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Lean Manufacturing Implementation in the Assembly shop of Tractor Manufacturing Company

Gundeep Singh, R.M. Belokar

Abstract— ***Lean manufacturing has received a great deal of attention in its application to manufacturing companies. It is a set of tools and methodologies that aims for increased productivity; cycle time reduction and continuous elimination of all waste in the production process. The Lean manufacturing technique - Kaizen is internationally acknowledged as a method of continuous improvement, through small steps, of the economical results of companies. In this paper a case study is presented in which bottlenecks are identified in the assembly shop of the tractor manufacturing automobile company due to which the productivity was low. Thus, the implementation of lean manufacturing kaizen technique results in the removal of bottlenecks by reducing cycle time, increasing the productivity and eliminating all kinds of waste.***

Index Terms— ***Bottleneck, cycle time, gear box, lean manufacturing, productivity, waste.***

I. INTRODUCTION

Lean manufacturing is the systematic elimination of waste from all aspects of an organization's operations, where waste is viewed as any use or loss of resources that does not lead directly to creating the product or service a customer wants when they want it. Thus, it is a way of thinking, a culture of eliminating non-value adding activities while responding to customer needs and wants. It reaches into every aspect of a company. The process of becoming lean may mean transforming oneself from one's existing style of operations to an entirely different one [1]. Lean manufacturing is a technique that allows work to be performed without bottlenecks or delays. This method will eliminate wasteful activities by linking and balancing equal amounts of work steps together, enabling products to be consumed directly into the next step, one piece at a time until completed [2, 3].

Lean manufacturing is more than a set of tools and techniques. Lean manufacturing is a culture in which all employees continuously look for ways to improve processes. The essential goal of lean manufacturing is to compress time from the receipt of an order all the way through receipt of payment. The results of time compression are greater productivity, shorter delivery times, lower cost, improved quality, and increased customer satisfaction [4]. There are numerous methods and tools that organizations use to implement lean production systems.

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Eight core lean methods [5] are Kaizen Rapid Improvement Process; 5S; Total Productive Maintenance (TPM); Cellular Manufacturing / One-piece Flow Production Systems; Just-in-time Production / Kanban; Six Sigma; Pre-Production Planning (3P) and Lean Enterprise Supplier Networks.

This paper will review the basic fundamentals of lean manufacturing and presents a case study in which the lean manufacturing technique- kaizen is implemented in the assembly shop of the tractor manufacturing automobile company.

II. LITERATURE REVIEW

According to Womack Jones, and Roos, [6] lean manufacturing uses less of everything compared to mass production ,half the human effort in the factory, half the manufacturing space, half the investment in tools, and half the engineering hours to develop a new product. In addition, it requires keeping far less than half of the needed inventory on site, results in many fewer defects, and produces a greater and ever growing variety of products. Ohno (1988) [7] coined the seven wastes targeted by lean manufacturing initiatives: (1) defects (activities involving repair or rework), (2) overproduction (activities that produce too much at a particular point in time), (3) transportation (activities involving unnecessary movement of materials), (4) waiting (lack of activity that occurs when an operator is ready for the next operation but must remain idle until someone else takes a previous step), (5) inventory (inventory that is not directly required to fulfill current customer orders), (6) motion (unnecessary steps taken by employees and equipment), and (7) processing (extra operation or activity in the manufacturing process).Russel and Taylor, (1999) [8] explained that the major purposes of the use of lean manufacturing are to increase productivity, improve product quality and manufacturing cycle time, reduce inventory, reduce lead time and eliminate manufacturing waste. To achieve these, the lean manufacturing philosophy uses several concepts such as one-piece flow, kaizen, cellular manufacturing, synchronous manufacturing, inventory management, poka-yoke, standardized work, work place organization, and scrap reduction to reduce manufacturing waste. Haque and Moore (2004) [9] suggested that although explicit application of the five Lean principals to Product Development by academia and industry is lacking, many companies have begun with implementation of the five Lean principles and the set-based concurrent engineering. Further, the study reveals that in most cases concurrent engineering as such could not work in isolation of Lean thinking.

Also, application within two aerospace companies showed encouraging results such as clear waste identification, lead time reduction, singles piece flow and cost improvements.

Aulakh and Gill [10] discussed importance of five elements of lean i.e. manufacturing flow, organization, process control, metrics and logistics to appreciate the synergetic effect of each element on others, towards making an organization lean. Further, a case study on lean manufacturing implementation experience of an Indian manufacturing firm i.e. 'plastic injection molded auto-parts' manufacturer is presented and thus productivity was increased by 25 %, WIP inventories were reduced and defect free production was done due to single piece flow and poka-yoke.

