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A REVIEW OF PRODUCTIVITY COST ANALYSIS

Ramji Mishra*, Prof. R. P. Kori
* M.Tech. (Production Student) MITS Gwalior
Assistant Professor, (Mechanical Engineering) Department of Mechanical Engineering, MITS Gwalior

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ABSTRACT
The automotive industry has been experiencing a competitive environment and striving hard to find methods to reduce manufacturing cost, waste and improve quality. Lean manufacturing concepts are used by the industries to reduce work in progress inventories and also to reduce the waste for competing in the global market. The ultimate goal is to speed up the process there by increasing productivity through a proper utilization of man and machine. In a manufacturing industry, the layout and material flow in the shop floor decides its productivity. Material handling system also plays a key role in influencing productivity, throughput time and cost of the product. This research work has been carried out as a case study in an automotive industry with the objective of waste reduction. Efforts are made to reduce the motion wast in the shop floor. The problems in the current layout are identified and analyzed through simulation. Then the layout is modified, simulated and the results are compared with the current layout. The results revealed an improvement of something 20% in productivity.

INTRODUCTION
Lean manufacturing is "A systematic approach for identifying and eliminating waste through continuous improvement by flowing the product at the pull of customer in pursuit of perfection". Lean manufacturing concepts are mostly applied in industries where more repetitive human resources are used. In these industries productivity is highly influenced by the efficiency working people with tools or operating equipments. To eliminate waste, it is important to understand exactly what it is and where it exists. The processes add either value or waste to the Production of goods. The seven manufacturing wastes originated in Japan, where waste knows as "muda" as demonstrated by Rotaru (2008). The concept of Lean manufacturing first came to be more widely known with the book 'The Machine That Changed the World' published by Womack et al.(1990) and later through the book 'Lean Thinking'. The Key points of emphasis in Lean appear to be reducing process variability, reducing system cycle times, and above all, eliminating wastes in the manufacturing cycle as stated by Womack and Jones (1986). Paul and Rabindra (2006) used subjective assessment through questionnaire, direct observation method, and archival data to improve productivity, quality, increasing revenue and reducing rejection cost of the Manual Component Insertion (MCI) lines in a printed circuit assembly (PCA) factory. Live experiments were conducted on production lines. The drawback of this work is that an experimental design could not be performed to find the best insertion sequence and component bin arrangements as there was a hindrance in conducting experiments in real-life line, i.e. the study itself might reduce line output and affect quality. Brown and Mitchell (1988) did an investigation into operators, engineers, and managers of PCA factories to determine the work environment parameters that inhibited their performance and they recommended opportunities to improve productivity & quality. Lim and Hoffmann (1997) found that improved layout of the workplace increased productivity of the workers, through more economical use of hand movements by conducting an experiment on hacksaws assembly.

Christopher (1998) stated that the success in any competitive context depends on having either a cost advantage or a value advantage, or, ideally, both. Imad Alsyouf (2007) illustrated how an effective maintenance policy could influence the productivity and profitability of a manufacturing process and showed how changes in the productivity affect profit, separately from the effects of changes in the uncontrollable factors, i.e. price recovery Browning and Heath (2009) developed a revised framework that reconceptualises the effect of lean on production costs and used it to develop eleven propositions to direct further research and illuminated how operations managers

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International Journal OF Engineering Sciences & Management Research

might control key variables to draw greater benefits from lean implementation White et al. (1999) found that plant size had a significant effect on the implementation of lean practices. This shows that, regardless of establishing what lean is, it remains important to establish how best to become lean in varied contexts. Shah and Ward (2003) empirically validated four "bundles" of inter-related and internally consistent practices; these are just-in-time (JIT), total quality management (TQM), total preventive maintenance (TPM), and human resource management and investigated their effects on operational performance. Flynn et al.(1995) and McKone et al.(2001) have explored the implementation and performance relationship with two aspects of lean. Crute et al.(2003) discussed the key drivers for Lean in aerospace and did a Lean implementation case comparison which examines how difficulties that arise may have more to do with individual plant context and management than with sector specific factors. Womack et al.(1990) developed from the massively successful Toyota Production System, focusing on the removal of all forms of waste from a system. Krafcik, (1998) describes the Japanese-style manufacturing process pioneered by Toyota, which uses a range of techniques including just-in-time inventory systems, continuous improvement, and qualit circles. In the cited literatures, Researchers revealed the importance of lean concepts in the competitive industries especially for improving the productivity, quality of products, profitability, and for reducing lean wastes and inventories.

