International Journal of Manufacturing & Industrial Engineering – IJMIE
Volume 1: Issue 2 *[ISSN: 2374 -1589]*
Publication Date : 25 June 2014

Investigation of Lean Tools to Enhance the Productivity in Indian Manufacturing Sector

A case study on Lamina Suspension Products Ltd.

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Abstract— The purpose of this work is to implement the lean manufacturing tools in Lamina Suspension Products Ltd. - an Indian manufacturing sector and develop a plan for reducing lead-times and increasing the output. The increase in lead-times due to undefined batch size and poor product flow is causing the manufacturer a loss in market share to its competitors and thus the challenge is to provide qualitative products with reduced lead time. Value stream mapping (VSM) – a lean tool is used to determine areas of potential improvement on the plant floor. The paper concentrates on the production line of main leaf spring. A current state map is developed and analyzed, to pin point areas that have potential for improvement. After analyzing the current map and discussing with the experts, a future state map is created to suggest ways to reduce lead-times and increase productivity/output. The map will include lean manufacturing methods to enhance the productivity and reduce the lead time.

Keywords—Lean manufacturing, Value stream mapping, Producitvity Improvement.

I. *Introduction*

The recent economic crisis that started in 2008 hit most countries to a varying extent. Though the crisis was triggered in the financial sector with the burst of the housing bubble in the U.S., it spread quickly to other countries in most parts of the world and negatively affected growth differentially across sectors of the economies. In particular, the manufacturing sectors and construction industries have been severely affected. This was accompanied by an unprecedented collapse of the world trade and negative impacts on the employment, which manifested in rising unemployment rates especially for low-qualified people. Most of the countries are now recovering from this severe slump [1] and India is one amongst them. A similar but worsened crisis was faced once during World War II especially by Japan and gave birth to a productivity improvement philosophy known as lean manufacturing. Lean manufacturing is a system whose techniques aim to significantly eliminate waste in the manufacturing process.

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Japan had learned management and improvement techniques/methods such as industrial engineering (IE) and quality control (QC) from Europe and America. Those methods were further developed in Japan and resulted in the technique known throughout the world as Kaizen. During this movement, Toyota developed their own unique methods in manufacturing. The concept was completely different from the mass production method [2]. Lean manufacturing has the capability to produce product using the least amount of non-value-adding activities that add time and subsequently cost to the manufacturing process. The lean methodologies include certain mathematical formulas that balance work being performed to optimize the manufacturing resources necessary to achieve customer demand while helping to model the ideal physical layout of the manufacturing shop floor. The methodology provides an objective set of tools for designing manufacturing processes with minimum wait, move and queue time normally embedded in launched and routed shop-order-based systems, regardless of products manufactured or the processes used to manufacture them [3].

II. Value Stream Mapping

Value Stream Mapping (VSM) is one of the key lean tools used to identify the opportunities for various lean techniques since it helps to visualize the hidden waste and sources of waste. A Current State Map is drawn to document how things actually operated on the production floor [4]. Researchers and practitioners have found that focusing on mapping value is a key issue. Several mapping tools have been used for improving and redesigning manufacturing systems making them to become more competitive, flexible and efficient in order to face market economic challenges in their manufacturing environment. A research was conducted to analyse various mapping techniques - their evolution, strengths, weaknesses, key aspects to consider and how they have been adapted to real environments with different characteristics. Among the mapping techniques analysed, it was seen that VSM is an approach that seems to be more suitable in complex working environments where the manufacturing processes involve several subassemblies and complex bill of materials [5]. While VSM helps in identifying the wastes, the secondary tools like Kanban, Heijunka, Kaizen etc are used to eliminate the identified wastes [6] [7] [8].

III. *Company and Product*

A. Company Profile:

Lamina Suspension Products was set up under the technocrat scheme as a private limited company in the year 1976. It was set up as a small-scale industrial unit for manufacture and sale of Automobile Leaf Springs. The capacity has been gradually increased and as on date the unit is having a capacity of 12000 mega tons per annum. The success of the unit is due to the effective marketing network of the company comprising of its own depots located at Madurai, Madras, Vijayawada, Calicut, Goa, Solapur, Indore, Cuttack, Ahmedabad and Hubli. Other channels of distribution are through the distributors, commission agents, own sales representatives and the direct dealers catered by the company and /or by the distributors [9].

B. Product Profile:

The production line of parabolic leaf spring (export model for Volvo truck) was selected, since it was the most profitable and in-high-demand product for the selected manufacturing firm. The detailed company specification of the product is as represented in Table 1 below.

