INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume3, Issue2)

Value Stream Mapping On Gear Manufacturing Company

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Abstract: Lean manufacturing is being followed by various organizations over these few decades. Lean manufacturing is started in many companies in order to enhance manufacturing practice change which mainly focuses on improving the efficiency of operations by eliminating and reducing wastes. Value Stream Mapping (VSM) is one of the key lean tools used to identify the opportunities for various lean techniques. The contrast of the before and after the LP initiatives in determine managers potential benefits such as reduced production lead-time and lower work-in-process inventory. As VSM involves in all of the process steps, both value added and non-value added, are analyzed and using VSM as a visual tool to help see the hidden waste and sources of waste. A Current State Map is drawn to document how things actually operated on the production floor. Then, a Future State Map is developed to design a lean process flow through the elimination of the root causes of waste and through process improvements. An Implementation Plan then outline details of the steps needed to support the LP objectives. This paper demonstrates the VSM techniques and discusses the application in an LP initiative on a product case study.

Keywords: Lean, Value Stream, Super Market Pull System, Kaizen, FIFO System.

1. INTRODUCTION

This paper is a case study explaining about the successful implementation of lean manufacturing tool and techniques in the development and implementation of gear manufacturing system at the case industry plant. Gear manufacturing is the critical process and it involve nine operation starting from facing to till shipping. The focus of the company is to reduce the cost by eliminating non value added activities via applying a management philosophy which focus on identifying and eliminating waste from each step in the production chain respective of energy, time, motion and resources.

Lean enterprise or lean production, often simply, Lean is centered on preserving value with less work. Lean manufacturing is a philosophy derived mostly from the Toyota Production System (TPS) and termed as Lean in the 1990 (Womack, James 1990). TPS is renowned for its focus on reduction of the original Toyota seven wastes to improve value for the customer. Waste is anything other than the minimum amount of equipment, materials, parts, space and worker's time which is essential to add value to the product. (Toyoda 1959). Toyota's view was focused on the reduction of main three types of waste which are Muda (non-value-adding work), Muri (overburden) and Mura (unevenness)...The company is planning to implement the 5's' system in its first plant. Thus so as to compliment the first plant , we visited to the company to implement value stream mapping for plant producing of planetary gear of size '3' ,which is being manufactured in the first unit of company. The size '3' planetary gear manufactured in company is used to produce the final product of planetary gear box with the help of sun gear.

Company manufactured 7 types of planets of standard sizes 1,2,3,4,5,6,7 .These standard sizes have again different sub types. 'KT 06' model have 5 types-

Table: Planet size/ Ratio & No of Teeth Table

Sr. No.	Sizes/Ratio	No Of Teeth
1	7.2 size planet	25
2	5.43 size planet	24
3	4.44 size planet	22

2. PROBLEMS IN EXISTING SYSTEM

The following wastages were identified in the current system of gear manufacturing production process;

- High additional processing time.
- Consumes more resources.
- More inventory.
- More scrap.
- High cycle time.

3. METHODOLOGY

Value stream mapping (VSM)

VSM is a lean manufacturing technique used to map the flow of materials and information required to bring a product to a consumer. VSM was initially developed in 1995 to help researchers to identify waste in value streams and improvement areas. It also finds an appropriate route of waste removal. It tracks flow of materials starting from customer delivery and goes back through the entire production process. It documents all the process graphically and also collects the data. Finally it results in a single page map called Value stream which contains data such as cycle time, change over time, work-in-process (WIP) levels and number of operators.

VSM presents the relationships between the manufacturing processes and the controls used to manage these processes, such as production scheduling and information exchange. VSM is about eliminating waste, even in information flow. Whilst value stream mapping is more complicated to construct than other process maps; it has the benefit of containing much more information than a standard map. Due to the competitiveness and the challenges of present markets, manufacturing companies need to redefine and redesign their production systems VSM enables a company to see the entire process in both its current and desired future state. . VSM is a visual presentation of the entire value stream from customer order entry through purchasing, manufacturing and shipping of the finished product in a facility. VSM is used to map a production process or entire supply-chain networks.

