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ANALYZING THE BENEFITS OF LEAN TOOLS: A CONSUMER DURABLES MANUFACTURING COMPANY CASE STUDY

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ABSTRACT: Lean manufacturing is one of the initiatives that many major manufacturing industries in the world have been trying to adopt in order to remain competitive in an increasingly global market. The focus of the approach is on cost reduction by eliminating non value added activities. Originating from the Toyota Production System, many of the tools and techniques of lean manufacturing (e.g., just-in-time, 5S, total productive maintenance, single-minute exchange of dies, kanban) have been widely used in manufacturing production line and assembly line. Applications have spanned many sectors including automotive, electronics and consumer products manufacturing. In this paper, a case study is described where lean tools and techniques are adapted for the consumer durables manufacturing company. The work is focused on a specific product family, table-top wet grinders. Value stream mapping was the main tool used to identify the opportunities for various lean techniques. Also "before" and "after" scenarios in detail are described in order to illustrate the potential benefits such as reduced lead-time and improver lean rate.
KEYWORDS: Line balancing, Assembly line, One-point lesson, Lean rate

INTRODUCTION

Toyota Production System or Lean Manufacturing is a system focused on pinpointing the major sources of waste, and then using tools such as JIT, production smoothing, 5S, setup reduction and others to eliminate the waste. The influence of lean practices contributes substantially with the operating performance of plants [1, 2] and the use of lean tools allows the improvement of results [3]. The tool value stream mapping (VSM) is applied as a way to progress toward lean manufacturing and as a formula to lead the activities of improvement [4-8].

The consumer durables manufacturing industries in India have gained significant stride due to growing domestic demands. The Indian durables market, with a market size of US $27.38 billion in 2008-2009, has grown by 7.1% over the previous year. Production in the consumer electronic industry has been estimated at US $6.7 billion in 2009-2010. The segment registered a growth of 18% in 2009-2010 from US $5.5 billion in the previous year. The consumer electronic segment contributes about 27% to the total hardware production in the country [9]. In order to achieve the improved market share and compete with their global counterparts, these industries necessarily need to improve productivity while ensuring lower cost and world class quality. In this direction, the implementation of lean tools is highly recommended, in order to identify the areas generating waste; thus, it further facilitates the improvement of the operating conditions in a minimal investment.

This work presents a case study of a medium-scale consumer durables manufacturing company which needs to improve its operations in one their table-top wet grinder assembly line. This paper focuses on the implementation of lean tools and to develop different strategies to eliminate waste. The strategic influence of lean tools is measured by means two lean metrics: lean rate and dock-to-dock time.

BRIEF LITERATURE REVIEW

The characteristics and impacts brought by lean tools and techniques have been presented in a number of works [10–14]. The successful application of various lean practices had a profound impact in a variety of industries, such as aerospace, computer and electronics manufacturing, forging company, process industry (steel), and automotive manufacturing. Their methodology is similar, using lean tools, and they are adapted to the study variables, but the improvement point and the results achieved are different. In recent years, assembly lines are studied to get the smoothing of production system [15] and they are analysed under several operative perspectives seeking its flexibility [16, 17]. In assembly lines, pull and lean systems are concepts frequently connected, although they pursue different objectives; pull system toward the reduction of work-in-process and lean system toward minimizing the buffer variability [18]. Considering the available literature, the present work is the first attempt that explores the benefits of lean tools in consumer durables manufacturing company and provides direction for future continuous improvement.

❖ COMPANY AND PROCESS BACKGROUND

The goal of this paper is to use a case-based method to demonstrate how lean tools when used appropriately, can help the industry eliminate waste, improve productivity and product quality, reduce lead time and obtain better operational control. A medium scale table-top wet grinder manufacturing company's assembly line is used to illustrate the method followed. The complete assembly process includes two main assemblies namely base frame assembly and shell assembly and many more sub assemblies. The line consists of sixteen stations before the product is ready for transport. Each station consists of a single worker and all the operations are done manually. Figure 1 shows the typical product handled in the assembly line and Table 1 summarises the overall nature of the assembly line.

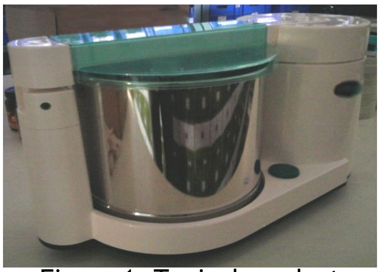

Figure 1. Typical product handled by the line

Table 1. Summary of the assembly line characteristics

Sl. No.	Description	Data
1.	Nature of production system	Batch production
2.	Transfer of material	Manual
3.	Total man power	16 per day
4.	No. of shifts	1 per day
5.	Material travel distance	22 ft.
6.	No. of stations involved	16
7.	Space occupied	83 sq.ft.