TABLE I. COMPANY SPECIFICATION FOR PARABOLIC LEAF SPRING

Part Number	40-015/257931 P03
Model	Volvo FM-9-400, Front II Axle
Section	100mm x 25mm
Camber	118mm
Painted Color	Grey

C. Process Description

The raw material received from the suppliers is just pushed into the inventory and is ordered randomly. It is then sent to the cutting zone to obtain the required length which is followed by a hot rolling, where the cut bar pieces are heated to a temperature of 910^{o}C in a heating furnace and then rolled using a rolling machine. The rolled bar is then straightened and the excess length is cut. A hole is then drilled at the centre using a manual drilling machine.

This follows the hot grooving and ribbing using a pressing machine and then allowed to cool at the room temperature. Bar is now sent to eye rolling machine, where it is heated on the end area where eye is to be rolled. When heated, it is taken out from the furnace and end taper is cut quickly before it cools down and quickly fed to the eye rolling machine. Full bar is now heated in the closed furnace at 910^{o}C and then pressed at red hot condition in the pressing machine to attain the elliptical profile.

It is then quenched inside an oil bath for about 10-15 minutes after which it is fed to the furnace for tempering. Once tempering is done, it is taken out from the furnace and allowed to cool down to the room temperature. The hardness is then tested sent for a profile correction, wherein the profile of the leaf spring is corrected using a pressing machine. This follows the bushing operation, after which it is sent for the assembly and then the paint shop.

IV. Approach

A. Current State Mapping

The material flow diagram was drawn and the data pertaining to each operations were collected which comprised of cycle time, changeover time, uptime, process lead time, inventory level at each stage mode of operation and number of operators. Figure 1 to Figure 4 represent the various steps in drawing the current state map. Figure 5 represents the exploded view of the calculated production lead time and total cycle time.