III. LEAN MANUFACTURING PRINCIPLES

Lean Thinking is the antidote to waste. There are (5) Lean Principles [11]:

1) Specify Value. Value can be defined only by the ultimate customer. Value is distorted by pre-existing organizations, especially engineers and experts. They add complexity of no interest to the customer.
2) Identify the Value Stream. The Value Stream is all the actions needed to bring a product to the customer. If the melter, forger, machiner, and assembler never talk, duplicate steps will exist.
3) Flow. Make the value creating steps flow. Eliminate departments that execute a single task process on large batches.
4) Pull. Let the customer pull the product from you. Sell, one. Make one.
5) Pursue Perfection. There is no end to the process of reducing time, space, cost and mistakes.

IV. CASE STUDY

The project work associated with the implementation of lean manufacturing was carried out in an assembly shop of a leading tractor manufacturing automobile company of India i.e. Mahindra and Mahindra Swaraj Divison Ltd, Mohali (Punjab).

A. Problem Identification

Increased cycle time at different machines due to which the overall productivity of the tractor was decreased as assembly line coupling was badly affected due to shortage of various sub assemblies prepared in assembly shop.

B. Observation

By doing the observation and scrutinizing the details of sub-assemblies that are manufactured in assembly shop, it was found that the major bottleneck was gear box assembly. Number of gear box manufactured per shift were not according to the target requirement as per the customer demand as shown in Fig. 1

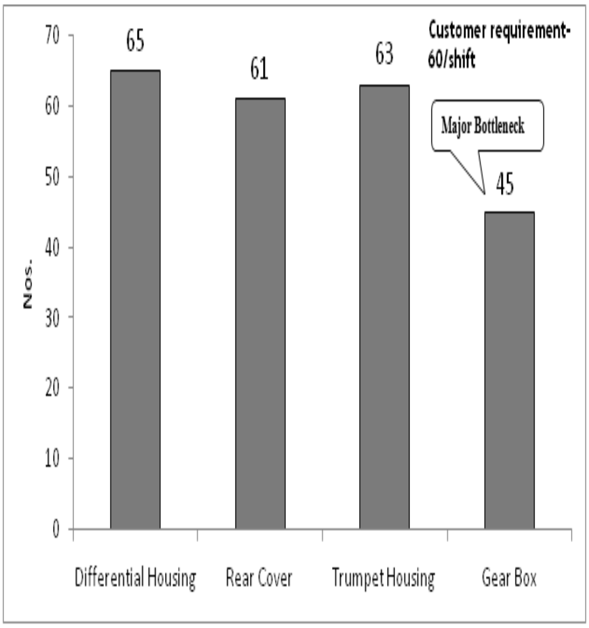

Fig. 1 Line capacity with the customer demand

1. Observation of Process

After the problem identification, next phase is of observation i.e. observing the complete process by scrutinizing each and every manufacturing operation which is being done on different machines in gear box assembly area. The process flow diagram of operations performed on different machines is shown in Fig. 2.

An initial cycle time study is performed on all the machines which cover the gear box assembly area to identify the bottle necks as shown in Fig. 3.

2. Observation of Symptoms

- Four machines i.e. M/C 492.10, 492.01, 491.02 and 491.03 are identified as the bottlenecks because the cycle time on these machines was more than that of the required cycle time target.
- Due to high cycle time on these machines, productivity became low and so the assembly line coupling was badly affected due to shortage of subassemblies and various parts that are produced.