With regard to the VSM application process, it is based on four phases put into practice:

(1) Selection of a product family
(2) Current state mapping
(3) Future state mapping
(4) Formation and achievement of the work plan for future state.

4. THE CURRENT STATE MAP

4.1 Level of Mapping

Developing a future state begins with an analysis of the current production situation. This section shows you how to create a "current-state map" using a simple example factory we call Acme Stamping. Mapping begins at the level of the door-to-door flow in your plant, where you draw process categories like "assembly" or "welding," instead of recording each processing step.

We use a set of symbols, or "icons," summarized inside the back cover of this workbook, to represent processes and flows. You can develop additional icons of your own, but keep them consistent within your company so that everyone will know how to draw and understand the maps that you need to institute lean manufacturing. Once you see the overall flow through the plant, you can change the level of magnification; zooming in to map every individual step within a process category, or zooming out to encompass the value stream external to your plant.

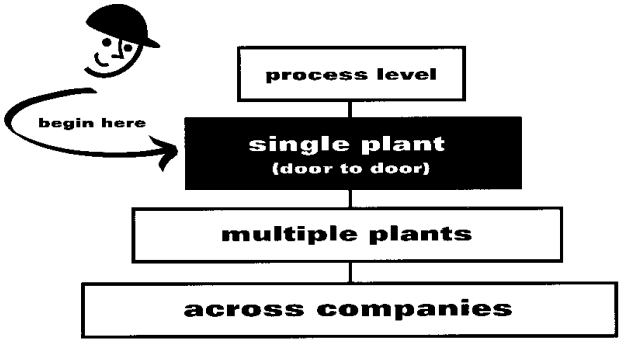
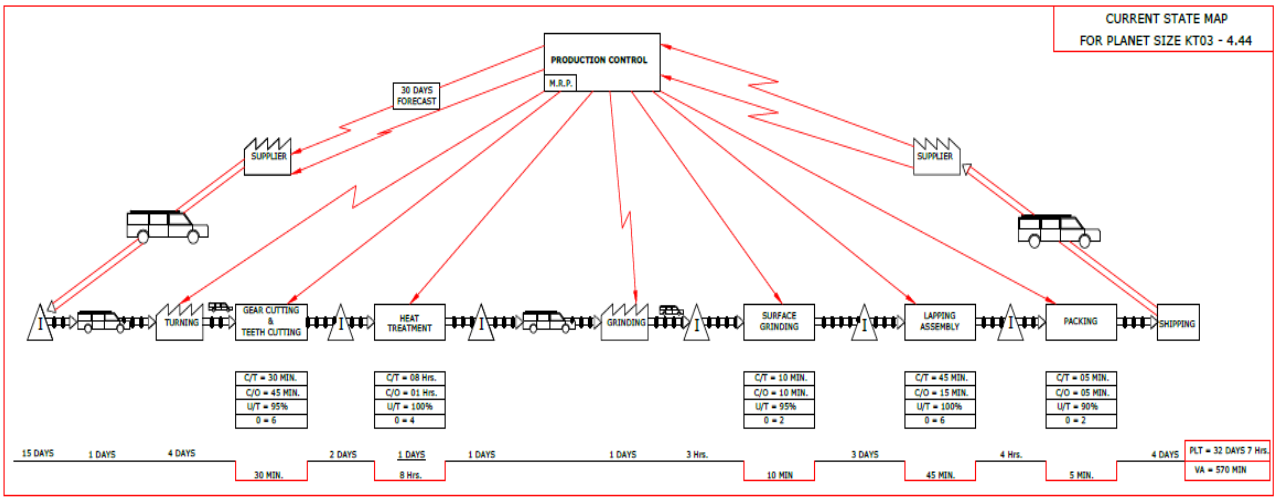


Fig. Levels of mapping the value stream for a product family

There is a standard process to follow when current state map which usually follows these steps.

