Reducing Waste in Production by Lean Thinking - A Case study

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***Abstract*— Lean manufacturing or lean thinking is one of the widely used industrial technique worldwide and in India now widely used to improve the production efficiency of the industry by reducing the waste ('muda' in Japanese) which is the main problem of reducing the production. In presented case study, by using the Poka-yoke, tool of lean manufacturing which means error proofing eliminate the root cause because of which defects or waste are produce in the system. Errors may be in operating or in operation carried out on the particular part. In the presented case study, seventeen percent improvement is done by eliminating root cause of rejection which improves the quality of the product and customer satisfaction.**

Keywords*— Lean manufacturing, poka-yoke, rejection, waste reduction

I. INTRODUCTION

To incorporate the high production rate with desired quality of the product in this competitive world is must but while maintaining the high production rate it is not possible to maintain the quality of the product for industries. The solution of this problem may be get by applying the lean thinking, **use the available resources with their maximum efficiency, improve the value adding activities by reducing the waste in the production.** Lean banishes the waste and creates the wealth in your organization Lean is the way of continuous improvement by eliminating the non value added activities of the system.

II. LITRATURE REVIEW

The true forerunner to lean manufacturing was the Toyota Production System (TPS), pioneered by Taiichi Ohno, Shigeo Shingo and Eiji Toyoda. Lean manufacturing is a way of thinking and developing manufacturing processes to minimize inefficiencies in production and waste in resources.

The four goals of lean manufacturing are:
1. Improve Product and Process Quality
2. Minimize Waste
3. Reduce Production and Process Time
4. Reduce Costs

Many manufacturing companies have implemented LM in many different ways and names in order to suit with their environment and needs. Therefore, it is important to conduct the research in order to identify the approaches and processes in LM implementation. The goal of the lean thinking is to improve the quality and to move the product faster in the production flow by just eliminating the waste in the system.

These waste and causes for the waste are as follows:
Overproduction
- Making more than is required by the next process
- Making earlier than is required by the next process
- Making faster than is required by the next process

Inventory - Causes of excess Inventory
- Protects the company from inefficiencies and unexpected problems.
- Product complexity
- Unleveled scheduling
- Poor Market forecast
- Unbalanced workload

Defects - Causes of Defects
- Weak process control
- Poor quality
- Unbalanced inventory level
- Deficient planned maintenance
- Inadequate education/training/work instructions
- Product design
- Customer needs not understood

Over processing - Causes of Processing Waste
- Product changes without process changes
- Just-in-case logic
- True customer requirements undefined
- Over processing to accommodate downtime
- Lack of communications
- Redundant approvals
- Extra copies/excessive information

Waiting - Causes of Waiting Waste
- Unbalanced work load
- Unplanned maintenance

- Long process set-up times
- Misuses of automation
- Upstream quality problems

Motion –
Movement of machine or person does not add value to the product or service. Causes of Motion Waste

- Poor people/machine effectiveness
- Inconsistent work methods
- Unfavorable facility or cell layout
- Poor workplace organization and housekeeping
- Extra .busy. movements while waiting
- Expediting

♦ Transportation - Causes of Transportation Waste

- Poor plant layout
- Poor understanding of the process flow for production
- Large batch sizes, long lead times, and large storage area [1]

The Lean Enterprise Research Centre (LERC, 2004) at Cardiff Business School highlighted that for most production operations 5% of activities add value, 35% are necessary non-value activities, 60% add no value at all.[2]
Therefore, there is no doubt that the elimination of waste represents a huge potential in terms of manufacturing improvements—the key is to: 1.Identify both waste and value, 2.Develop our knowledge management base 3.Realize that sustainable improvement requires the buy in of the people operating the processes and managing the business, and therefore a culture of continuous improvement.[2]

Typical of the benefits attributed to lean production are those cited by Kotelnikov (2001) : Reduction of waste by 80% (waste includes intellect, motion, overproduction, transportation, inventory, waiting, and defects); Reduction of inventory by 80%; Decrease in manufacturing cycle times by 50%; Reduction in labor by 50% Increased capacity in facilities by 50%; Improved product quality by 50% Higher profits; Higher system flexibility; Better cash flow; Just-in-time delivery.[3]

By using the various tools of the lean thinking we can eliminate these wastes not completely but at most instance. The various tools which are use in the lean thinking for eliminating all these waste are listed below

1. Pokayoke
2. 5s visual manegment
3. One piece flow producion
4. TPM
5. Level mix model production
6. Kanban pull demand
7. FMEA
8. Value stream mapping
9. Six sigma

These are some tools used while working on the lean thinking in the industry. The lean is the approch which can be used in any type of the orgnization to improve their valuse and customer satisfaction.
In the , presented case study the technique use to reduce the waste by proofing the cause because of which the defect are cause in the system and reduces the production, also less satisfaction at customer end .

