"The first challenge is to get rid of unnecessary delays and costs. This is done by eliminating 'fumbles' – bottlenecks, changes, rework, and unnecessary work." -Lightning Strategies for Innovation, Willard I. Zangwill

Introduction

Lean Manufacturing is the systematic elimination of waste, and the implementation of continuous flow concepts and customer pull. Lean is the best management system for satisfying customers on delivery, quality, and price.

Many companies are turning to lean manufacturing in an effort to become more profitable. Implementing "Lean" can create superior financial and operational results. Lean manufacturing comes from the Toyota Production System. Practiced by Toyota for many years the ultimate goal of the syste, is to produce quality products by cost reduction activities and a cultural focus on employee involvement through empowerment. Lean manufacturing uses concepts pioneered by Toyota Motor Company's former vice president Taiichi Ohno. This "new" manufacturing culture is based on working in every facet of the value stream, to include instilling the discipline to reduce cost, to generate capital, to make the money, to bring in more sales, and to remain competitive in a growing global market.

Lean Manufacturing

The Value Stream of a business is the sequence of steps that a company performs in order to satisfy a customer's need. In every Value Stream, a 50-70% reduction in the number of steps in the process can be achieved. The first step a company must take to change their value stream is to determine its lean status by identifying efficiency gaps and areas for waste/cost reductions. Lean manufacturing is a fundamental enterprise transformation that must be approached as a total organizational and cultural transformation. Value stream mapping is a good way to train staff to find waste, identify the root cause, and prepare a strategic plan for its elimination.

The seven categories of non-value added waste are overproduction, inventory, transportation, waiting, motion, over-processing, and correction. Overproduction is a source of waste for most firms and is referred to as the batch and queue mode of operation. This large-batch processing mode is an outdated paradigm. Another problem with large batches is that there is no connection between the pace of production and the pace of demand. Reduced lot sizes with quick set-up capability is the paradigm of the 21st century. Producing various models in small lots improves responsiveness to customers and flexibility to respond to changes in demand. The smaller the lot means the smoother the process flow. The following five areas drive lean manufacturing/production: cost, quality, delivery, safety, and morale. Lean manufacturing views continuous, one-piece flow as the ideal and emphasizes optimizing and integrating systems of machines, materials, people, and facilities. Continuous flow follows the produce one-by-one as efficiently as possible ideology.

Lean manufacturing elements

Waste elimination, continuous one-piece workflow, and customer pull are the basic elements of lean manufacturing. Focusing these elements in the areas of cost, quality, and delivery forms the basis for a lean production system.

Lean techniques can also be applied to the service industry. In the service industry eliminating waste is the process of eliminating anything that does not add value to your customer.

Lean Manufacturing Terms

Setup time: work required to change over a machine or process from one to the next.

<u>Cycle time</u>: the normal time to complete an operation on a product, which should be less than or equal to takt time.

<u>Takt time</u>: takt, is a German term for rhythm. Takt time is the allowable time to produce one product at the rate customers are demanding it.

<u>Kanban</u>: a card or sheet used to authorize production or movement of an Item. When fully implemented, kanban operates according to the following rules:

- 1.All production and movement of parts and material take place only as required by a downstream operation, i.e. all manufacturing and procurement are ultimately driven by the requirements of final assembly or the equivalent.
- 2. The specific tool which authorizes production or movement is called a kanban. Kanban have various formats and content as appropriate for their usage. A kanban for a vendor is different than a kanban for an internal machining operation.
- 3. The quantity authorized per individual kanban is minimal, ideally one. The number of circulating or available kanban for an item is determined by the demand rate for the item and the time required to produce or acquire more. Thus inventory is kept under control while production is forced to keep pace with shipment volume.

<u>Heijunka</u>: a production scheduling/leveling tool, used to distribute kanban cards in an efficient manner.

<u>Jidoka:</u> a form of automation in which machinery automatically inspects each item after producing it, ceasing production and notifying humans if a defect is detected.

<u>Just-in-time</u>: a production scheduling concept that calls for any item needed at a production operation - whether raw material, finished item, or anything in between, to be produced and available precisely when needed, neither a moment earlier nor a moment later.

