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VALUE STREAM MAPPING: POWERFUL TOOL FOR LEAN MANUFACTURING

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ABSTRACT

The purpose of this study is to develop a plan for reducing lead-times and increasing throughput in a product manufacturing plant by using value stream mapping. The plant produces rubber screening media and wear products used in the mining and aggregate industry that is sold throughout the western hemisphere.. The rubber products manufacturer is inefficient because it produces products in batch quantities and has poor product flow due to operations being departmentalized. The increase in lead-times could cause a loss in the market share to its competitors. The rubber products manufacturer must reduce its lead-times in order to remain competitive and continue its growth by providing quality products in a timely manner. A study will be carried out using value stream mapping to determine areas of potential improvement on the plant floor. A current state map will be developed and analyzed to pin point areas that have potential for improvement. A future state map will then be created to suggest ways to reduce lead-times and increase throughput. The map will include lean manufacturing methods to reduce wastes in the system; increasing throughput and reducing lead-times

Key Terms: Lean Manufacturing, Value Stream Map

I. INTRODUCTION

Lean Thinking, a concept that is based on the Toyota Production System, extends continuous improvement efforts to reduce the costs of serving customer/s beyond the physical boundaries of a manufacturing facility, by including the suppliers, distributors and production system that support the manufacturing function [2]. These improvements and cost reductions are achieved by eliminating the muda (wastes) associated with all activities performed to deliver an order to a customer. Wastes are defined as "all activities that consume resources (add costs to the product) but contribute zero value to the customer." According to Womack and Jones, there are five steps for implementing Lean Thinking in an enterprise: 1) Define Value from the perspective of the Customer, 2) Identify the Value Streams, 3) Achieve Flow, 4) Schedule production using Pull, and 5) Seek Perfection through Continuous Improvement. Womack and Jones define a Value Stream as "the set of all the specific actions required to bring a specific product through the three critical management tasks of any business: problem solving, information management, physical transformation". Alternatively, Rother and Shook define a Value Stream as "all the actions (both value-added and non-value-added) currently required to bring a product through the main flows essential to every product" [1].

II. OVERVIEW OF VSM

A value stream is a collection of all actions (value- added as well as non-value-added) that are required to bring a product (or a group of products that use the same resources) through the main flows, starting with raw material and ending with the customer [1].These actions consider the flow of both information and materials within the overall supply chain. The ultimate goal of VSM is to identify all types of waste in the value stream and to take steps to try and eliminate these [1]. While researchers have developed a number of tools to optimize individual operations within a supply chain, most of these tools fall short in linking and visualizing the nature of the material and information flow throughout the company's entire supply chain. Taking the value stream viewpoint means working on the big picture and not individual processes. VSM creates a common basis for the production process, thus facilitating more thoughtful decisions to improve the value stream. VSM is a pencil and paper tool, which is created using a predefined set of standardized icons (the reader is referred to [1]. The first step is to choose a particular product or product family as the target for improvement. The next step is to draw a current state map that is essentially a snapshot capturing how things are currently being done. This is accomplished while walking along the actual process, and provides one with a basis for analyzing the system and identifying its weaknesses. The third step in VSM is to create the future state map, which is a picture of how the system should look after the inefficiencies in it have been removed. Creating a future state map is done by answering a set of questions on issues related to efficiency, and on technical implementation related to the use of lean tools. This map then becomes the basis for making the necessary changes to the system.