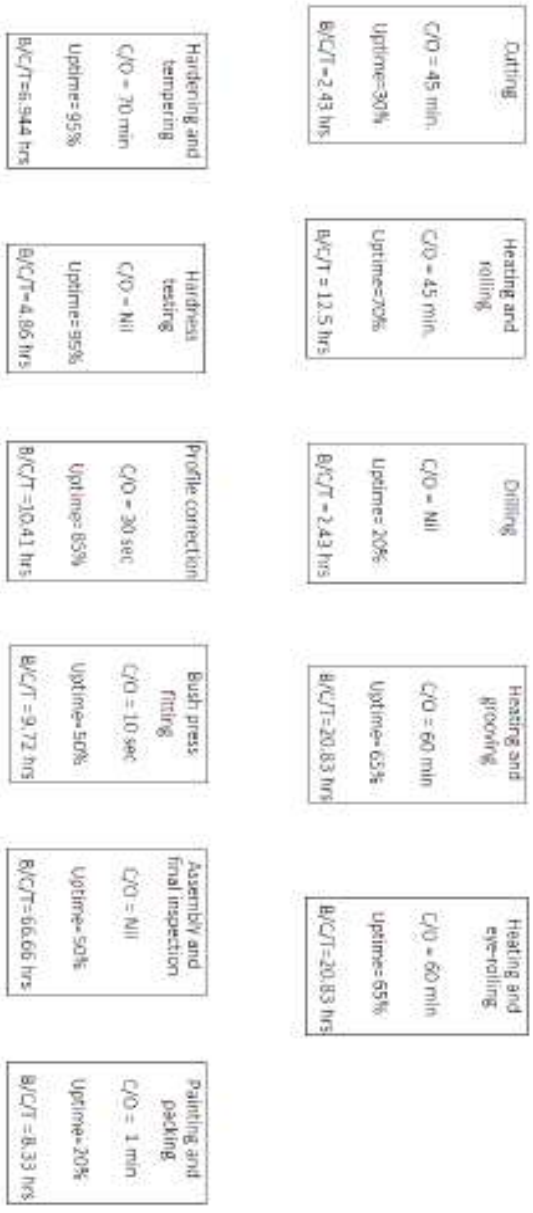

Figure 1. Material flow map with initial necessary data

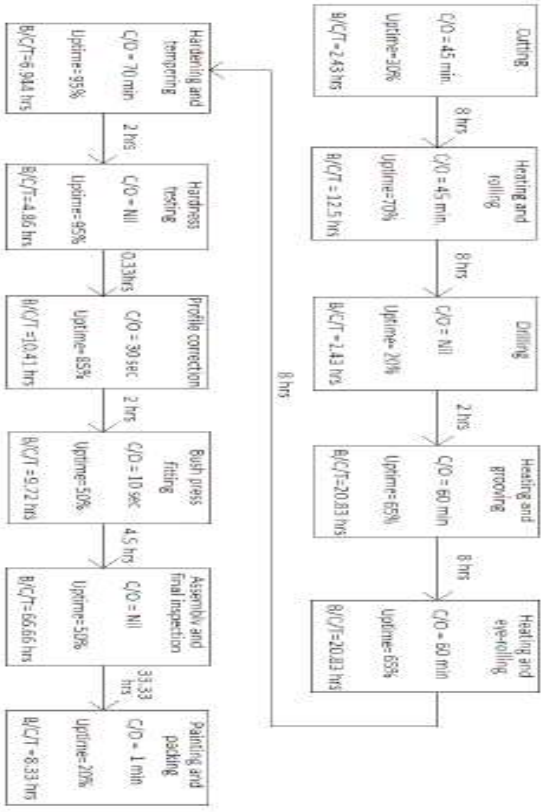

Figure 2. Material flow map with lead times

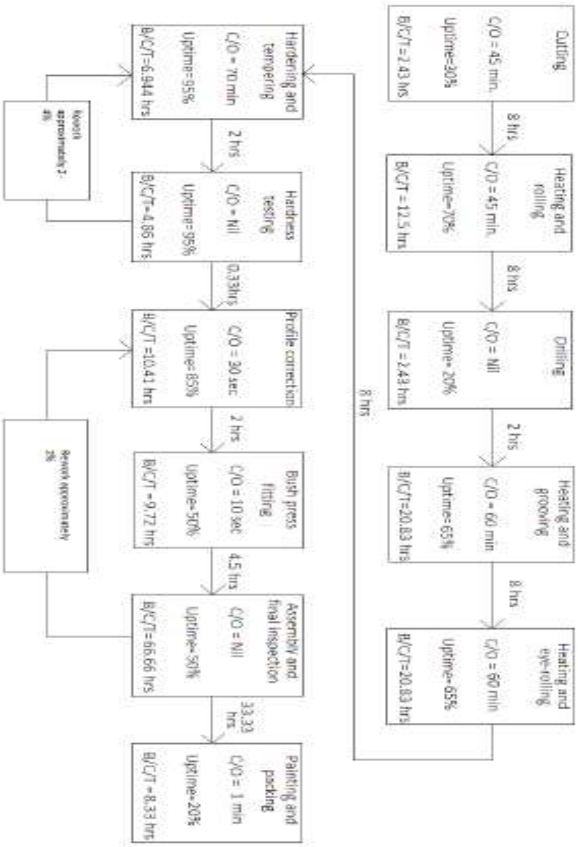

Figure 3. Material flow map with loop backs

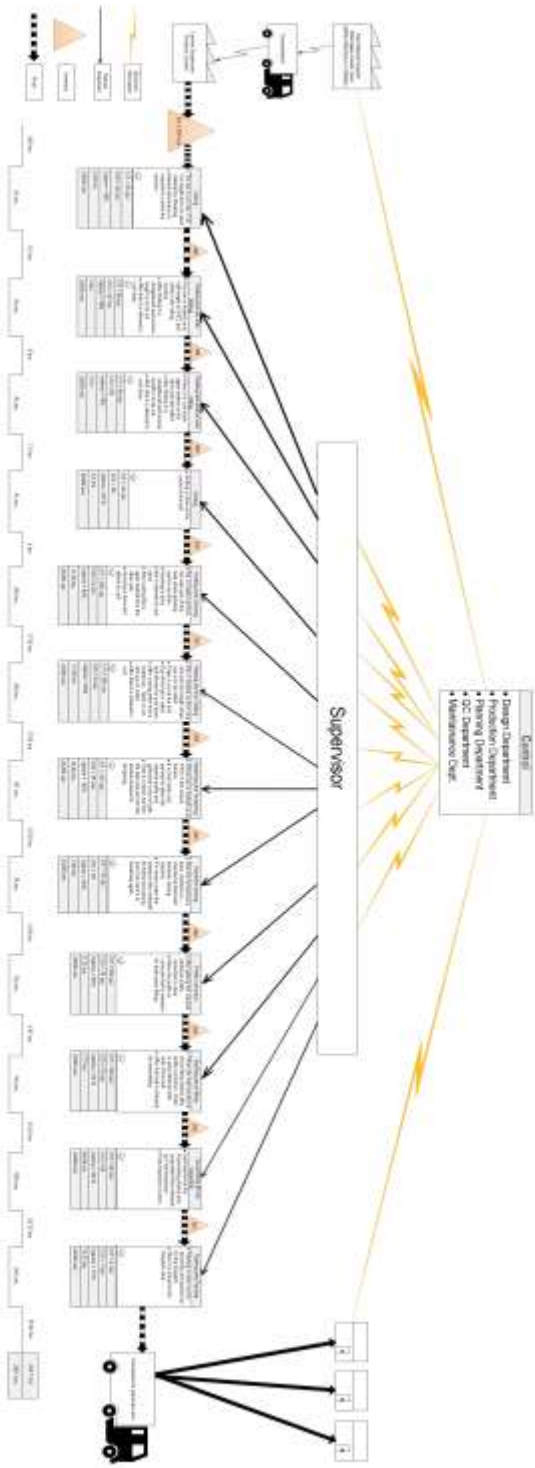

Figure 4. Current state map for the main leaf spring

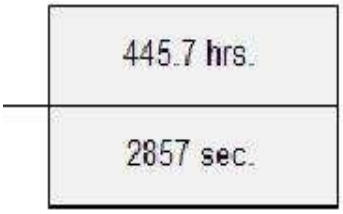

Figure 5. Prodution lead time and cycle time as per current state map (Exploded View)