III. WHAT IS POKA –YOKE ?

Poka – Yoke is the Japanese word which means removing error or error proofing. It the basically a strategy to remove the error in the system i.e. mistake proofing. Poka-yoke is a preventive action that focuses on identifying and eliminating the special causes of variation in production processes, which inevitably lead to product nonconformities or defects [4]. Poka-yoke is policy which can removes the nonconformities in system from its root cause to prevent the defect. It is the economical as well as easy to understand and apply in the system which offers continuous improvement of the system, it is the way two move toward QMS (quality management system). It is strategy developed by the Japanese industrial engineer Shigeo Shingo in 1960s to attain the goal of zero defects in the system. The basic principle of the poka-yoke not allowed producing a single defective product in the system but it is not possible in actual manufacturing practices. A poka-yoke device or solution is any mechanism or idea that either avoids the mistake from being made or makes the mistake easily detected at a glance. The ability to find mistakes at a glance is important because, as Shingo states, "The causes of defects lie in worker errors, and defects are the results of neglecting those errors. It follows that mistakes will not turn into defects if worker errors are discovered and eliminated beforehand He also adds to this that "Defects arise because errors are made; the two have a cause-and-effect relationship. Yet errors will not turn into defects if feedback and action take place at the error stage[4].
In actual manufacturing there are several processes , on which the operator had to work daily it may cause the fatigue to the operator of working in the same process cycle mistake or error may cause in the operation of that operator or on operating work station because of malfunctioning of some machine component. This may lead to defect in the system. To avoid these kind of mistakes or error which causes the defective product poka-yoke is the technique or strategy should be effectively use.

IV. METHODOLOGY

Lean thinking is use in any type of industry by various but it is not single day job and had to work in team to implement the overall lean thinking it had work with top level management and also a low level management. The problem focused methodology must be there to implement the lean effectively. Applying to top level management, one may use the question and answer way to taking out the information to solve the problem, but in presented case study we had to remove the problem at lower level and the methodology we are applying is cause detection , problem solving way.
The methodology, we are applying is given in the flow chart diagram given below

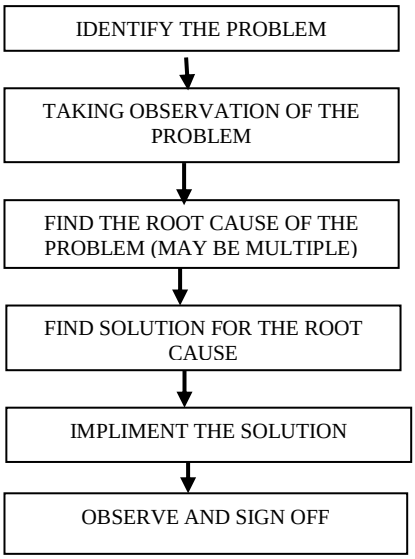

Fig 1.Methodology

Steps of working methodology

1. Identify the problem ; because of which the defects are produce in the system
2. Taking the observation on the problem; for checking its severity and in what way it causes in the system.
3. Finding the root cause of the problem ;there may be multiple causes for the single defect
4. Fining the solution on the problem ; using cause effect table , cause effect diagram , and some logical analytical skills
5. Implement the solution ; which is found from the above step and take the observation on the same for its proper implementation and result after implementation
6. Continuous monitor and sign off; have continuously monitored on that part of the system so that the same problem would not cause because of the same problem and the sign from that task ,switch to other tasks.

V. DETAILED CASE STUDY

Case study is carried in the industry that performs the machining on the casting part and supply to the customer. The parts machined by the company are clutch housing, oil sumps and transmission unit. Casting is the input to the company and machined parts are supplied to the industry.

Compliant are recorded for the quality and rejection of the parts from customer end. And there is rejection of 17% per lot of hundred units. Means, if we go economically then there is loss of the Rs.1, 60,000 per lot including the time , labor and rework machining . This is not affordable by the company and for this company had to find out some strong solution, graph of rejection per hundred for the six month rejection is as shown below