III. CASE STUDY: INTRODUCTION ABOUT COMPANY

A VSM emphasizes the requirement for redesigning the production line. It visualizes the whole production line and also identifies waste in the value stream. This tool mainly improves the material and information flow of a production line. The VSM forms a base for implementing the lean techniques and the concepts across the organization. The future plan is to implement the lean tool (VSM) in a well-reputed industry named "XYZ", a well known in the manufacturing of Single Phase Contractors and Submersible Units from the past 8 years. The company spreads over in 21780 sq. ft. area with advanced technology CNC Machines, Hydraulic Presses and Mechanized Silver Plating Plant. The Company has a turnover of 15 crores/annum. The Company has an efficient production infrastructure of Industry knowledge, Motivated Employees and Manufacturing Process. Raw material formulations are optimized by critical in-house testing and standardized for consistent quality and reliability. The component selected for study is contractor. A **contactor** is an electrically controlled switch used for switching a power circuit, similar to a relay except with higher current ratings. A contactor is controlled by a circuit, which has a much lower power level than the switched circuit. A contactor has three components. The contacts are the current carrying part of the contactor. This includes power contacts, auxiliary contacts, and contact springs. The electromagnet provides the driving force to close the contacts. The enclosure is a frame housing the contact and the electromagnet. Enclosures are made of insulating materials like Bakelite, Nylon 6, and thermosetting plastics to protect and insulate the contacts and to provide some measure of protection against personnel touching the contacts. And the manufacturing process to complete the contactor is showing in the following diagram:

Bobin Process → Coil Winding → Coil Moulding

Assembly ← Body Manufacturing ←┘

The Machine Shop of "XYZ" is facing problems of delay in delivery process, improper utilization of workforce and higher WIP inventory which lead to poor quality and more input cost and hence reduce profitability. The problem consists of an existing traditional manufacturing system of Machine shop. Machine shop has; hydraulic presses, Copper winding m/c's, CNC's. Parts have to be transferred from machine to machine to complete the required operations. This arrangement increase material handling cost and decreases labor productivity. These results in delay of orders, which further disturb the overall, schedule at floor shop and affect the production of machine parts. Although the plant has the ability to produce more than they are producing, it is having following limitations: Lower quality, Less labor productivity, More Waiting times, Large WIP, Longer material movement. To overcome these limitations there is a need to identify the key areas, which are producing trouble and wastes, and to identify bottleneck operations at shop floor.

Table -1: Processes and their Attributes for Contractor

Process	Attributes	
Bobbin process **Done on a manual hydraulics press**	Cycle time	70 sec's
	Change over time	30 mins
	No. Of shifts	02
	No. Of operators	01
Coil winding **Done on a copper winding machine**	Cycle time	39 sec's
	Change over time	05 mins
	No. Of shifts	02
	No. Of operators	01
Coil Moulding **Done on a automatic hydraulic press**	Cycle time	46 sec's
	Change over time	10 mins
	No. Of shifts	02
	No. Of operators	02
Body Manufacturing **Done on a automatic hydraulics press**	Cycle time	62 sec's
	Change over time	10 mins
	No. Of shifts	02
	No. Of operators	01
Assembling	Cycle time	90 sec's
	Change over time	Ø
	No. Of	02

	shifts	
	No. Of operators	02

Table- 2: General Data of Company

Work time	26 days in a month. 2-shift operation in all production departments. Eight hours every shift. 30 mins break during each shift. Manual processes stop during breaks.
Production control department	Receives a 2-month forecast from the Customer. Loads forecast in MRP. Issues 2 week forecast to Supplier. Generates weekly department schedules through MRP. Issues weekly shipping schedule to shipping
Shipping	Remove parts from finished goods warehouse and stages them for truck shipment to customer.