The company was experiencing severe pressures internally to improve its operations in the assembly line. In recent years, the company has tried many options with huge capital investments; however, the results achieved were not significant. In the pursuit of consistency, the management decided to implement lean tools. After several brain storming and a thorough study of the shop floor, it was observed that the wet grinder assembly line consists various forms of non-value-adding activities as follows:

- High lead time
- Accumulation of high inventory occupying 40% of shop floor
- Unnecessary material flow (back tracking)
- Human fatigue in material handling (10% of lead time)
- Underutilized man power
- Poor inventory management

❖ OBJECTIVES

In order to implement lean tools, a task team was formed with people from different department, all having wealthy knowledge and information pertaining to production, machinery, scheduling and planning. The prime objective is to develop different strategies to reduce the level of non value activities present in any form by implementing the various lean tools. The research targets for the task team are as follows:

- Line balancing
- Increasing the line productivity by 20%
- Improving the material flow
- Reducing the material travel distance to 10 ft.
- Reducing the man power by 25%
- Implementing 5S

❖ METHODOLOGY

The methodology followed throughout the lean tools implementation process is given in Figure 2.

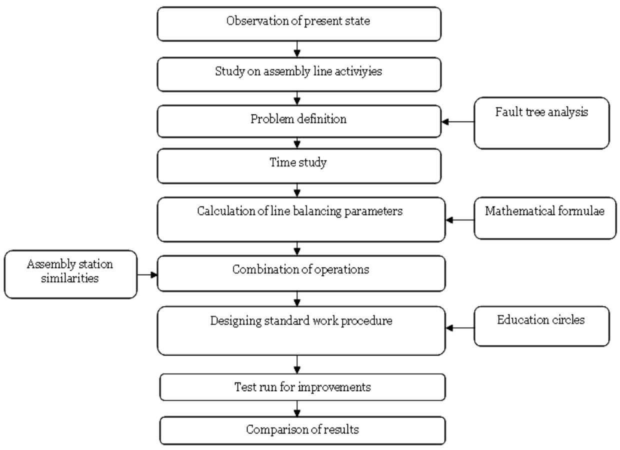

Figure 2. Methodology for implementation

❖ TOOLS FOR IMPROVEMENTS - CURRENT STATE VALUE STREAM MAPPING

The lean tool value stream mapping is applied as a method to lead the activities. In order to visualize the non-value-added activities it was decided to first construct the current state value map.

All the necessary information from various departments is collected to construct the current state value stream. Information related to the assembly line, such as cycle time at each work stations, machine down time for each process, inventory, change-over time, set-up time, number of workers and operational hours per day are also collected and documented properly. Table 2 summarizes the major activities associated with wet grinder assembly line. To complete the value map, a timeline is added at the bottom of the map recording the total processing time and the value-added time. Finally, the value stream map for the current state is constructed as shown in Figure 3.

Table 2. Major activities in the assembly line

No	Description of activity	
1	Drivenpulley+bearing+bearing housing: driven pulley is pressed against the bearing and houser assembly	
2	Shell switch mounting : it is an independent operation where switch is connected to the shell assembly manually	
3	Shell spring mounting: the shell is assembled with the top cap and spring assembly	
4	Base plate shoe assembly: it is an independent operation where baseplate is fitted with bottom shoe manually	
5	Arrangement of fasteners on base plate: the base plate is then arranged with fastners in seperate stations	
6	Fastening driven pulley in base plate: the arranged fastners are then fastened using pneumatic device	
7	Motor assembly: this is an independent operation in which the motor is tested and fitted for its accessories	
8	Motor+baseplate assembly : motor is fastned with base plate in this station	
9	Fixing connectors : connector assembly is done for fixing the electric cables	
10	Shell+baseplate+motor assembly: this is a main assembly stage where motor with base plate is connected to shell	
11	Fastening shell assembly : the above assembly is fastened	
12	Arm assembly: the arm and channel is fastned with each other	
13	Arm+shell assembly:the main assembly is fitted with the arm assembly	
14	Drum and stone assembly: the drum and the grinding stone is sticked using glue	
15	Testing :the assembled grinder is checked for its rpm, load	
16	Packaging:this is the final stage where packing is done	

As the Table 2 indicates, there are sixteen stations through which a single grinder is manufactured. There were no specific procedures for the work stations in which a collapsed and non-repetitive manner of work was carried out. From the current state value map, the total lead time is found to be 634 seconds in which only 196 seconds are value added activities compared to 438 seconds of non-value-added activities and there is steady demand of 300 pieces per day. The following sub-sections describe a planned and integrated approach adopted to reduce the non-value-added activities.

