Productivity Improvement through Lean Manufacturing System in a Steering Gear Manufacturing Industry

T. M. S. Ravi Kiran[1], Dr. M. S. Shamprasad[2]
[1, 2] Department of Industrial & Production Engineering
[1, 2] The National Institute of Engineering, Mysuru

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 bottleneck is identified in the Housing machining cell in steering gear manufacturing due to which the productivity is 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.*

Keywords- Bottleneck, cycle time, steering gear box, lean manufacturing, productivity, waste.

I. INTRODUCTION

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 Housing machining cell of steering gear manufacturing industry.

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. 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. 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. There are numerous methods and tools that organizations use to implement lean production systems. Eight core lean methods are Kaizen Rapid Improvement Process; 5S;); Cellular Manufacturing / One-piece Flow Production Systems; Just-in-time Production / Kanban; Six Sigma; Pre-Production Planning (3P) and Lean Enterprise Supplier Networks.

II. LITERATURE REVIEW

According to Womack Jones, and Roos, 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) coined the seven wastes targeted by lean manufacturing initiatives: defects (activities involving repair or rework), overproduction (activities that produce too much at a particular point in time),transportation (activities involving unnecessary movement of materials),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),inventory (inventory that is not directly required to fulfill current customer orders),motion (unnecessary steps taken by employees and equipment), and processing (extra operation or activity in the manufacturing process).

Russel and Taylor,(1999)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) 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.

III. CASE STUDY

The project work associated with the implementation of lean manufacturing is carried out in an Housing machining cell of steering gear manufacturing industry for International Tractor Divison.

A. Problem Identification

Increased cycle time at VMC (vertical machining centre) machine a final machining operation in housing cell, due to which the overall productivity of the tractor is decreased.

B. Observation

By doing the observation, it was found that the major bottleneck was gear box at VMC machine. Number of gear box manufactured per shift is not according to the target requirement as per the customer demand Takt Time is 375 sec per component shown in Fig1.

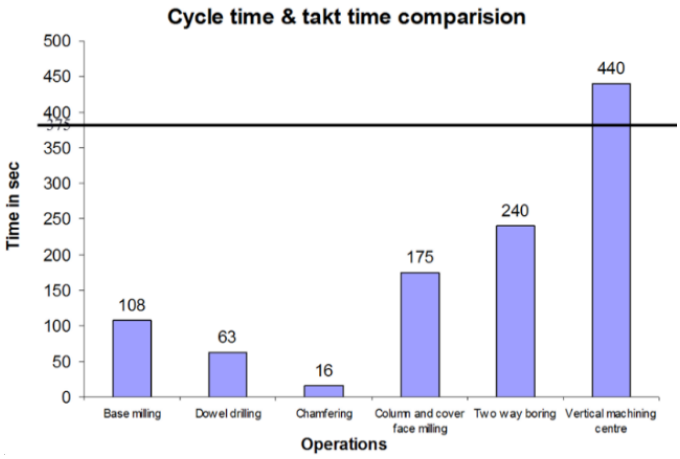

Figure1:Cycle time & takt time comparison

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 housing machining cell. The detail cycle time study of operations performed on different machines is shown in Table 1.

Table 1: cycle time study

Seq.	Description	Cycle time in secs				Remarks
		Unload	Load	Machining	Total time	
10	Base milling	4	20	84	108	
20	Dowel drilling	7	9	47	63	
30	Chamfering	0	0	16	16	
40	Column and cover face mi	14	21	140	175	
50	Two way boring	3	16	221	240	
60	Vertical machining centre	25	45	370	440	Bottleneck

Analysis

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.2

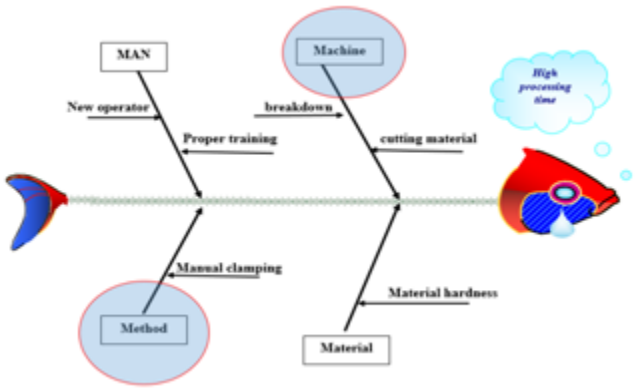

Figure.2 Cause & Effect diagram

Following possible cause for high processing time and inventory are identified from the cause & effect diagram

- The method used for clamping and declamping the work piece is manual clamping method.
- Tool material used for machining the work piece VMC machine.