- Determining what function is to map (e.g. Manufacturing process).
- Sequentially drawing the process flow.
- Adding the material and information flow.
- Collecting and adding process data (e.g. times, inventory) to the map.
- Verifying the map.

4.2 CURRENT STATE MAP



4.3 Current state map calculation

Value Added Time (VA) = 9hrs 30 min, Non Value Added Time (NVA) =32 days 7 hrs

Production Lead Time = Value Added Time (VA) + Non Value Added Time (NVA)

= 9 hrs.30 min. + 32 days 7 hrs. = 32day, 16 hrs. 30min.

Store inventory = 3 Day

4.4 Process Information

1 Testing

- The part of material is cut & sends to the Laboratory for inspection at Aurangabad.
- The report is received after 4 days of sending material. This is to be inspected & send for turning.

- **Turning**
  - After getting the result of inspection the material is send to outside vendor for turning.
  - 30% for work is done from vendor and remaining 70% is done at the plant.
- **Gear Teeth Cutting**
  - Manual process with 6 operator
  - Cycle Time: 30 min.
  - Changeover time: 45 min.
  - Reliability: 95%
- **Heat Treatment**

  Heat treatment is carried out at backside of Automation plant using induction furnace.

  There are 4 operators working in heat treatment plant.
  - Cycle Time: 8 hrs.
  - Changeover time: 1hr. 10 min.
  - Reliability:100%

- **Grinding**

  After heat treatment the planet are send to the vendor for grinding.

- **Surface Grinding**

  After heat treatment the harden planets are surface grinded using surface grinding machine.
  A batch of 20 is grinded at a time.
  - Manual process with 2 operator
  - Cycle Time: 10 min.
  - Changeover time: 10 min.
  - Reliability: 95%

- **Lapping & Assembly**
  - Manual process with 6 operator
  - Cycle Time: 45min.
  - Changeover time: 15 min.
- **Painting & Packaging**
  - Manual process with 2 operator
  - Cycle Time: 5 min.
  - Changeover time: 5 min.
  - Reliability:100%