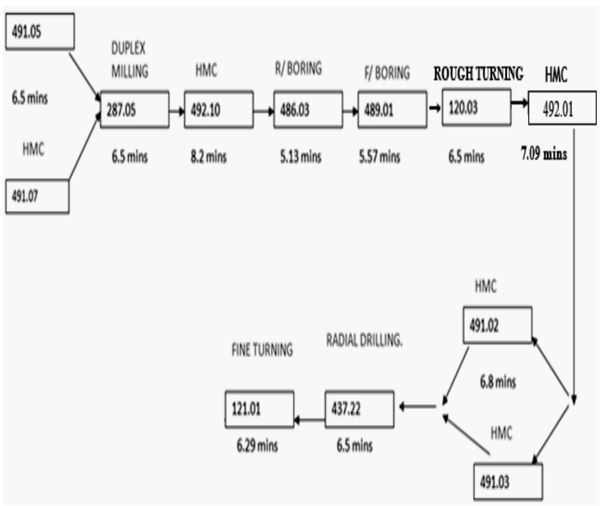

Fig.2 Process Flow Diagram

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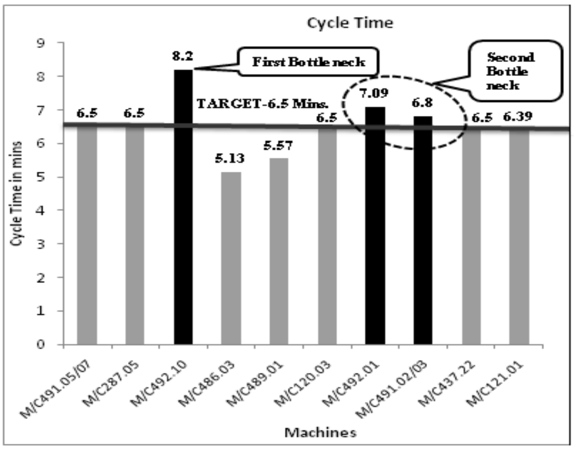

Fig. 3 Initial Cycle Time Study

C. Analysis

1. Possible Causes (Brainstorming):

The first step in analysis is to find out the number of causes that can be the reasons behind the increased cycle time of these machines. Ten causes that were generated during the brainstorming session are as follows-

- Available time not utilized properly by the machine operators.
- Number of operations involved.
- Abnormal absenteeism by the machine operators.
- Machine breakdown problem.
- Late start of work by the machine operators.
- Metallurgical problem in the material to be machined.
- Programming not correct.
- Multiple cutting tools being used for same type of operations.
- Number of quality parameters to be inspected.
- Inspection stage far from work station.

2. Possible Cause and Effect Diagram:

Now a cause and effect diagram is prepared for the possible causes. This diagram is also known as Ishikawa or the Fish bone diagram and is shown in Fig.3.

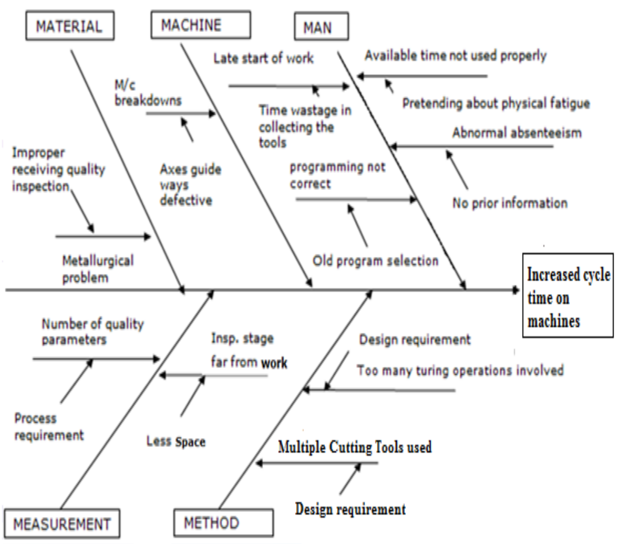

Fig. 3 Cause and Effect Diagram

Table I Testing of Hypothesis

S. No.	Probable causes	Testing and Observation	Conclusion
1.	Multiple cutting tools used for same type of operations.	The cycle time is more due to the use of multiple tools for same operations on HMC 492.10 as shown in Table II.	Hypothesis is **valid**
2.	No. of operations involved.	The cycle time is more due to multiple operations performed on HMC 492.01, 491.02 and 491.03	Hypothesis is **valid**

From the analysis of all the possible causes, two probable root causes are selected and testing of hypothesis was done as given in Table I.

D. Action-To eliminate each root cause

- Kaizen idea for Root cause 1:
  Single tool is used against three tools due to which the cycle time gets reduced on HMC 492.10. Therefore, the first bottleneck gets eliminated. This is shown in Table III and IV..
- Kaizen idea for root cause 2:
  Merging of three M/C's operations into one which were earlier carried on three different machines i.e. HMC 492.01, 491.02 and 491.03.

Thus, the new process flow diagram is formulated as shown in Fig. 4.

Table II Cycle time on M/C HMC 492.10

S.No	Activity	Cycle time in min
1	Drilling Dia. 23.5mm	1.2
2	Drilling Dia. 39.0 mm	0.8
3	Hole mill Dia. 25.0 mm	0.9
4	Rough milling	3.8
5	Finish milling	1.5
Total		**8.2**

Table III Reduced Cycle time on M/C HMC 492.10

S.No.	Activity	Cycle time in min
1	Drilling Dia 23.5, 25.0 & 39.0mm	1
4	Rough milling	3.8
5	Finish milling	1.5
Total		**6.3**

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V. RESULTS

Thus, due to the implementation of lean manufacturing-kaizen technique the bottlenecks were identified in the gear box assembly area and were removed by reducing the cycle time on the machines which were earlier having high cycle time as compared to the target. Therefore, the productivity of the gear box assembly area was also improved like other sub assemblies in the assembly shop of the organization as per the required target.

