ISSN 2229-5518

Improving the Productivity using Value Stream Mapping and Kanban Approach

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Abstract— "Change is constant", is the phrase today most of the industries believe in and act upon. Industries today are trying to be flexible enough towards the fluctuating demands. Out of several countries participating in this business race, India is an emerging but prime competitor. The industries have observed that just by increasing the productivity by some or the other means is not the objective of their business but the most important fact is by what means they are accomplishing the same. Many techniques have been adapted for this purpose, which have been broadly classified mainly under technical approach and behavioral techniques for increasing productivity. Value stream mapping (VSM) and Kanban are the techniques which fall under technical approach method and when used together as a combination gives a tremendous result.

Index Terms— Current State Mapping, Future State Mapping, GHPL, Kanban, Process information, Software, Value stream mapping

1 Introduction

Value Stream is all the actions (both value added and non-value added) currently required to bring the product through the main flows essential to every product: (1) the production flow from raw material into the arms of the customer, and (2) the design flow from concept to launch. This paper looks at the production flow from customer demand back through raw material, which is the flow directly related to lean manufacturing and precisely the area where many have struggled to implement lean methods. Taking a value stream perspective means working on the big picture, not just individual processes, and improving the whole, not just optimizing the parts. If one truly look at the whole and go all the way from molecules to the arms of customer, one will need to follow the value stream for the product across many firms and even more facilities. Like many other in recent years, the Indian industries are struggling to find ways to implement lean systems instead of isolated process improvements. Implementing VSM not only removes wastes but also helps to know the sources of the wastes so that they would never come back.

Kanban (*kahn-bahn*) is Japanese word that when translated literally means "visible record" or "visible part". In general context, it refers to a signal of some kind. Thus, in the manufacturing environment, Kanbans are signals used to replenish the inventory of items used repetitively within a facility. The Kanban system is based on a customer of a part pulling the part from the supplier of that part. The customer of the part can be an actual consumer of a finished product (external) or the production personnel at the succeeding station in a manufacturing facility (internal). Likewise, the supplier could be the person at the preceding station in a manufacturing facility. The premise of Kanbans is that material will not be produced or moved until a customer sends the signal to do so.

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2 Problem Definition

Geared Hydro-Power Private Limited (GHPL), Belgaum has been serving a wide spectrum of Indian industries for the past decade and a half in hydraulic industrial section. GHPL has developed a wide range of gear pumps of different sizes and constructive variants for different applications. With a strong presence in the domestic market, GHPL has now moved on to compete in the International market in line with its vision to move ahead with continual improvement in its product quality maintaining its highly competitive pricing.

A recent survey could reveal that there are few companies which are trying to capture the market of GHPL by providing the customers almost same quality product at a much lower rates.

This has called for the emergency in the organization to know – how whether is it possible for the company to remain in competition by reducing the rates further maintaining the same quality. Also they found that the implementation of "Process Kaizen" was not pretty successful and were eager to know where they gone wrong.

In short, the company is now interested to reduce all the 7 wastes, which they think must be identified and eliminated.

3 Problem Approach

GHPL industries produce several assemblies of various pumps and motors which include mainly the manufacturing of Gears, Pumps, Brackets, etc. This paper concerns two product families – 206 series Gears and 206 series Covers – which are produced in many configurations. The wide varieties of the product configurations and the customer configuration requirement vary from order to order; hence the company follows "Make – to - Order" inventory policy. It currently takes a customer order 30 days to get through GHPL production processes. This long lead time and a significant order backlog have prompted GHPL to quote a 60 day lead time to customers.

ISSN 2229-5518

Although GHPL production control releases customer orders to production roughly in the order that they are received, orders are batched by product configuration on the shop floor to reduce the number of time consuming changeovers. This creates a need for the reduction of production lead time and increasing the value added time and hence value stream mapping and Kanban was used to do so.

The first step in value stream mapping is data collection which is done as follows.

3.1 Customer Requirements for 206 Series Gears

- 500 pieces required per month (250 driven and 250 driver)
- A customer order ranges from 50 to 500 pieces, with an average of 100 pieces.
- The corrugated-box packaging with up to 50 gears in a box.

