place or don't have strong material requirements planning (MRP), production scheduling or production allocation systems in place. It also showed that certain techniques such as a 5s or value stream mapping could be worked universally. The primary idea of this paper is to help the industry to take new initiatives such as a lean manufacturing in order to become a most cost-competitive in today's global market. Recently, some companies in Vietnam have actively conducted training and implemented lean methods to eliminate process inefficiencies. This resulted in an improvement to their production and service lead times.

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