Case study

A case study on machining of bearing cap has been chosen to find the working of current layout and its performance. The Bearing cap for engine is machined using CNC and Special purpose machines. The surfaces of bearing cap to be machined are marked by arrows in Figure

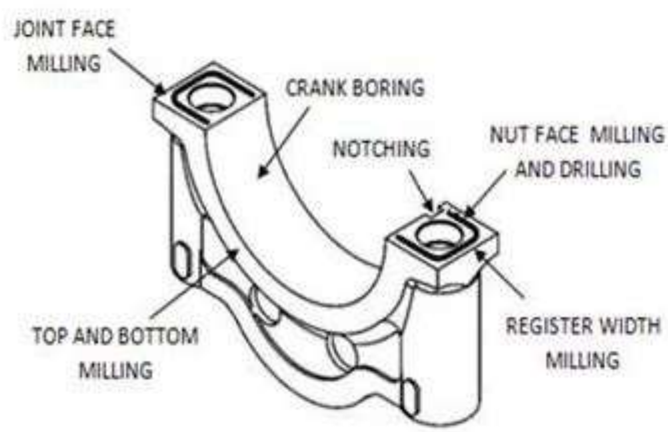

Figure 1: Bearing cap machining details

Takt time calculation

Takt time is the average time allowed to produce unit production to meet customer demand and the process time should be less than or equal to the takt time. Takt time is calculated based on machine available time and the required number of units. The procedure followed to determine takt time for the current production of bearing cap is as follows

Total available time	= 3 Shifts / day /25 working days in a month
Customer Demand / day	= 1167 pieces

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International Journal OF Engineering Sciences & Management Research

Available Working time/shift (Excluding lunch and tea break) = 420 minutes=25200 seconds. Available time/day = 25200 x 3=75600 seconds.

Takt Time = Total available time /Customer demand
= 64.78 seconds/piece ≈ 65 seconds/piece

Cycle time calculation

From the time study on current layout (Table 1), it is identified that the operations 30A and 30B are identical and so the cycle time of one component is found to be 55 seconds by averaging the cycle times of these two machines. Similarly, operations 40A and 40B are identical and by taking the average, one components' cycle time is found to be 58 seconds. For all the operations, cycle time for a single component is estimated and listed.

Proposed layout

Owing to the problems existing in the current layout, a new layout is proposed based on the study and analysis of the current scenario. The features of the new layout are listed as follows All machines are connected with a new gravity feeder for carrying material from one station to another which reduces transportation waste by the amount of 34.19 meters as shown in Table 1 and feeder is shown in the Figure 7 as number 1.The transportation in the proposed layout is pictorially depicted in Figure 2.

Sl. No.	Stations	Current layout without MHS in	Proposed layout	Difference in distance travelled
1	RM- opn.10	1.53	1.53	
2	opn.10-20	3.66	0	
3	opn.20-30	12.2	0	
4	opn.30-40	13.7	0	
5	opn.40-50	10.7	0	
6	opn.50-60	18.3	16	
7	opn.60-70	4.88	0	
8	opn.70-80	0.91	0.5	
9	opn.80-FG	3.05	3.05	
Total (meter)		68.93	21.08	**47.85**

Table 1 Operator motion distance comparison

Two machines are interchanged because it is identified that the idle time of the operator is more as mentioned in the Table 1. Operation 30B and 40B having high idle times 70s and 75s respectively. In order to reduce the idle time of operators, the machines C and D are interchanged and the orientation of C, E and F are altered as shown in the Figure2 as number 2. In this new arrangement, Machines B and D are operated by a single operator simultaneously. Similarly, machines E and F are operated by a single operator simultaneously. This helps the operator to run two machines simultaneously by utilizing the idle time. A new

