Basic concepts of Lean Manufacturing

LEAN MANUFACTURING

The fundamental philosophy behind Lean Manufacturing is to provide superior quality products for more Customers at a significantly lower price and to contribute to a more prosperous society.

It is important to build a Company production system based on this philosophy. Lean Manufacturing has endeavored to rationalize production by:

- Completely eliminating waste in the production process
- To build quality into the process
- To reduce costs - productivity improvements
- To develop its own unique approach toward corporate management
- To create and develop integrated techniques that will contribute to corporate operation.

This is Lean Manufacturing.

The Goals of Lean Manufacturing

Cost Reduction by Elimination of Waste

It requires constant effort at cost reduction to maintain continuous profits in manufacturing. The prime way to reduce costs is to produce only those products determined by sales in a timely fashion, to restrain excessive manufacturing and to eliminate all **waste** in manufacturing methods.

There are various ways to analyze and implement cost reduction, from the start of designing all the way through to manufacturing and sales. One of the goals of Lean Manufacturing is to locate waste pragmatically in each process and then eliminate it.

It is possible to uncover a very large amount of waste by observing employees, equipment, materials and organization in the actual production line from the perspectives of the process itself and the actual work involved. Some types of waste are obvious, but others are hidden. Waste never improves value; it only increases cost.

The thorough elimination of waste leads to greater employee self-respect and to major cost reductions by preventing unneeded losses.

Creating Conditions to Guarantee Product Quality

To produce a high-quality product is the first commandment of any manufacturing company. The high quality of any product, in which many component and parts do not fail and are trouble-free, must be built into it at every process.

Lean Manufacturing has developed various ways to support the commitment to "build the quality into the process." This principle gives each operator the responsibility to check quality

thoroughly at every stage of work within the process, and brings product inspection directly into the process so that good products flow to the following process and defects are extracted at that point.

Each operator must be aware that "the following process is a customer" and must never send a defective product to downstream processes.

If equipment is defective or operates abnormally, either the machine itself or some system must be able to detect the problem and stop operation. Foolproof devices are often used as simple means for this purpose. This also makes it easier to maintain quality.

Lean Manufacturing has taken many measures and expended much effort to see that, if a defect in quality should occur, we can uncover the true cause and apply countermeasures to prevent its recurrence.

Quality First

Producing high-quality products is paramount for, and therefore must be given priority by, any manufacturing industry. Customers will never continue purchasing a product if its quality is poor, and no matter how cheaply it is produced, the producer will only incur losses.

In the case of any product, safety is considered especially important. Taking shortcuts or doing shoddy work, in the extreme case, putting a faulty product on the market, amounts to a harmful act and can have devastating consequences for a company.

Therefore, it should be Company's mission to supply our customers with trouble-free product. To do this, we must produce products that conform exactly to design quality specifications. Attaining high quality must also be given foremost consideration in our work, and neglecting quality can never be excused, hence the necessity of checks to verify quality.

All parts produced in a process must be inspected there to make sure defects are not occurring, and ensure that defective parts do not reach downstream processes. Ways must thus be devised to perform such inspections economically.

Ensuring Quality of all Products

In generally practiced conventional methods, finished parts and products are inspected by an inspector then sent on to downstream processes. But good quality cannot be assured if finished goods are to be judged good or bad.

An inspector can randomly sample goods and judge their quality good, but excuses won't mean much to the customer who gets the one bad unit from among 1,000 good ones. Defective goods reaching the customer damages consumers' trust in the cooperation and the product, and must be avoided at all costs because it can lead to manufacturing products that are no longer salable.

Generally, defective products are discovered by an inspector and repaired before they make it to the customer. The stronger the determination not to let defective products out of the plant the more stringent inspections become and the more often corrective adjustments and repairs are made.

But inspection work carried out by inspectors working off the line yields no added value, so research to find ways to manufacture quality products with fewer inspectors is necessary. In other words, "building quality into the product" is essential.

Building In Quality at Each Process

The concept of "building in quality at each process" is the basis for preventing the flow of defective parts to downstream processes. It therefore requires that operators are aware that "downstream processes are my Customers."

In practice, "building in quality at each process" brings the inspector's function into each process so defects can be uncovered immediately when they occur. Only in this way can it be ensured that all parts are defect-free, and that no faulty parts reach downstream processes.

If defects are discovered at a downstream process, it would do no good were they merely corrected and their cause not investigated, as the defect would continue to recur. Therefore in such cases, the previous process must be promptly notified of the problem, and the process or department where the defect originated must immediately investigate the cause and institute measures to prevent recurrences.

Under the generally accepted notion of quality control, inspectors are stationed at the end of processes or lines. There the inspector judges the products coming off the line, calculates the results, and passes the results on to the processes concerned. Usually, this is all that happens; the results are known, but it is difficult to affect countermeasures to prevent recurrences.