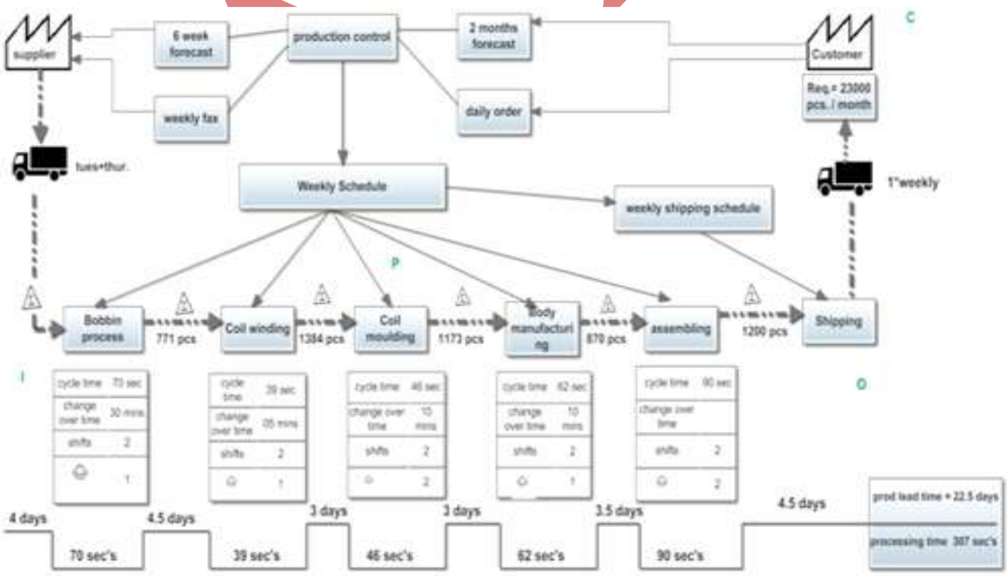

Fig -1: Current State Map

IV. ANALYSIS OF CURRENT STATE MAP

Concepts of value stream provide a picture of the current state of affairs as well as a guide about the gap areas. Thus it helps in visualizing how things would work when some improvements/ changes are incorporated.

Describing and defining the future state map actually starts while developing the current state map, where target areas for improvement begin to show up. Following gap areas were observed from the current state map of electrical contractor:

1. WIP inventories between various operations are considerably high.
2. Station cycle time variation is more, which lead to production imbalance and WIP inventories on the shop floor.
3. Production lead-time is quite high.
4. Production in the plant is below the installed capacity as per the data of PPC department.
5. Improper utilization of workers.
6. Long distance is covered by products in the plant as revealed by the study of Plant Layout.

By reducing inventory, we may attain on-time completion of orders and can automatically improve quality. e.g. reducing work in process will reduce the amount of defects to be reworked, which in turn will improve quality. Also less WIP means that tracing the root cause of a defect will be easier.

KEY QUESTIONS THAT CONVERTS THE CVSM TO FVSM

1Q: What is the Takt Time of “XYZ”?

The Takt time is the demand rate and consequently the time between completions of each product off of the production line. It is first necessary to find the available capacity of the production line.

Takt time can be first determined with the formula:

{T= Ta/Td}

Where:

T = Takt time, e.g. [minutes of work / unit produced]

T_a = Net time available to work, e.g. [minutes of work / day]

T_d = Time demand (customer demand), e.g. [units required / day]

Net available time is the amount of time available for work to be done. This excludes break times and any expected stoppage time (for example scheduled maintenance, team briefings, etc.).

Takt Time of “XYZ”:

1. Customer requirement = 23000 products/month.
2. No. Of working days = 26
3. No. Of shifts= 2
4. Time available in each shift = 8 hrs. = 28000 sec’s.
5. Time for breaks or non-working time per shift = 30 mins = 1800 sec’s.
6. Net available working time per shift = 28000 – 1800 = 27000 sec’s.

Therefore, **Takt Time = 27000 sec’s ÷ 442 units per shift = 61 sec’s.**

What this takt number means is that to meet customer demand within its available work time, the company needs to produce a contractor in every 61 seconds.

2Q: Will we ship directly to the customer, or to a finished goods warehouse?

The contractor can wait a long time in the warehouse before being shipped. Even though the contractor are bulky, it is believed that Company “XYZ” should produce to a supermarket (warehouse); moving the contractor is not a significant issue due to the existence of the contractor being stored on moveable trolleys. The Company "XYZ" should designate an area at the warehouse (which would be called the supermarket) and store the contractor based on a kanban system. Whenever the supermarket inventory is below a certain level this would trigger the assembly line to replenish the supermarket according to the level set at the super market.

3Q: Where can we use continuous flow?

Continuous flow is producing products using a batch size of one. This is a very efficient means of production since no inventory is created between process steps. An automobile assembly line is generally an example of continuous flow.