5. FUTURE STATE MAP

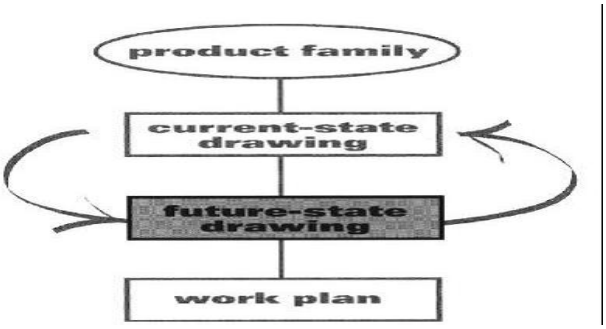
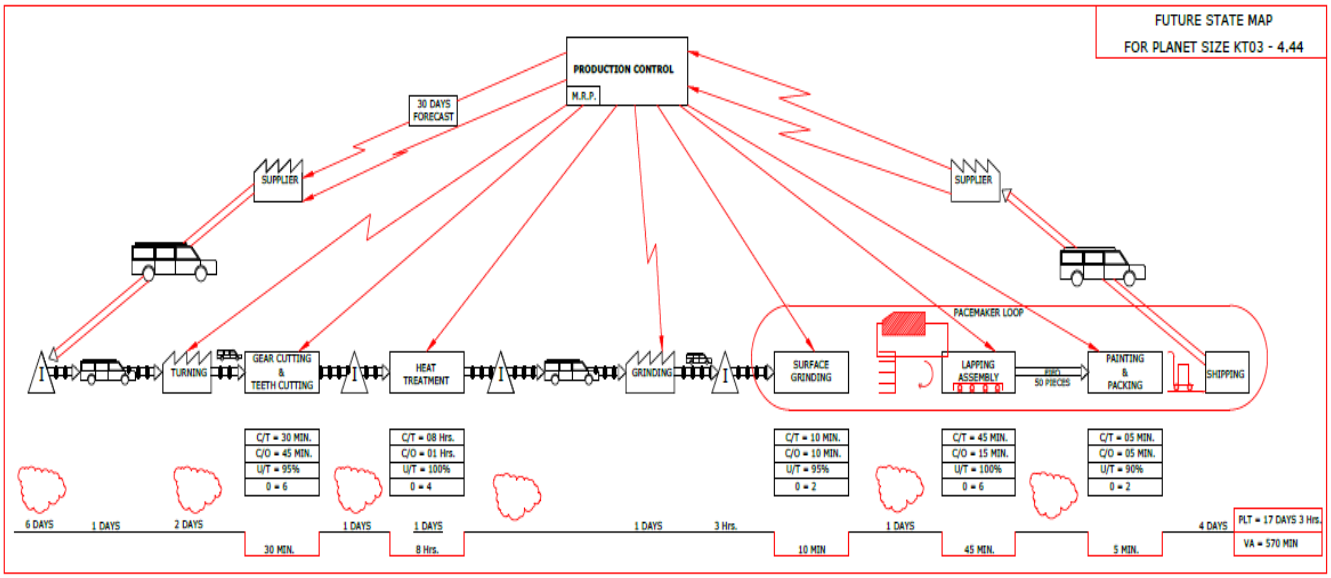


Fig. Future state map

The purpose of value stream mapping is to highlight sources of waste and eliminate then by implementation of a future-state value stream that can become a reality within a short period of time. The goal is to build a chain of production where the individual processes are linked to their customer(s) either by continuous flow or pull, and each process gets as close as possible to producing only what its customer(s) need when they need it. Assuming you are working at an existing facility with an existing product and process, some of the waste in a value stream will be the result of the product's design, the processing machinery already bought, and the remote location of some activities. These features of the current state probably can't be changed immediately. Unless you are involved in a new product introduction, the first iteration of your future-state map should take product designs, process technologies, and plant locations as given and seek to remove as quickly as possible all sources of waste not caused by these features. (With the exception of minor purchases think, "*What can we do with what we have?*") Subsequent iterations can address your product design, technology, and location issues.

We have found that the most useful aid for helping people draw future-state maps is the following list of questions. As you develop your future-state concepts, answer the questions in roughly the following order. Based on your answers to these questions, mark you future-state ideas directly on your current-state map in red pencil. Once you have worked out your future-state thoughts in this way, you can draw a future-state map.

5.1 FUTURE STATE MAP



5.2 Future state map calculation

Value Added Time (VA) = 9hrs 30 min.
Non Value Added Time (NVA) =17 days 3 hrs.
Production Lead Time = Value Added Time (VA) + Non Value Added Time (NVA)
= 9 hrs.30 min. + 17 days 3 hrs.
= 17 days, 3 hrs. 30 min.

Q.1) TAKT TIME

"Take time" is how often you should produce one part or product, based on the rate of sales, to meet customer requirements. Takt time is calculated by dividing the customer demand rate per shift (in units), into your available working time per shift (in seconds).

TAKT TIME CALCULATION

Total time available in one shift = 60* 8 Hr (In min.) = 480 min,
Lunch break = 30 min, Tea break = 20 min,
Total working time available = Total time – (lunch break +tea break) = 480-(30+20) = 430min
Daily demand = 400 (approx.) units
There are 2 working shifts in company, so per shift demand = 400/2= 200Units

Takt time result = 129 sec.

- Customer is buying this product at the rate of one every 129 sec.
- Target rate for producing product and its components.

Q.2) How 15 days of testing are reduced to 6 days in future state map?