This brings us to the conclusion that it is important for operators to inspect the quality of the goods they themselves have produced, and naturally every article produced must be inspected. There are many means to achieve this; the way to assure quality achievement is strict observance of the ***Standardized Work*** established under the prevailing working conditions at each process.

Standardized work is devised so that required quality levels can be achieved and maintained. Standardized work weaves inspection work, both visual and inspection work using measuring instruments, into the production work performed in each process. If such inspection work is not interwoven into the process work, the concept of "building in quality at each process" will not function properly.

Inspection Work

Inspection work is not merely the action of judging whether parts or finished products are good or bad. It also entails -- and this we want to emphasize -- pursuing the cause of defects, gaining a comprehensive understanding of the circumstances to pinpoint the real cause, and instituting measures to effectively prevent their recurrence.

Emphasis on pursuit of real causes is necessary because cursory observation of a defect phenomenon can lead to trying to cure symptoms instead of the disease. For example, a defect resulting from installation of a wrong part might be discovered, but installation of the wrong part may be only a symptom of a more deeply rooted problem rather than the real cause. Careful investigation might reveal that the wrong part was installed because a symbol in the work instruction sheets is illegible and prone to misinterpretation, or that

parts are not arranged in the order of their installation sequence, or even that an employee was just inattentive.

Defects are reduced by effectively grasping all these factors, than introducing countermeasures based on a comprehensive understanding.

Thus the purpose of inspection work is not to pick out the defective products, but to eradicate the occurrence of defects. In a nutshell, inspection work goes beyond mere diagnosis to encompass full treatment and rehabilitation. It is essential that inspection work be understood in this way.

The Added Value of Repairs

Even when everyone in each process is observing standardized work, a few products that require repairs are bound to turn up. Although, ideally, the need for repair work should not occur, it does. It seems to be generally accepted that when repair work is required it will be enough just to make the repairs on a repair line and let everyone else get on with their normal work. So in some companies the necessity for repair is taken as a matter of course.

But repair work requires wasteful manpower increases, lowers rates of added value, and raises production costs. If defective products and products requiring repairs are taken as a matter of course where defect-free products should be produced, the necessity arises for extra manpower and additional facilities, tools, and conveyance measures.

The prevention of defects and the necessity for repairs can be achieved by aggressively promoting **Kaizen** (improvements) in conjunction with quality. By producing high-quality products and eliminating the need for repairs, not only can man-hours for repairs be reduced, but also we can reduce the man-hours required for inspection work.

Creating a Work Site with Operators in Mind

If labor is expended on a product but does not contribute any additional value to it, that labor is of no value. On the other hand, if the labor expended on a product enhances the product's value, then that labor is of great value because it is effective. This type of effective labor use translates into showing respect for human dignity, the dignity of the employee.

In the Lean Manufacturing measures have been taken so that the labor or every employee will enhance the value of our products. One of these measures is ***Standardized Work***. This is a way to perform the most effective sequential production without waste by rationally concentrating the work around the Operators' movement. Some companies use a system that stresses the performance of equipment and machines. In this case, the equipment is considered to be of prime importance and the employee mere expansion of the machine.

Mutual support is indispensable if each employee, who plays the leading role for his particular task, is to perform the work and improve the efficiency of the whole production process. In Lean Manufacturing the implementation of mutual support between the preceding and succeeding processes has affected highly efficient work.

If the Operator discovers some problem in the work for which he is responsible, he or she is permitted to stop the line depending on the gravity of the problem. This is only possible against a backdrop of respect for the judgment and intelligence of the employees. A work site, where

every employee can fully display his own ability, can be created with a system in which the work accomplishments of each individual are a matter of public knowledge, and anyone can propose kaizen for work problems.

Creating a Flexible Work Site

As the Global Economy has matured and become internationalized, users' tastes have expanded to encompass a wider range of product types, models and status value, with an enormous increase in the amount of production time – ***Lead Time***.

At the same time, the user wants a short delivery time. And a short delivery period is now one of the key points in sales. Furthermore, the sales quantity is always indefinite and difficult to predict. Under these conditions, the fixed production of product types or quantities may lead to shortages or surpluses and cause considerable waste. Therefore, it is important for the production department to shorten the Lead-time between the receipt of an order for a product and its delivery as much as possible.

One of the goals of Lean Manufacturing is to set up a process so the production department can manufacture a product in sufficient time for a market that is always changing and diversifying. The basic concept behind the shortening of lead-time is to:

- Take orders
- Produce immediately
- And deliver on time.

A strong and vigorous production system can produce the required items in the necessary time without waste, cope with minor changes in production quantity, and meet schedules satisfactorily with a good line operation rate because problems can be easily discovered and rectified. As a result, it can satisfy the customer's desires.