3.2 Production Process for 206 Series Gears

- GHPL's processes for gear product family involve cutting the inspected metal rod followed by Rough and Finish Turning, Drilling (Driver) and Milling (Driven) and Hobbing. Finished gears are sent to assembly line.
- Switching between the rod lengths requires a 15 min changeover at the cutting, half an hour at CNC and milling and 20 min at the drilling.
- The rods are supplied by Mumbai based company. The lead time for obtaining rods is 5 days

3.3 Process Information for 206 Gears

1. **Cutting** (The saw cuts the rods to required numbers according to the given dimensions)
   - Manual process with 1 operator.
   - Cycle time : 3 min
   - Changeover time: 15 min.
   - Reliability: 75%
   - Observed inventory 2days of uncut rod before the saw and 5 days of cut rod.
2. **CNC operation** (Rough and Finish facing operations is accomplished here.)
   - Automated process with 1 operator to load and unload the job.
   - Cycle time : 8.25 min
   - Changeover time: 30 min.
   - Reliability: 85%
   - Observed inventory 15 days of machined jobs.
3. **Drilling and milling** (The holes are drilled in the driver gears and the driven gears are at the same time taken for milling operation as per the specifications.)
   - Both are manual operations running simultaneously on different machines with one operator each.
   - Cycle time : 9 min (Total)
   - Changeover time: 30 min.
   - Reliability: 85%.
4. **Gear hobbing** (The gears are then outsourced to Bangalore for hobbing process which takes almost 45 days to return.)
5. The gears once received are inspected and then sent for assembly process and then ready for shipping.

3.4 Customer Requirements for 206 Series Covers

- 250 Pieces per month
- A customer order ranges from 15 to 150 pieces, with an average of 25 pieces.
- Box packing with up to 25 cover in each.
- Customer's configuration requirements vary greatly from order to order.

3.5 Production Process for 206 Series Covers

- GHPL's processes for cover product family involve Drilling and Tapping operations, Deburring operation and Phosphating. Finished covers are sent to assembly line.
- Switching between the varieties of covers requires a 15 min changeover at the VMC and Drilling Machine each.
- The raw materials are supplied by Mumbai based company. The lead time for obtaining raw material is 5 days.

3.6 Process Information for 206 Series Covers

1. **VMC:** (Drilling and Tapping operations are carried partially out here according to given specifications.)
   - Automated process with 1 operator to load and unload the job
   - Cycle time : 6.93 min
   - Changeover time: 15 min.
   - Reliability: 85%
   - Observed inventory 5 days of un-machined rod before the machining and 5 days of drilled and tapped job.
2. **Drilling machine:** (Drilling and Tapping operations are carried partially out here according to given specifications.)
   - Manual process with 1 operator.
   - Cycle time : 10 min
   - Changeover time: 15 min.
   - Reliability: 85%
   - Observed inventory 5 days of drilled and tapped job.
3. **Deburring:** (The burrs and the chips adhered to the machined part is removed.)
   - Manual process with 1 operator.
   - Cycle time: 1.5 min.
4. **Phosphating:** (The covers are then outsourced to sub-contractor within Belgaum for Phosphating process which takes almost 15 days to return.)
5. The covers once received are inspected and then sent for assembly process and then ready for shipping.

The second step is to compile all the data collected and draw a current state map. Figure 1 represents the current state map of 206 series gears and Figure 2 represents the current state map of 206 series covers.

In the third step the current state map drawn is critically analyzed and following suggestions were given to improve the process i.e. to increase profit with decrease in the production lead time while maintaining the quality.

- Effective JIT Implementation
- Use of Kanban
- Implement Effective Production Planning

The final step is to draw the predicted future state map of the product. The following guidelines were followed:

- The TAKT time was produced for all the 4 products being observed.
- The Continuous flow was developed where-ever it was possible and required.

- Store was converted to supermarket to control production where continuous flow does not extend upstream.
- The customer schedule is sent to only one production process.
- The idea of production mix is suggested.
- Replace Push by Pull system.

On the basis of the prior mentioned important guidelines and suggestion, the future state map is drawn. The non value adding processes are terminated and the current state map is modified. Figure 3 represents the future state map of 206 series gears and Figure 4 represents the future state map of 206 series covers.