B. *Analyses*

Each process were studied carefully and with the help of certain standard online calculators, the standard cycle time was calculated and compared with the present ones. Also depending on the conditions prevailing in the selected manufacturing sector, an economic order quantity was calculated. The analysis stage helped in identifying various non-value adding parameters in the production line. Some of the important changes suggested for the production process of main leaf spring are as listed below:

1. The quantity flowing between processes must be 250 rather than 200.
2. In cutting operation the change over time could be reduced from 45 min to 20 seconds.
3. The drilling time for each component could be reduced by 10 seconds.
4. The operating time for heating and grooving process and Heating and eye rolling process could be reduced to the highest level by efficiently using all the 4 machines available rather than overloading 1 machine.
5. The operating time of hardening and tempering operation could be reduced by 49.4%.
6. By reducing the extra movement of workers, the assembly time and the painting time could be reduced by 70% and 50% respectively.

C. *Future State Mapping*

Based on the findings and after the discussion with experts, a conceptual future state map was drawn. Figure 6 depicts the exploded view of the modified conceptual production lead time and cycle time and Figure 7 represents the conceptual future state map.

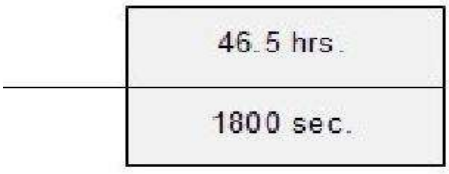

Figure 6. Prodution Lead time and cycle time as per conceptual future state map (Exploded View)

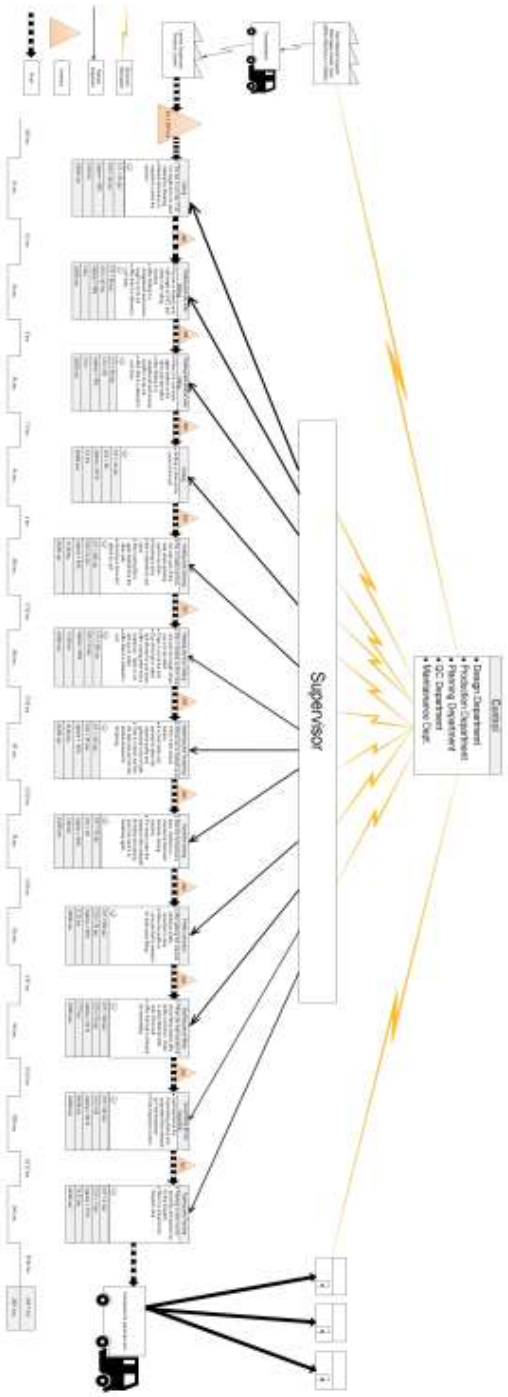

Figure 7. Conceptual future map for the main leaf spring

v. Conclusion

Value Stream Mapping proved to be a great help in understanding the underlying problems of the selected manufacturing sector. Combining VSM with secondary lean tools like Supermarket concept and Kanban, the conceptual result shows that the total cycle time for the main leaf could be reduced from 2857 seconds to 1800 seconds (reduction by 37%) and the production lead time of the main leaf could be reduced from 445.7 hours to 46.5 hours (reduction by 89.57%).

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