Reduction of Wastage Using Value Stream Mapping: Case Study

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Abstract
The fundamental attention on lean production is the organised elimination of non-value added activity and waste from the production process. The acomplishment of lean principles and methods results in improved system and surrounding performance. Value stream mapping is used to first map the current state used to identify sources of waste and to identify lean tools to eliminate this waste. The future state map is then developed for a system with lean tools applied to it. VSM is a pencil and paper visualization tool that shows the flow of material and information as a product makes its way through the value stream. VSM serves as a starting point to help management, engineers, suppliers, and customers recognize waste and its sources. This paper demonstrates the implementation of lean philosophy through layout modification.

Keywords
Lean Manufacturing, Value Stream Mapping

I. Introduction

Value stream maps should imitate what actually happens rather than what is supposed to happen so that opportunities for improvement can be identified.
Value Stream Mapping is often used in process cycle time improvement projects since it demonstrates exactly how a process operates with detailed timing of step-by-step activities. It is also used for process analysis and improvement by identifying and eliminating time spent on non value-added activities
The lean movement started in the automotive industry (Womack et al., 1990) and has since been widely applied in discrete manufacturing. However, extensions to the (semi-) process industry have been much slower.
Companies in several industries are implementing lean practices to keep pace with the competition and achieve better results. In this article, we will focus on how companies can improve their inventory turnover performance through the use of lean practices.
The main purpose of LM is to satisfy customer needs on the highest possible level through the elimination of waste. Some sources of waste are overproduction, faulty products, sub-optimized processes, unnecessary waiting, movement or transportation, and excess inventory.
In factories using lean manufacturing, large machines characteristic of batch-and-queue processes (typically referred to as ''monuments'') are often no longer aligned with lean work cells and are not needed or desired. Instead, smaller more flexible machines are typically organized into work cells dedicated to the production of a family of products. Workers then operate the machines in the cell to minimize the cycle time for a family of products, minimize inventory, and maximize value.
VSM is an activity improvement technique to visualize an entire production process, representing information and material flow, to improve the production process by identifying waste and its sources.
A value stream map provides a plan for implementing lean manufacturing concepts by illustrating how the flow of information and materials should operate.

II. Theory

A VSM, both current and future state, is created using a pre-defined set of icons (shown in fig. 1). VSM creates a common language about a production process, enabling more purposeful decisions to improve the value stream.

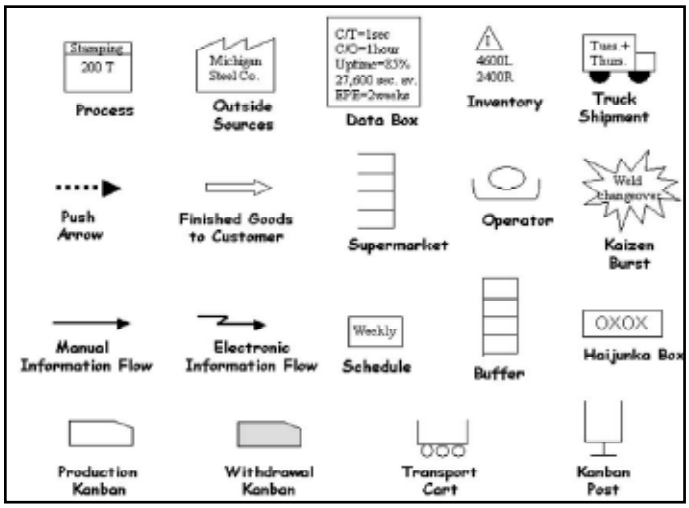

Fig. 1: VSM Icons

Lean production combines the advantages of craft and mass production, while avoiding the high cost of the former and the rigidity of the latter. Towards this end, lean producers employ teams of multi-skilled workers at all levels of the organization and use highly flexible, increasingly automated machines to produce volumes of products in enormous variety.
Lean production is lean because it uses half of every-thing that mass production uses Ð 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 half the time.
The major purposes of the use of lean production 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 production 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.
The fundamental of lean production is to identify and eliminate wastes, all work of an enterprise can classified into three parts, the first is value-added work includes essential activities that add value to a project in a way the customer is willing to pay for. The second is incidental work includes the auxiliary activities that don't necessarily add value, but must be done to support value-added work.