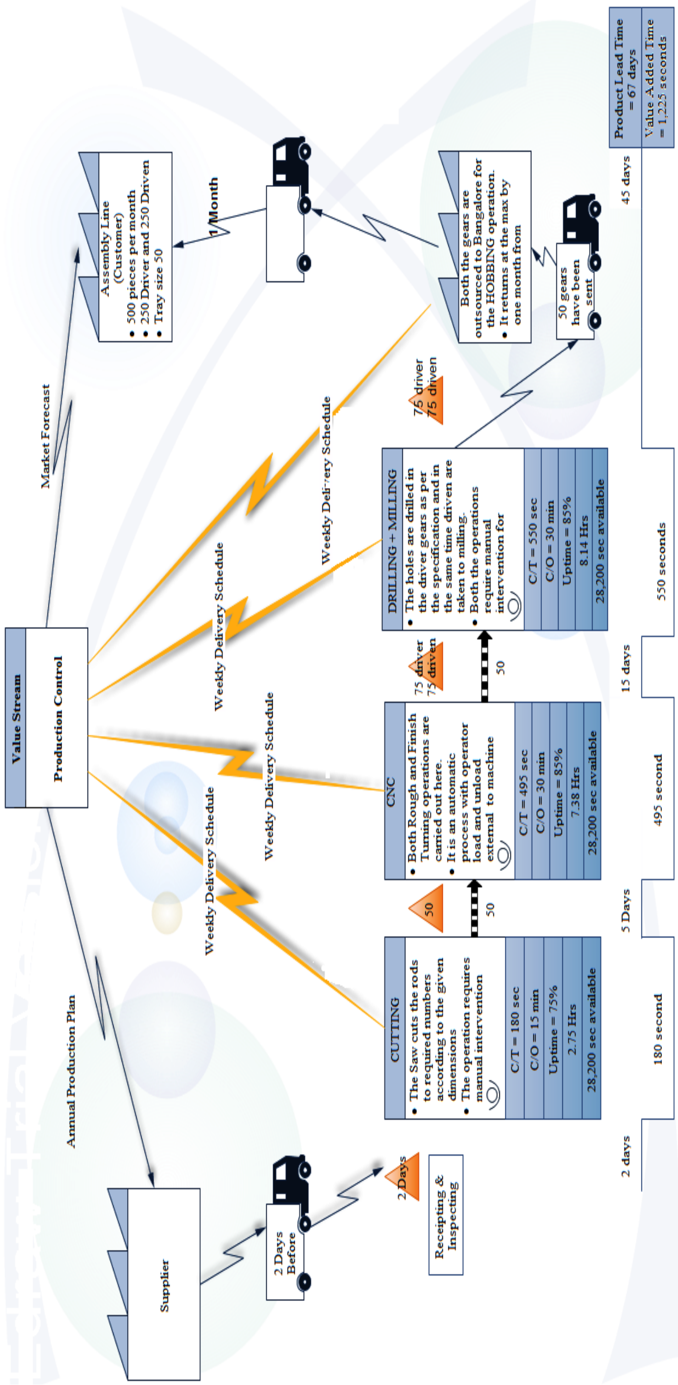

Fig 1. Current state map of 206 series gears

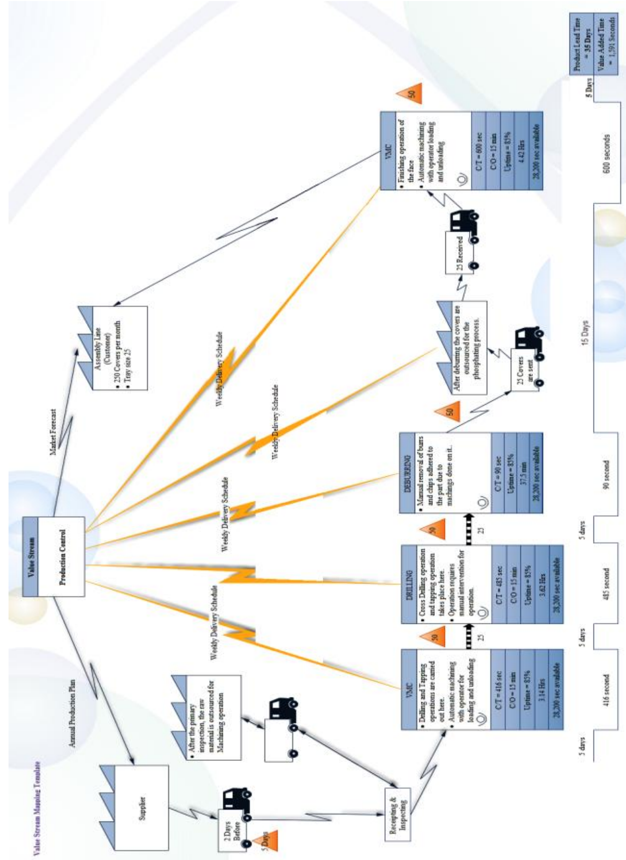

Fig 2. Current state map of 206 series covers

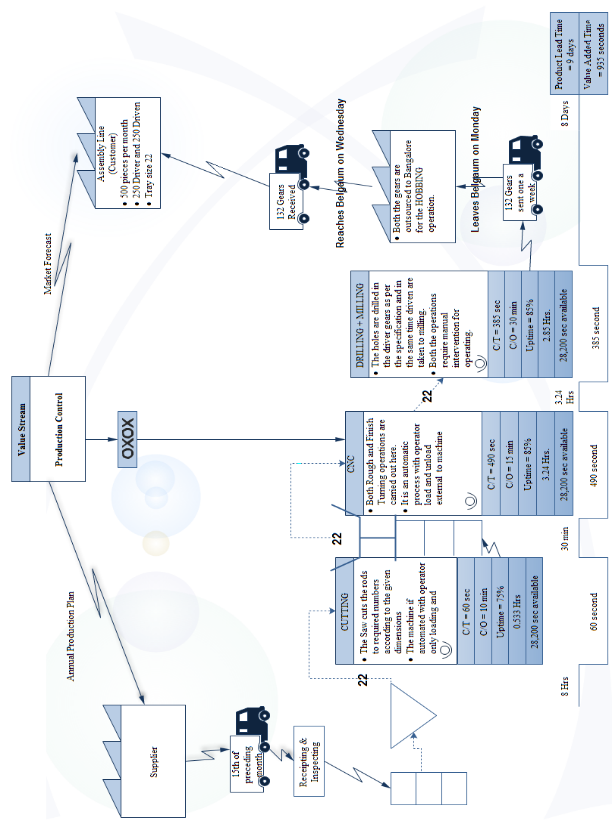