Ans- When the raw material is received from vendor, the material is first kept for seven days during which material is sent to testing lab to check the quality & metallurgical properties. Material sample is cut & send to testing laboratory. Material is tested in laboratory & report is send back within 3 to 4days. Within next 4 days the tenders of the vendor for turning is received & optimum vendor is selected for turning. 30% of material (Rods of large dia.) is given to vendor for turning & remaining 70% is turned in the shop.

In future state map improvement is proposed as sample must be send and received within six day for testing. For it the testing result must be fast & duration must be four days during which vendor for turning must submit their tenders. The selection of vender for turning should be taken within one days & material must be send.

Q.3) How 4 days are reduced into 2 days in between turning & gear cutting?

Ans-Current State Map-After receiving turned part from vendor the material is inspected. The time required for inspection is 1 day. After inspection work pieces are again send to vendor for gear cutting & teeth cutting operation. The time duration for whole process from sending to receiving with in-house working is 3 days.

Future State Map-The proposed alternative is that the material must be inspected & send to vendor for gear & teeth cutting. Within 1 day the material must be send back after doing operation on next day. Thus we can save 2 days.

Q.4) How 2 days are reduced into 1 day in between gear cutting & heat treatment?

Ans-Current State Map-After material is received from gear cutting & teeth cutting process the inspection of that material takes 1 day. After that material is send to heat treatment plant, which takes 1 day. Then the heat treatment is done which takes 1 day.

Future State Map-The proposed alternative is that the receiving of material & inspection must be done in 1 day & material must be send further for heat treatment. Heat treatment process must be carried out at next day& thus 1 more day can be saved here.

Q.5) How 2 days are reduced into 1 day in between heat treatment & grinding?

Ans-Current State Map-The material is inspected after heat treatment which then again takes 1 day. Then forwarded to the further grinding process.

Future State Map-The material after heat treatment is directly sent to the grinding and no inspection is done thus 1 day is saved.

Q.5) How 3 days are reduced into 1 day in between surface grinding & lapping, assembly?

Ans-In current state map time required for surface grinding is about 3 days. In future state the proposed improvement is reducing time of surface grinding from three days to 1 day. In this process we implement

- Continuous flow process
- Supermarket pull system
- KANBAN Card

A) Continuous flow process

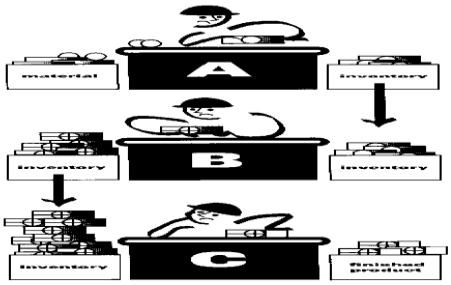


Fig. Isolated is land

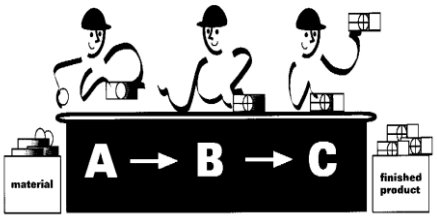


Fig. Continuous flow

Continuous flow refers to producing one piece at a time, with each item passed immediately from one process step to the next without stagnation (and many other wastes) in between. Continuous flow is the most efficient way to produce, and you should use a lot of creativity in trying to achieve it.

The mapping icon we use to indicate continuous flow is simply the process box. In your future state drawing, each process box should describe an area of flow. So if you introduce more continuous flow in your future state, then two or more current-state process boxes would combine into one box on the future state map. Sometimes you'll want to limit the extent of a pure continuous flow, because connecting processes in a continuous flow also merges all their lead times and down times. A good approach can be to begin with a combination of continuous flow and some pull/FIFO. Then extend the range of continuous flow as process reliability is improved, changeover times are reduced to near zero, and smaller, in-line equipment is developed.