The third is non value-added work or waste includes non-essential activities that add time, effort, cost, but no value, which we are familiar in production site that has not implemented lean production including superfluous inventory, unnecessary transportation, waiting, excess processing, wasted motion and products with defects.

Value stream mapping helps us understand where we are (Current State), where we want to go (Future State) and map a route to get there (Implementation Plan), which can create a high-level look at total efficiency, not the independent efficiencies of individual works or departments, visually show three flows - material flow, product flow and information flow to identify improvement opportunities, and help identify applicable lean improvement tools and plan for deployment.

III. Methodology

Steps to apply VSM-

A. Identify Product Families

Usually, an enterprise manufactures products different in volume and variety according to business environment.

So the first step is to identify product families by matrix methods, namely, to classify products into different product families according to formula (1), which is the basis for applying VSM. Generally, total work content for producing one part should be within 25 to 30 percent (range) of all other different parts in one product family.

(Highest value-Lowest Value)/highest value ….(i)

For example:

(20 – 10) ÷ 20 = 50% (out of range)

(14 – 10) ÷ 14 = 29% (within range)

B. Analyze Business to Prioritize Product Families and Selected One to Implement LP

After identifying product families, we should prioritize them according to their size, share of the business contribution to the net profit, criticality for the business, market position, technology outlook, potential for gainful growth, expected impact from lean and resource requirements, etc. Then we select a product line at a time to implement lean production according to the prioritization.

C. Draw Current State Map of the Selected Product Line and Analyze the Whole Process for Improvement

We should walk the process on the spot to gather first-hand and practical information required for a good VSM and effective deployment of lean production, by doing so we can avoid fighting only on paper. Then we ask questions on each element of VSM and begin to draw current state map with a pencil and a piece of paper from the customer, the shipping end, and work upstream through the process.

D. Draw Future State Map

The bursts in current state map show us improvement direction, so we need to make preparations for future state map. We summarize several principles practically used for drawing future state map.

1. Combine process steps : Lean production require processes done in one activity by one person in one place, or even better, at one time with no human intervention. We should be "reluctant" in adding activities and resources to the process. When design a process so one person can move through it and efficiently perform all the work elements, we should combine process steps by avoiding isolated islands of activity, minimizing material and information between processes, eliminating excessive walking, therefore to reduce cycle & total lead time.
2. Adopt continuous flow to build speed Continuous Flow Manufacturing (CFM) means processes flow smoothly through all operations without stopping, which increases production speed
3. Think parallel not linear layout: When study the layout of a production line, we should consider building it in parallel to realize make-one-move-one that save space and eliminate waste of operators' unwanted walking.
4. Reduce sources of variation by 6 sigma management 6sigma management has gotten great success in many well-known companies such as GE and Motorola. We suggest adopting DMAIC (define, measure, analyze, improve and control) method of six sigma management to eliminate waste associated with adding spare capacity and contingency into processes to reduce variation and improve process efficiency.
5. Re-design a process: Re-designing a process for a future state map requires participants who can step back and look at the process with a fresh set of eyes. And, ask ourselves how we would design this process if it had no restrictions. We need to be visionary, system-level thinkers that can see the total flow as it cuts across functional boundaries. Most often, these are management type, with no direct connection with the current process.

E. Implement Future State

If we don't make great effort to realize future state, the map is meaningless at all. We propose steps for an enterprise to implement future step designedly.

IV. Observation

A. Preparation of Current State Map-

The data box envelopes the following data like cycle time, change over time, up time and available time. Readings are taken on product (steel handle) on which various operation performed.

The data are collected by means of the stop watch time study and interviews of manager as well as workers. The cycle time was recorded more than one time (12 times) if it is less than 30 seconds. Then the average cycle time was calculated for construction of value stream mapping.