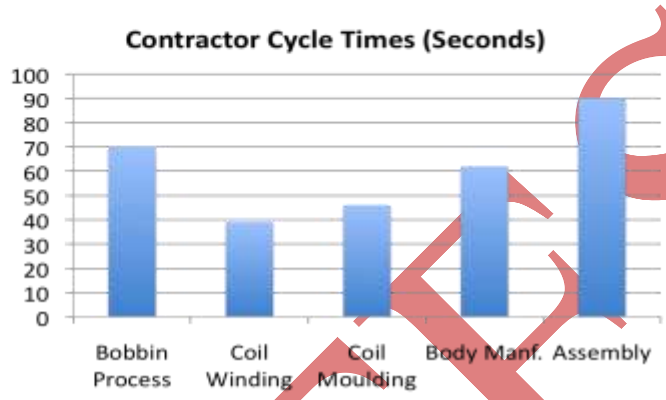

Chart -1: Operator Balance Chart

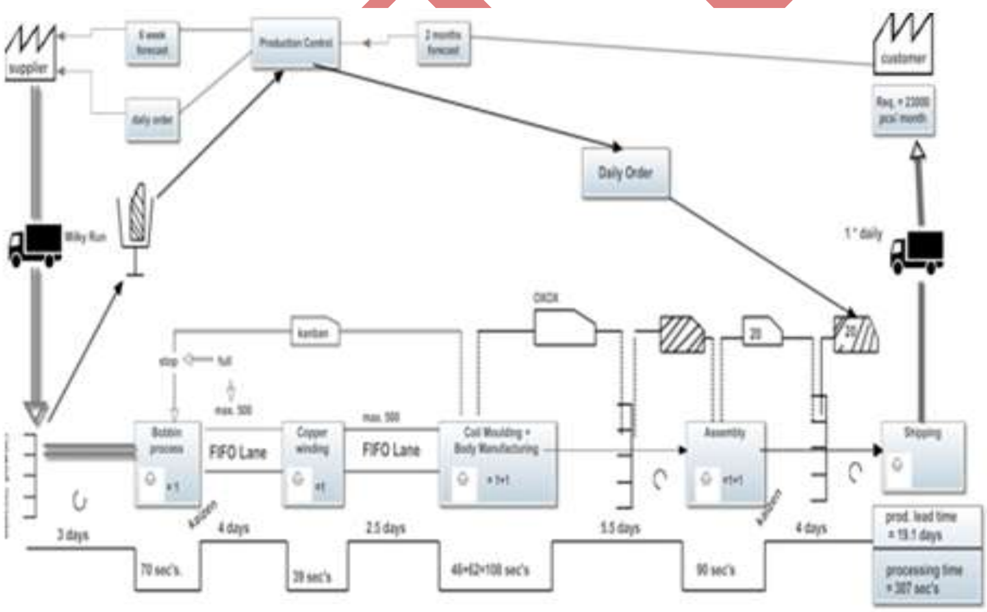

Fig -2: Future State Map

In this case of contractor the coil moulding process and body manufacturing process are done on the same machine (automatic double hydraulic press), and as shown in the operator-balance chart the cycle time of both the processes are near to each other. These two workstations are dedicated to contractor product family, so continuous flow in production line certainly is possibility. Notice that in Future state map the two coil moulding and body manufacturing processes boxes are combined to one process box to indicate the continuous flow. Also Examine the Questions like "Where to use Pull System" , the company has the Future State Map showing next:

V. CONCLUSION

Future state proposed to the Company "XYZ" removes large amount of waste.

Thus increase in productivity and efficiency, which results in increase in profit. This can be seen in the following table which compares previous status and status after future implementation for electrical contractor.

Table -1: Comparison Between Previous And Proposed Condition

	Before	After
Production lead time	22.5 days	19.1 days
No. Of operators	07	06
Total Cycle time	307 sec's.	307 sec's.
Change over time	55 mins.	35 mins.

It is seen that VSM tool proves a useful technique for global competitiveness environment. It provides a company with a "blueprint" for strategic planning to deploy the principles of Lean Thinking for their transformation into a Lean Enterprise.

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