<u>Kaizen</u>: the philosophy of continual improvement, that every process can and should be continually evaluated and improved in terms of time required, resources used, resultant quality, and other aspects relevant to the process.

<u>mixed-model production</u>: capability to produce a variety of models, that differ in labor and material content, on the same production line. Allowing for efficient utilization of resources while providing rapid response to marketplace demands.

<u>Flexible manufacturing system</u>: an integrated manufacturing capability to produce small numbers of a great variety of items at low unit cost. Characterized by low changeover time and rapid response time.

<u>Nagara</u>: smooth production flow, ideally one piece at a time. Characterized by synchronization of production processes and maximum utilization of available time, including overlapping of operations where practical.

<u>Pull system</u>: a manufacturing planning system based on communication of actual realtime needs from downstream operations ultimately final assembly or the equivalent.

<u>SMED:</u> Single Minute Exchange of Die; changing a die on a forming or stamping machine in a minute or less. The ability to perform any setup activity in a minute or less of machine or process downtime.

United Electric Controls: One-Piece Flow Manufacturing

One-piece flow manufacturing describes a reliable method for production flow that is well suited for the low volume production of a wide variety of products. UE's One-Piece Flow Manufacturing system is a blend of many reliable methods that applies the concepts of Lean Manufacturing, just-in-time (JIT), Takt time, levelized scheduling, finite loading, KanBan card system, Heijunka box, one-piece flow, and Kaizen methodology.

UE manufactures over 2,000 different varieties of temperature sensing probes and thousands more varieties of pressure sensors, mostly per unique customer specifications from around the world. Previously, UE had a typical leadtime of four to five weeks for customized orders. Since implementing one-piece flow manufacturing, UE reduced its leadtime to two weeks, on average, and can provide same-day response for partial orders from customers.

UE achieved tremendous results by understanding and applying the basic philosophy of Lean Manufacturing and associated reliable methods for continuous improvement. Key factors include:

Reducing lot sizes to one piece, which leads to production flexibility and shorter leadtimes.

Pulling production through the process at a rate equal to the rate of sales. Producing only what is needed when it is needed (equal to the rate of sales). Using pull systems that connect all islands of production from end to end. Arranging production equipment in the order that employees work instead of grouping them by equipment function.

By applying Lean Manufacturing, UE can also identify and eliminate waste associated with storage, unnecessary production, inventory movement, and cost related to correcting a defect. Associated reliable methods that support Lean Manufacturing include JIT, autonomation, and Kaizen methodology. In JIT production, processes are arranged as orderly and close together as possible. Downstream processes pull small amounts of work from upstream processes at a pace that reflects the customers' demands for finished products rather than pushing work downstream in batches. Autonomation refers to automating a process where possible to include mistake proofing (Poka-yoke) and inspection. The operator is alerted only when necessary, such as when a defect occurs. Kaizen methodology encourages employees to be an effective contributor to the ongoing processes by constantly identifying and eliminating waste.

The primary technique that runs the operation on the production floor is the KanBan card system. In one area, UE uses a very simple card form of KanBan based on color-coded paper in a vinyl envelope. Each card, representing one unit, acts as a signal to initiate the production of a test, assembly, or kit. UE also uses barcoding to assist with the paperwork and inventory tracking. KanBan cards and associated work instructions are loaded into the slots of the Heijunka box, which functions as a levelized scheduling tool. Each slot represents three minutes of production time (Takt time) for electromechanical switches and one minute for temperature sensors. The process flow coordinator removes a KanBan card/work instruction from the Heijunka box as a signal to build. The work coordinator sets the pace for the entire operation by depositing work at the stations an simultaneously delivering products to their next destination. The KanBan system is used for both stock items and made-to-order parts.

The KanBan system enables UE to be more responsive to its customers' needs. UE significantly improved quality and now produces sensors at a rate of one per minute. In addition, the KanBan system offers minute-by-minute flexibility on the production floor, allowing UE to respond to any volume and variety of product with ease.