Table 1: VSM Data (Current State Map)

Operation	WIP	Cycle Time(sec)	Changeover Time(sec)
Cutting	200	24	4
Centering	150	6	14
Drilling	550	58	20
Tapping	600	86	18
Cutting	200	26	4
Milling	375	48	6
Polishing	75	4	4
Inspection	450	60	2
Welding	125	6	6
Polishing	250	22	4
Inspection	450	41	2
Packing	200	17	17

Table 2: Inventory

Raw material	1500
WIP	3625
Finished goods	600
Total	5725

Available time =9*60*60 - 1*60*60 =28,800 sec.
Customer order = 15000/month
Dispatch = 4000 weekly
Production/day = 600
(1). TAKT Time
= Net available time/customer demand
=28800/15000/26(per shift)
=50seconds
(2). No. of work station required
= line cycle time/TAKT Time
=398/50 =7.96≈ 8
(3). Lead time = LCT+∑ IT +TT
= 398+3600/600 + 7*24*60*60/4000
= 555sec.
where LCT= Total Line cycle Time
IT = Idle time
TT = Transportation Time
Bar Chart : According to above datas the bar chart is shown as below-

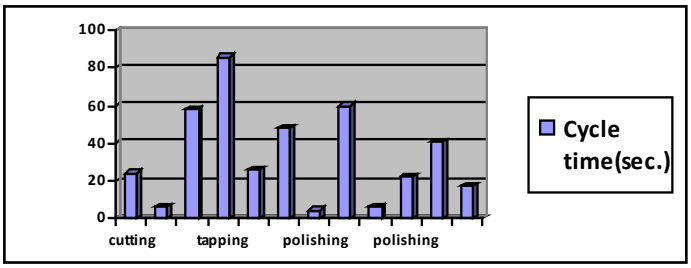

Fig. 2: Machine Statistics

II. Proposed Map

From the above bar chart it is clear that the two processes, drilling and tapping takes more seconds as cycle time compared to takt time 50 seconds. These two processes need more intension. To reduce the cycle time of these processes company should increase workers as well as machines to achieve cycle time near takt time.

Table 3: VSM Data (Proposed Map)

Operation	WIP	Cycle Time(sec)	Changeover Time(sec)
Cutting	200	24	4
Centering & drilling	550	48	20
Tapping	600	48	18
Cutting	200	26	4
Milling	375	48	6
Polishing & Inspection	75	4	4
Welding	125	6	4
Polishing, inspection & packing	250	22	4

Table 4: Inventory (Proposed)

Raw material	1500
WIP	2375
Finished goods	0
Total	3875

Lead Time = LCT + ∑IT +TT
= 226 +6 + 151
=383sec.

V. Results

We observed From this analysis –

- No. of work station reduced to 12 to 8.
- WIP inventory reduced to 1250 units
- Finished goods inventory also reduced by 600 units.
- Lead time is reduced by 172 seconds.

Management says that lean manufacturing is highly effective, but it is not the case of all product range. There are some barriers in implementing lean manufacturing. The main barriers in implementing Lean Manufacturing found in survey are:

- Company culture
- Frequent changes in designs and products
- Inconsistent market demand
- Lack of senior management commitment
- Investment cost
- Inability to quantify benefits
- Lack of communication and Lack of understanding on LM concepts.

Beside these barriers some driving forces are there which motivated companies to implement Lean Manufacturing. The main driving forces are:

- To increase market share
- Government subsidies
- To increase flexibility
- Need for survival from internal constraints
- Development of key performance indicators
- Desire to employ world best practice
- Part of the organization's continuous programme and drive to focus on customers.

VI. Conclusion

We observed from this paper that VSM is an ideal tool to expose the waste and to identify improvement areas. It helps the companies to reach their ultimate goal of sustainability and profitable growth in the future.

The case study on Value Stream Mapping shows that it is very useful lean manufacturing tool for companies in being able to visually see how the entire production process worked, as well as seeing how the individual processes worked. By being able to combine information and material on one map, this allowed us to see where the big issues were in regards to lead time. We will able to then analyze the big issues and make recommendations to remedy these problems.

This study has provided important insights into the current status of lean manufacturing implementation in the small industry in Jaipur, as well as highlighted some associated issues. Firstly, the respondent companies' involvement in lean manufacturing implementation has been discussed. The companies are found to have not a good understanding of Lean Manufacturing. Only 37% companies are aware about Lean Manufacturing which is a very small figure.

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