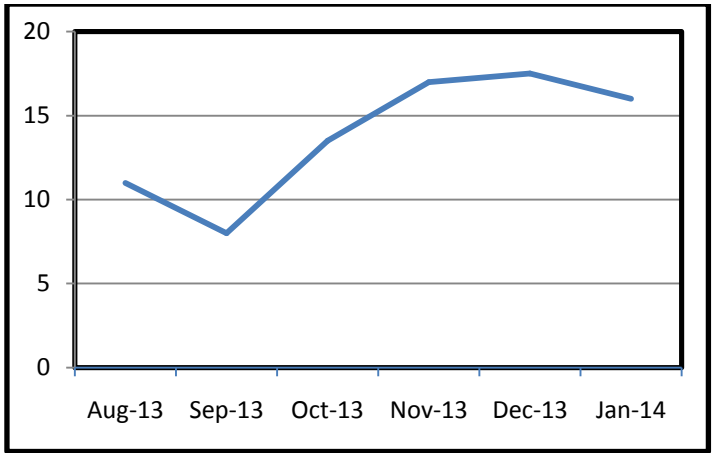

Fig 2 Graph of rejection per hundred

The pro
that while fitting the cover of the clutch housing it will not properly assembled. While observing and analyzing it was found that impression of the punch on the top face clutch housing is not clear while critically analyzing the problem it was found that the flatness of the flatness of the top window is hike upto 0.40mm which is above the limits specified by the customer for that part..

Problem description

This type of the defect may cause by the poor machining operation in the process flow. And the operation which performed the flatness job is Operation no. 20 on the process flow performed by the milling machine to get the flat face so the required observations are taken on the process /operation.

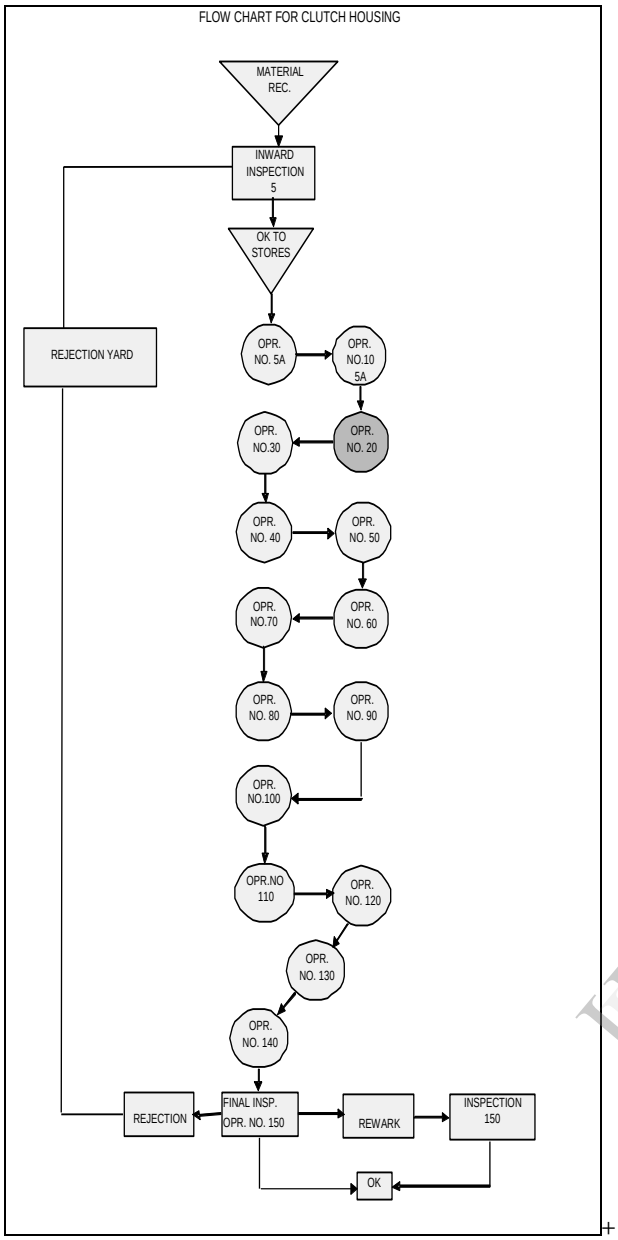

Fig. 3 Flow chart of clutch housing

Defect may cause on this operation because of following reasons

- Rejection may cause by improper operation on the part.
- May be because of improper operating condition
- Improper mounting of the part
- Improper tool cutting action

Observation and Variations in the process

During observation it is found that variations in the dimensions of the top window of the is 0.40 mm at the middle portion of the window , above the limit but required flatness of all portion of the window is 0.08 mm

Picture no. 1 Top window milling face

Observations of the process flow are as under –
Top window milling operation is done at operation no 20.

Part is rested on Bottom face in fixture.

Components rest on bottom face & clamped the part.

Picture no.2 Milling operation

Finding out the root cause of the defect

For finding out the root cause , some parameters are fixed and on that basis a cause and effect query is given to the personal that are related to the process like maintenance personals , quality personals , process and production personals .