VI. CONCLUSION AND FUTURE WORK

The main conclusions that can be drawn on implementation of lean manufacturing are:

- Increase in the productivity of gear box assembly.
- Cycle time reduction of the machines.
- Negligible work-in-process inventory.
- Defect free production.
- Assembly line coupling runs normally due to delivery of components on time.
- Reduction of all kind of wastes.

In terms of future research, the foremost recommendation would be to implement the proposed Lean manufacturing technique and methodology for automobile manufacturing organizations in order to gain an understanding of exact implications of the solution.

Given the utility of the measures in describing systems and processes within, it is possible to conclude that the manufacturing processes are complex systems and can benefit a lot from Lean Manufacturing concept.

Table IV Kaizen Action taken

Previous Cycle time (min)	Cycle Time Reduced (min)	Production increased/Shift	Action
8.2	1.9	15	Single tool is introduced against three tools

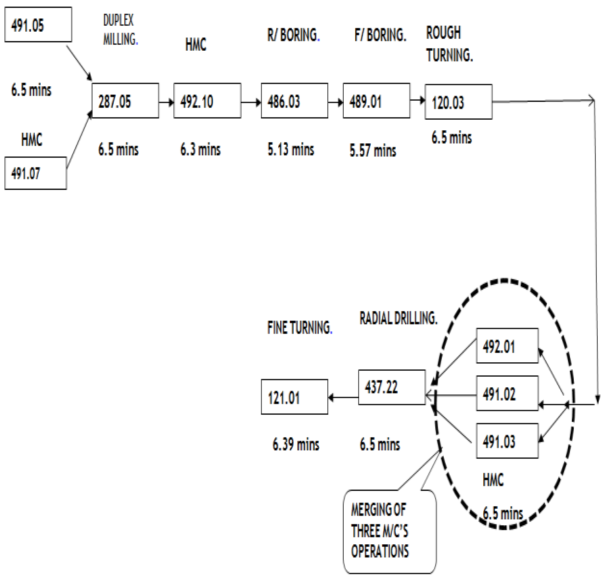

Fig. 4 New Process Flow diagram

REFERENCES

1. James A. Jordan, Jr. and Frederick J. Michel, 1999, "Valuing Lean Manufacturing Initiatives", Computer Technology Solutions conference, September 1416, 1999, Detroit, Michigan.
2. Farzad Behrouzi and Kuan Yew Wong, "Lean Performance evaluation of manufacturing systems: A dynamic and innovative approach", Procedia Computer Science 3 (2011) 388395, Malaysia.
3. Abdul Talib Bon and Norhayati Abdul Rahman, "Quality Measurement in Lean Manufacturing", University Tun Hussein Onn, Malaysia.
4. Mary S. Spann, Mel Adams, Maruf Rahman, Hank Czarnecki and Bernard J. Schroer, "Transferring Lean Manufacturing to Small Manufacturers: The Role of NIST-MEP", University of Alabama in Huntsville, Huntsville, Alabama 35899.
5. "Lean Manufacturing and the Environment: Research on Advanced Manufacturing Systems and the Environment and Recommendations for Leveraging Better Environmental Performance", Ross & Associates Environmental Consulting, Ltd. USA.
6. J.P. Womack, D.T. Jones and D. Roos, "The Machine That Changed the World", Rawson Associates, New York, NY, 1990.
7. Ohno, Taiichi. 1988, "Toyota Production System", New York: Productivity Press..
8. Russell, R.S. and Taylor, B.W., "Operations management", 2nd edition, Uppre Saddle River, NJ: Prentice Hall, 1999.
9. Haque, B., & James-Moore, M. (2004), "Applying Lean thinking to new product introduction", Journal of Engineering design, 15(1), 1-31.
10. Sachpreet Singh Aulakh and Janpreet Singh Gill, "Lean Manufacturing a Practitioner's Pespective", Department of Mechanical Engineering, RIMTInstitute of Engineering & Technology, Mandi Gobindgarh, India.
11. James P. Womack and Daniel T. Jones, "Lean Thinking: Banish Waste and Create Wealth in Your Corporation", Simon & Schuster, Inc., 1996, Second Edition, 2003.