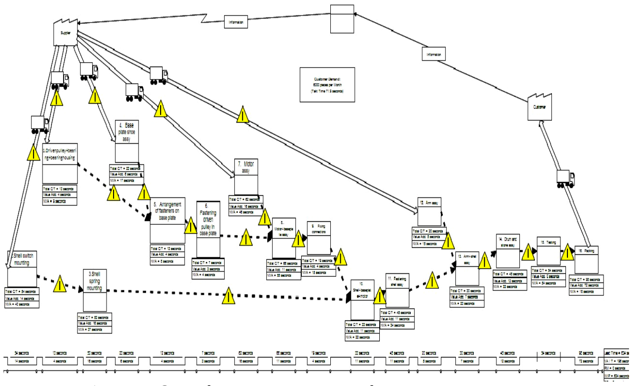

Figure 3. The present value stream map

❖ LINE BALANCING

A first analysis (Figure 4) of the line reveals that it is convenient to convert the unbalanced line to a balanced line. The intention is to reduce unnecessary time spent in the line and thus to increase lean rate. 'Combination of operations' is the method applied to increase the balance efficiency.

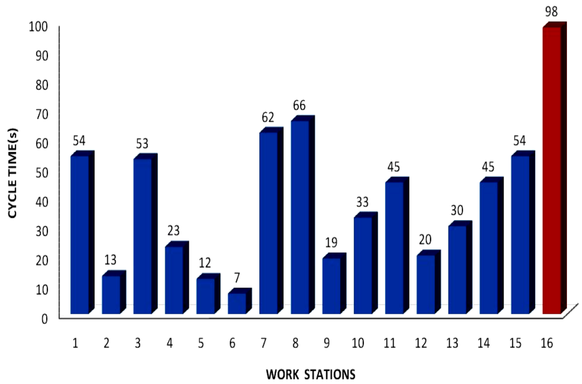

Figure 4. Unbalanced assembly line

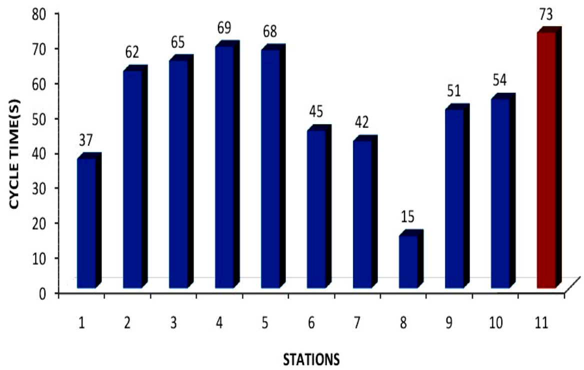

Figure 5. Balanced assembly line after "combination of operations"

As a result, the number of assembly stages is reduced from 16 to 11. Also, a set of distinct, sequential procedure for work at each stage is drawn considering the work complexities. Finally, the line balancing efficiency is increased from 40% to 72% with smoothing index 15. The line balancing result is given in Figure 5.

❖ IMPROVEMENT IN SPACE UTILISATION

The existing company's layout indicates that the floor area utilization is poor. In order to improve the existing scenario, the concept of bin system is introduced. The respective components, which are kept inside the store, have been allotted the required space through area calculation (Table 3). As a result, the floor area occupied by the in process inventory is reduced from 1875 to 1228 square feet (Figure 6).