Causes of the problem are mention on one side of the table and its relation had to be mention in terms of the points listing as

1- No Relationship
3- Weak Relationship
6- Medium Relationship
9- High Relationship

The aggregated cause-effect table is mention as below.
TABLE 1

From cause effect tables and suggestion from various personals of the company we found that the root causes of the problem are

1. Excess machining stock on the top window
2. Machine spindle perpendicularity is not ok
3.

Table 1 cause effect table

Cause effect (fish-bone) diagram

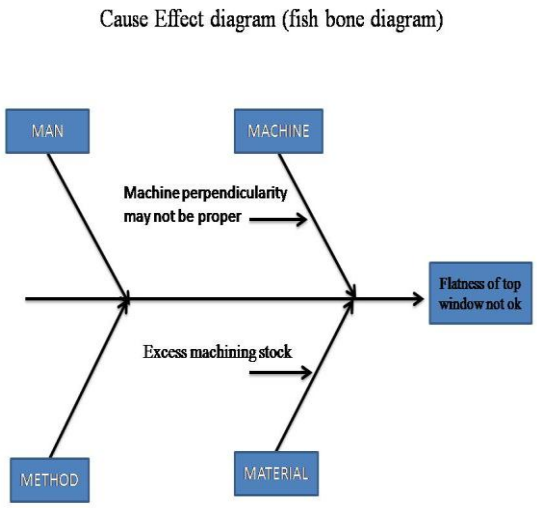

Fig. 4 cause effect diagram

A hypothesis testing performed on the probable causes by practical aspects is as follow

1. Excess machining stock on the top window.

Testing method:-10 numbers of parts are tested for machining stock by height gauge the results to testing are shown in the following table 2

From this table we had observe that 9 parts are within the range and 1 part had the excess machining stock because of which the machine spindle perpendicularity disturbed by 0.40 mm. so for this cause the hypothesis is valid.

2. Machine spindle perpendicularity disturbed.

Testing method: - testing is done by magnetic dial gauge , fix it on work table by taking reference of one side and the for the same reference reading is taken for other side in same plane.

Observation:- After checking the perpendicularity it is found that the machine spindle is tilt by 0.40mm on one side which cause the uneven machining on the top of the window

Picture no.3

So from this we concluded that our hypothesis is valid for both causes

Casting Number	Machining Stock in MM
NI 853	3.8
NI 860	4.2
NI 861	4.5
NI 893	4.8
NI 895	3.9
NI 823	5.8
NI 827	7.9
NI 899	4.3
NI 903	4.4
NI 905	4.5

Probable Cause	**Defect**
	TOP WINDOW FLATNESS FIRE UP TO 0.4 MM
Resting pad level not OK	3
Machine spindle head perpendicularity not OK	9
Cutter incomplete	3
Use of worn out insert	6
Casting not clamp properly	3
Milling on cast face	3
Excess machining stock	9
Machinability not ok	3

Table 2 Machine stock readings

Picture 3 Tilted machine spindle

So the possible root causes for these defects are

1. Excess machining stock on the top window
2. Machine spindle perpendicularity is not ok

For eliminating the both the root cause the remedial action has taken on it the remedial action are as follows

1. For first cause, the feedback is given to the foundry section i.e. the vendor of this company to check the machining stock of the top window before dispatching for the machining as this excess machining stock cause of disturbance of the perpendicularity of the milling machine spindle.
2. For second cause, the machine perpendicularity is makes to original condition i.e. to 0.08 mm as per the requirement of the machining, and perpendicularity should check periodically for proper functioning of the machine.

After applying the solutions the machining is done on the 10 parts and reading is taken for the flatness of the face it found to be within limit of the customers specification.

Result is shown in following table **No.3**

Casting Number	Flatness IN MM
NI 905	0.05
NI 911	0.06
NI 912	0.075
NI 915	0.06
NI 917	0.05
NI 921	0.05
NI 923	0.06
NI 925	0.075
NI 926	0.08
NI 928	0.07

Table no.3 Result of final observation

VI. SUGGESTION TO THE COMPANY

Suggestions given to company after compilation of the case study are

1. Frequency of the patrol checking for flatness had to increase to 2 per shift from 1 per shift
2. Frequency of checking Perpendicularity had to increase from once in year to twice in the six month so that same problem will not cause the defect again , proper training given to maintenance personal for this kind of problem.
3. Foundry shop had suggested checking their machining stock on the top window in each lot so that it should not disturbed the machine spindle.

VII. CONCLUSION

1. In the presented case study, we had conclusion that the defects are cause by the disturbance of the perpendicularity of the by 0.40 mm, it should minimize by
(a) Proper maintenance and continuous observation on the operation
(b) Proper checking of the material stock on the top window face of the clutch housing before dispatching for machining.

2. As we, reduce the defect which is one waste as per the lean thinking and the rate of the rejection suddenly goes down to minimum and improve the production rate as well as value of the industry in the market.

3. We had also concluded that the, POKA -YOKE is the strong technique to reduce the errors in the system because of which the defect cause.

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