Action-To eliminate each root cause

Kaizen idea for Root cause 1:

Table 2 Cycle time study

Seq. no	Description	Cycle time in secs			
		Unload	Load	Machining	Total time
10	Base milling	4	20	84	108
20	Dowel drilling	7	9	47	63
30	Chamfering	0	0	16	16
40	Column and cover face milling	14	21	140	175
50	Two way boring	3	16	221	240
60	Vertical machining centre	4	20	315	339

1. Improving the manual clamping & declamping method to Semiautomatic clamping method

Kaizen idea for root cause 2:

1. Improving the Final face milling Indexible Insert from 3 edge cutter to 8 edge cutter
   Introduction
2. Improving the Drill tool material from HSS to carbide for Column and cover face Drilling operation

CYCLE TIME STUDY OF ALL OPERATIONS

Cycle time study was carried out again after carrying out the kaizens for below mentioned operations separating loading, unloading, machining times

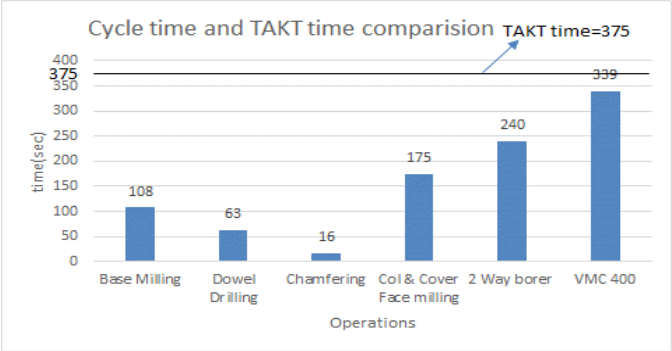

Figure 3: Cycle time and TAKT time comparison (after)

According to the above table, the time taken by the bottleneck operation on VMC is reduced and is well within the takt time as shown below in the line balancing chart.

IV.RESULT

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.

V.CONCLUSION

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

- Increase in the productivity of Steering gear box. Cycle time reduction of the VMC machine.
- Negligible work-in-process inventory. Defect free production.
- Components on time.
- Reduction of all kind of wastes.

REFERENCES

[1] Rasli Muslimen, Sha'ri Mohd Yusof, Ana Sakura Zainal Abidin" Lean Manufacturing Implementation in Malaysian Automotive Components Manufacturer: a Case Study" Proceedings of the World Congress on Engineering 2011 Vol IWCE 2011, July 6 - 8, 2011, London, U.K.

[2] S. P. Vendan *, K. Sakthidhasan "Reduction of Wastages in Motor Manufacturing Industry "Jordan Journal of Mechanical and Industrial Engineering Volume 4, Number 5, November 2010ISSN 1995-6665 Pages 579 – 590

[3] Ajith Kumar Sahoo, N.K. Singh, Ravi Shankar, M.K. Tiwari. Lean Philosophy: implementation in a forging company. International Journal of Advanced Manufacturing Technology. 2008.36:451-462

[4] Liker, J. Toyota Way. Blacklick, OH, USA: McGraw-Hill Professional Publishing, p. 28-33,2003.David Magee, How Toyota Became # 1 Leadership Lessons from the World's Greatest Car Company. New York, USA: Penguin Group. 67. 2007

[5] M.Eswaramoorthi, G.R. Kathiresan, P.S.S.Prasad, P.V. Mohanram. A survey on lean practices in Indian machine tool industries. International journal of advanced manufacturing technology.2011, 52: 1091-1101.

[6] Ajit Chavda, Prof. M.Y.Patil Increased Productivity of Tyre Manufacturing Process using Lean Methodology Institute Of Technology, Nirma University, Ahmedabad – 382 481, 08-10 DECEMBER, 2011

[7] Jafri Mohd Rohania, Seyed Mojib Zahraee a Production line analysis via value stream mapping: a lean manufacturing process of colour industry2nd International Materials, Industrial, and Manufacturing Engineering Conference, MIMEC2015,4-6 February 2015, Bali Indonesi

[8] R.Sundara, A.N.Balajib, R.M.SatheeshKumar A Review on Lean Manufacturing Implementation Techniques12th Global Congress On Manufacturing And Management, GCMM 2014

[9] Ritesh R. Bhat, Prof. S. Shivakumar Improving the Productivity using Value Stream Mapping and Kanban Approach International Journal of Scientific & Engineering Research Volume 2, Issue 8, August-2011 1ISSN 2229-5518.

[10] Palak P. Sheth, Vivek A. Deshpande, and Hiren R. Kardanivalue Stream Mapping: A Case Study of Automotive industry IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.

[11] General Guidelines for Selecting Cutting Tool Materials ASM Specialty Handbook: Tool Materials Joseph R. Davis, Editor .Milling Cutters and Operations

[12] Manufacturing Processes II Prof. A. B Chattopadhyay Department of Mechanical Engineering Indian Institute of Technology, Kharagpur