Operator Work and Machine Work

There is a key notion for the elimination of waste and the effective combination of work at the work site: the separation of machine work and operator work. If we investigate the work in which employees handle machinery, that work can be classified as employee work and machine work.

The meaning of Operator work

Operator work refers to work that cannot be completed without an Operator. Examples of operator work are picking up materials, putting materials in a machine, operating the controls of a machine, and performing manual operation.

The meaning of machine work

Machine work refers to work or incidental work that equipment, which has been started by human hands or other means, automatically performs. Machine work includes automatic machining, inspecting and conveying. Concrete examples are cutting, forming and welding of material, delivering and removing material and inspecting precision automatically by device.

Understanding the separation of operator and machine work is basic to multi-process handling work, and is quite effective in creating standardized work to enhance work-efficiency.

If operators are merely observing machine operation, then that observation is waste of waiting and should be eliminated. Paying attention to possible problems is important.

Awareness of Waste

Cost Reduction versus Cost Plus

Lean Manufacturing improves productivity through the principle of Cost Reduction.

With the principle of cost reduction, the sales price of a product is determined by actual market conditions. A profit cannot be secured, thus, without first reducing cost regardless of increases or decreases in the production quantity. This type of cost philosophy requires an overall company effort. Cost reduction is:

Profit = Sales price – Cost

In contrast to cost reduction, there is the cost-plus principle, in which product price is determined by combining all the costs -- such as those of raw materials, labor and other expenses needed for production -- with whatever company policy decides is needed as profit. Cost policy:

Sales price = Cost + Profit

The two formulas above are the same mathematically, but there is a great difference in the emphasis each one places on the variables. In other words, cost-plus considers that the cost is fixed. While cost reduction considers, that the cost can be effectively changed by manufacturing methods.

Cost and the Method of Production

A detailed analysis of any given production process will show that some portions are crucial and others not crucial for enhancing the value of the material. The ratio between these two has a major impact on cost.

For example, there is no difference between manufacturers in the price for 1 kilowatt of electricity, the price for 1 ton of sheet metal and the price for the same machine tools. But there is a difference in profits, even though they all use the same energy, materials and equipment to produce the same kind of product. This difference stems principally from the different manufacturing methods.

We shall now show how costs can be changed, by examining "the stock quantity of raw material."

If one hundred parts are manufactured today, we only need to have material on hand for 100 pieces. And if we consider that, at any given time, we only need to have material on had to cover the daily stock for the few days it takes to secure replacements, then we clearly do not have to maintain a large stock backlog.

The accumulation of stock for long periods of up to three or six months -- despite the fact that it might be easily acquired in just a few days -- will lead to wasteful interest and inventory storage costs and even to the possibility that it may not be used because of design changes.

To illustrate, let us look at the example of a stamping machine. Even if two companies buy the same press, there will be a difference in cost between the passive company that uses the machine according to the manufacturer's specifications, carefully calculates an economical lot size based on the prevailing set-up time, increases the number of pallets, expands the warehouse and stores a large quantity of press parts, and the active company that shortens the set-up time and produces parts efficiently using the practical know-how and effort of employees at the work site.

The costs can change significantly according to how the product is produced and how effectively the current equipment, material and labor are utilized in production. The reduction of costs by the method of manufacture plays an important role in the company's profits and that, in its turn, will maintain the company's stability and job security for its employees.

The actual production site must continue, in the future, to review our own production system guided by the cost reduction policy.

Work and Waste

In promoting Lean Manufacturing it is necessary to properly understand the meaning of "complete elimination of waste." Waste encompasses various phenomena, none of which enhance the value of the product. This includes all factors that do not add any value to the product, whether in parts, labor or production process. In short, this means "the various production elements that only increase cost."

If we focus on the employees' work movements in the workplace, their production activity may be divided into three classes:

1. Value Added Work

Value Added Work is work that actually adds value to the product. This includes processing, such as shaping, forming, treating, assembling, and so on. Other examples include assembly or installation or parts, welding, hardening of gears, and spray-painting bodies, etc. The higher the proportion of work that ads value, the greater the efficiency of production.

2. Incidental work

This refers to the type of work that does not directly add value to the product, but must -- under current production conditions -- be done for the value added work to enhance value. Examples of incidental work are removal of parts from boxes, delivering parts to the line, setting up a work station, loading and unloading the machine, tool pickup for parts installation and preparation of inspection equipment.

3. Waste

Waste is action that is not essential for the work being performed. This refers to the type of work that has no positive influence, even if it is removed from the work movement. This includes: waiting, unnecessary rearranging or restocking of materials, excessive transporting of parts, "watching" equipment, etc. Repair work is also considered to be waste. Such activities add no value to the materials or parts. Waste in a manufacturing site consists of various such factors or actions that serve only to raise costs.