B) Supermarket pull system

The purpose of placing a pull system between two processes is to have a means of giving accurate production instruction to the upstream process, without trying to predict downstream demand and scheduling the upstream process, without trying to predict downstream demand and scheduling the upstream process. Pull is a method for controlling production between flows. Get rid of those elements of your MRP that try to schedule the different areas of your plant. Let the downstream process' withdrawals out of a supermarket determine what the upstream process produces when and in which quantity. By using supermarket pull system the lot of selected quantity of working product is decided.

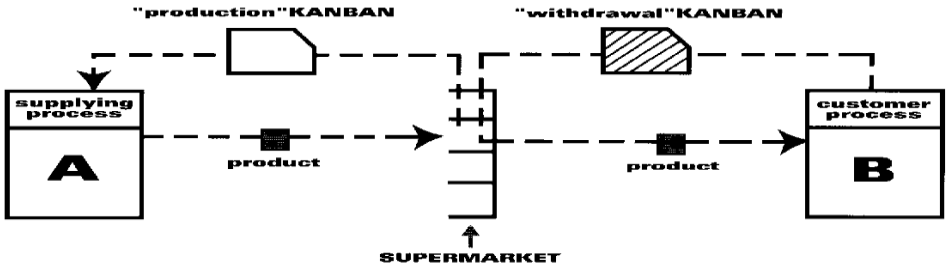


Fig. Supermarket pull system

C) KANBAN CARD

KANBAN CARD is used to denote that fix quantity after the fix quantity of material is surface grinded then the KANBAN CARD is passed to the person doing lapping process. After the material for lapping is about two over the KANBAN CARD is passed to the

surface grinding person here by declaring that material is about to over at lapping process & no stop must be replaced. Thus making the process continuous flow.

Q.6) How 4 hours are reduced in between lapping, assembly & painting, packaging?

Ans-Current State Map-After lapping & assembly process the material is inspected for any fault this inspection takes about 4 hours. Then it is send to painting & packaging.

Future State Map-After lapping & assembly process the use of first in first out (FIFO) is used & then material is send directly for painting & packaging, so 4 hours are reduced.

RESULT

Result Table

	Testing	**Turning**	**Gear & Teeth cutting**	**Heat Treatment**	**Surface Grinding**	**Lapping & Assembly**	**In Total**
Current State	15 Days	4 Days	2 Days	1 Days	3 Days	4 Hrs	25 Days & 4 Hrs
Future State	6 Days	2 Days	1 Days	-	1 Days	-	10 Days
Actual State	10 Days	3 Days	1 Days	1 Days	2 Days & 8 hours	4 Hrs.	18Days & 12 Hrs

Improvement Results

= Current State Lead Time – Actual State Lead Time
= 25 Days 4 Hrs – 18 Days 12 Hrs
= 6 Days & 8Hrs.

We manage to reduce 6 days & 8 Hrs actually. Before improvement there used to be storage of raw material for about seven days & we manage to reduce inventory to four days in actual. In next four days are for the testing & reporting raw material After the feedback of testing report of inventory is stored for one day & next day inventory is send for turning process.

Company was keeping inventory after turning for about four days. We found it could be reduced. Hence we reduced it to three days. After grinding there was inventory of three days which was kept we reduced it to 2 days & 8 hours so now we keep maximum inventory of about 2 days & 8 hours.

CONCLUSIONS

By performing value stream mapping the lead time 32 days 7 hrs can be reduced to 17 days & 3 hrs. The inventory of the product which is the prime factor in increasing the lead time is mostly reduced & the machining process is made in continuous flow. In actual we have reduced 6 days & 12 hours. So currently production lead time is 18 days 12 hours.

With its other advantages are as follows-

- Continuous flow of materials
- Reduction in lead time
- Reduced in process inventory
- Reduced stock levels
- Reduction in inventory cost

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