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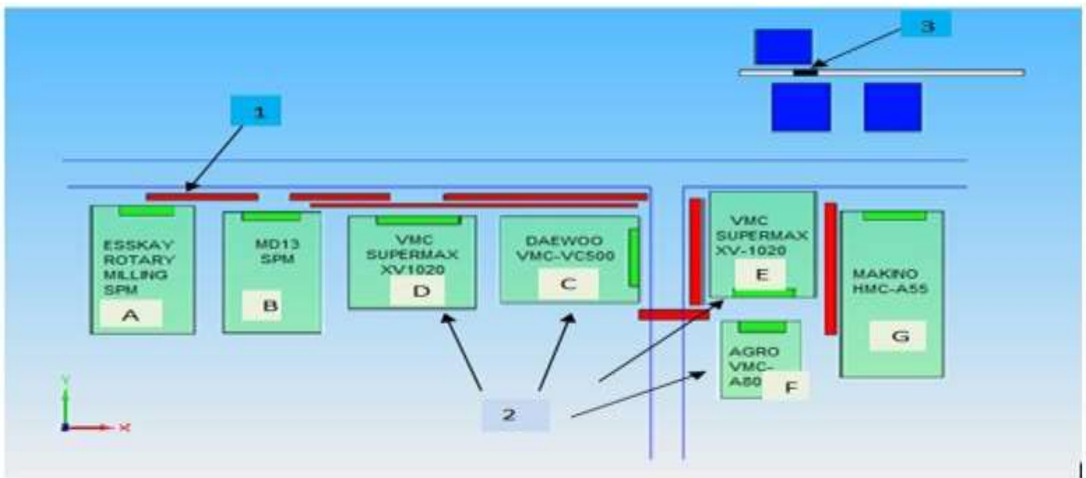
window is included in the wall between deburring and inspection area to transfer the material directly which reduces transportation and motion wastes. It is shown in the Figure 7 as number



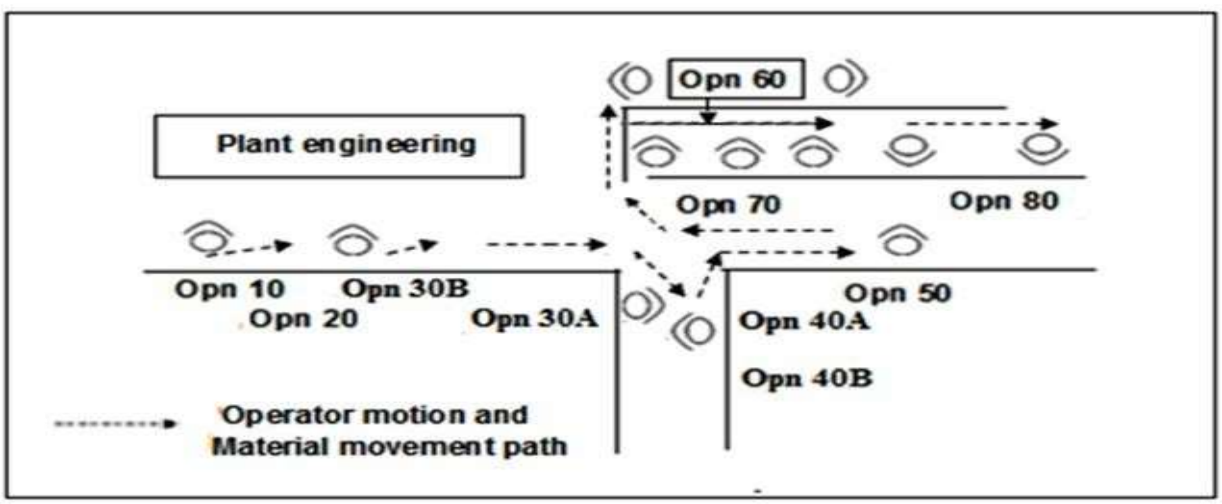


Figure 3: Proposed Layout

Simulation study

The imitation of the operation of a real-world process or system over time is called simulation. Simulation involves the generation of an artificial history of the system and the observation of that artificial history to draw inferences concerning the operational characteristics of the real system that is represented. The simulation is an indispensable problem-solving methodology for the solution of many real-world problems. It is used to describe and analyze the behaviour of a system, ask what-if questions about the real system, and aid in the design of real systems

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International Journal OF Engineering Sciences & Management Research

as explained by Adams et al.(1999), Jain and Leong (2005). A simulation study is carried out using WITNESS as simulation software. Both current and proposed systems are modelled and simulated in order to find out the optimum layout strategy

Summary and Conclusions

An attempt has been made to improve the productivity and profitability of the industry. The design and development of the gravity feeder for the material handling have been done to reduce the motion and transportation wastes. The simulation analysis of current layout is carried out to study the performance in lean perspective and modifications in the layout have been made. A window opening is made between the deburring and inspecting operation which saves time by 30 minutes for 100 parts .The machines are replaced and their orientations are changed for easy transfer of material and for sharing the idle time of the operators with other machines. The modifications in the layout will reduce two operators and increase the utilization of the operators by 11.95%. It saves 640 rupees per shift from the operator's salary. Hence it saves Rs. 5, 99,040 per year which is a considerable savings in the total revenue. Also the implementation of gravity feeder in between the workstations reduces the motion waste and monotonous efforts of the labours which further enhances the labours' job satisfaction and goodwill of the organisation.

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