If we observe work at the actual manufacturing site in great detail, we find that the amount of movement that enhances value is unexpectedly low. The activity of replacing movement that does not enhance value with value added work is called Kaizen.

Overload and Unevenness

Both overload and unevenness, like waste, are factors that raise cost and lower quality. Overload is application of a load in excess of ability or capacity: in the case of equipment it can cause breakdowns or defective parts, in the case of an operator it can lead to safety and quality problems.

Unevenness is considered to be a combination of waste and overload. This means that waste is either a repetition or a combination of redundant capacity and overload. It is caused by irregular production schedule or changes in the production quantities. And wherever unevenness is found, waste exists.

The elimination of waste, overload and unevenness from the production activity will improve productivity and lead to the maintenance and improvement of quality.

Kinds of Waste

A functional classification of the various elements that only raise cost in production activity gives the following seven types of waste:

1. Waste of defect repair
2. Waste of overproduction
3. Waste of waiting
4. Waste in delivery and conveyance
5. Waste in processing
6. Waste of inventory
7. Waste of motion

In Lean Manufacturing every type of waste must be eliminated.

Lean Manufacturing pays particular attention to the waste of overproduction – Overproduction is considered to be the number one cause of all manufacturing issues and problems. Since the ideal is to make the necessary goods at the necessary time in the necessary quantities, the manufacture of more goods than is justified by sales is waste. Waste of overproduction induces more waste, thus waste of overproduction must be taken seriously.

The following are types of costs that can be increased by waste of overproduction:

- Necessity for extra material and parts
- Increase in containers such as pallets and skids
- Increase in delivery vehicles
- The growth of stock and increase in man-hours for stock control
- Others

The following factors are causes of overproduction:

- A sense of security against machine breakdowns, defects and absenteeism
- Mistaken increases of operational rate and apparent efficiency
- The notion that line stoppages are 'sinful'
- Variations in load
- Others.

In overproduction, "waste invites waste." Therefore, work should be done based on standardized work and work rules observed.

Understanding Efficiency

Improvements in efficiency that ignore the production schedule will result in the waste of overproduction and push overall company efficiency in the wrong direction. Improvements in efficiency display their value by lowering costs. When evaluating efficiency, the key factor is the necessary production quantity: you must consider how the necessary items can be manufactured with the fewest man-hours possible in the best time. There are consequently two types of efficiency - True and apparent.

Apparent efficiency

Apparent efficiency is a way of raising efficiency by increasing the production quantity within the current man-hours without regard for sales, and is an "efficiency" only in terms of numbers. We call this "Just-in-Case" production.

True efficiency

True efficiency is an increase in efficiency by producing a salable quantity with the shortest man-hours possible, and is an improvement in efficiency that contributes to substantial reductions in cost. If the production quantity is to be increased, consider how to raise efficiency by performing mass production with the current man-hours to raise efficiency, and if the production quantity is to be maintained or decreased, consider how to raise efficiency by reducing man-hours.

Efficiency is used in various ways as a standard for evaluating productivity in equipment or labor, but we must never forget that its criterion is the necessary quantity warranted by sales.

Individual and Total Efficiency

When considering how to raise company efficiency by elimination of waste, we must look at efficiency in terms of each process, the line embracing those processes, and the whole plant that contains the line, prosecuting improvements in efficiency from lower to higher stages so the improved efficiency encompasses the total system. It is crucial to institute improvements in efficiency with this type of systems approach.

Individual efficiency

Individual efficiency means that the efficiency of an individual process, line, or machine (equipment) is raised without regard for the preceding or following process, line or machine (equipment).

Total efficiency

Total efficiency means that, at the level of process and line, efficiency is raised with a consequent improvement that is not merely numerical, and that spreads over the entire company.

Managers and supervisors tend to think of improvements in efficiency and quality only for their own processes, but they must always consider how local improvements will affect the total operation.

Thinking only about individual efficiency can easily lead to improvements in apparent efficiency. Always think about the necessary production quantity first.

The Importance of Problem Awareness

Lean Manufacturing constantly stresses how important it is to "achieve cost reduction by complete elimination of waste", as the way we think about waste can have significant consequences. The criterion to determine what is and is not waste varies depending on differences in background and context, and the same thing can be said about the evaluation of efficiency. Thus, the way we think about and judge waste or efficiency is quite important.

It has been said that only two things exist when doing work at the work site - things one must do and things one must not do. Whatever our activity, we must never forget to consider the true purpose of the activity and the best means to accomplish that purpose.

We always produce "products in response to sales" and carry out the work by aiming at improvement of quality, cost reductions and increased work safety.

In so far as we manufacture with the same equipment, materials and methods as other companies, there is no way to gain competitive ascendancy. Keeping one step ahead of the other companies will, however, make the difference between the victory and a failure in the competitive war.