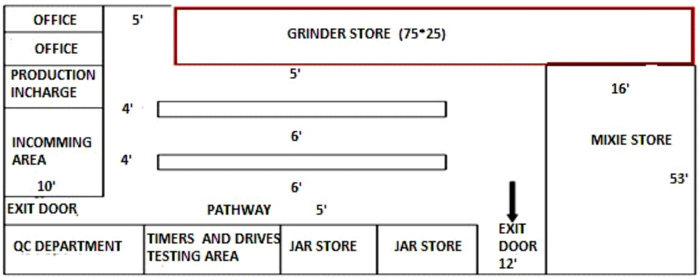

Figure 6. Improved floor area utilisation

Table 3. Effective floor space calculation

Sl. No.	Component name	Quantity to be stored	Floor space required (sq.ft)
1	Drum	900	120
2	Drum for curing	900	468
3	Roller stone	1800	70
4	Shell, base plate	500	265
5	Motor	900	177
6	Grinding stone	900	128
Total			1228

❖ IMPLEMENTATION OF 5S

In order to have better work place organisation, the 5S technique is implemented in the shop floor. Many number of activities are carried out as a part of 5S implementation (Figure 7) and the 5S score obtained is shown in Figure 8.

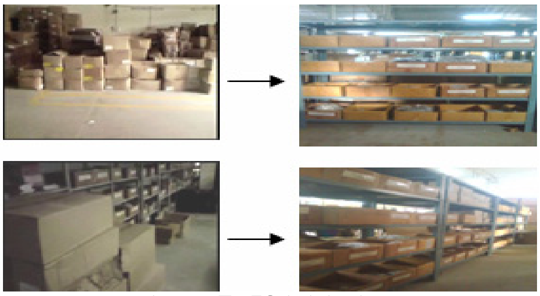

Figure 7. 5S initiatives

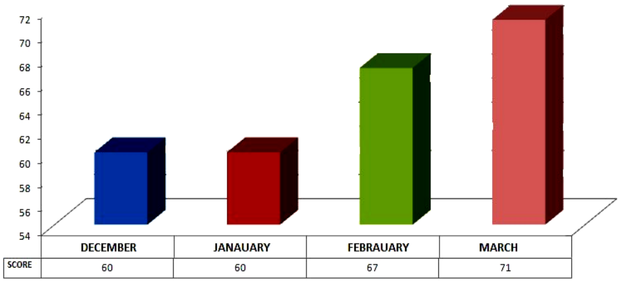

Figure 8. 5S score

❖ ONE-POINT LESSON

As the name indicates, these are some indications on the assembly which insists its purpose in a single line. These are in turn drawn to cover the line worker concentration about the "method of right work". Based on the feedback from experience employees, the lessons are drawn and presented as a picture for visual management throughout the assembly process (Figure 9).

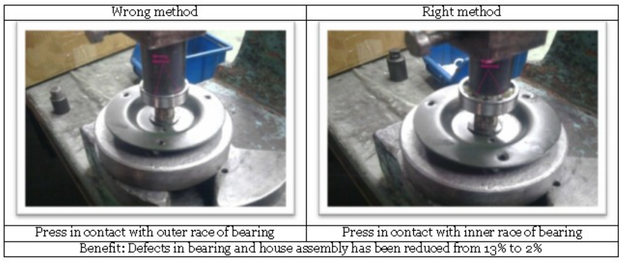

Figure 9. One-point lesson

❖ OTHER IMPROVEMENTS

The calculation of several critical magnitudes (Figure 10) of the assembly line indicates that the lean tools have significantly improved the assembly line performance. Also, the two lean metrics, lean rate and dock-to-dock time have been improved.

❖ RESULTS

Below is a summary of benefits and results obtained after implementing the various lean tools and techniques.

- ❒ Takt time is reduced by 26%.
- ❒ Cycle time is reduced by 8%.
- ❒ The assembly line production is increased by 23%
- ❒ Lean rate is increased from 31% to 43%.
- ❒ Improvement in 5s score
- ❒ Transportation and unnecessary floor space utilisation are reduced

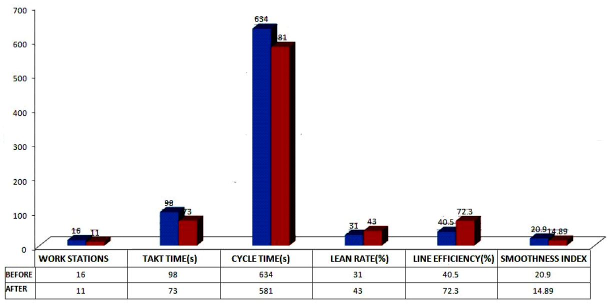

Figure 10. Other improvements and benefits

❖ CONCLUSIONS

This case study carries evidence of genuine advantages when applying lean tools to the manufacturing shop floor. A combination of lean tools is used to analyze, assess and improve the current situation. The effectiveness of lean techniques is substantiated in a systematic manner with the help of various measures. Further more, the benefits of lean are evident from the improved production output.

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