Fig 3. Future state map of 206 series gears

ISSN 2229-5518

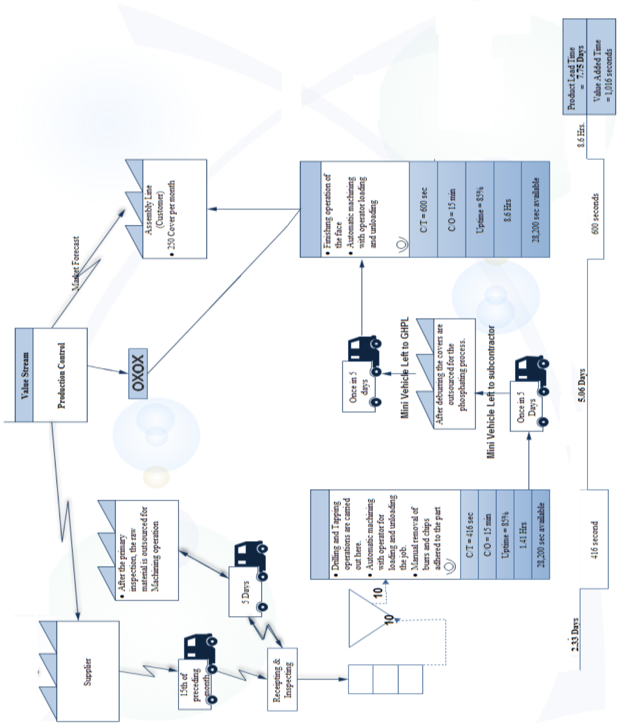

Fig 4. Future state map of 206 series covers

4 Results

TABLE 1
COMPARISON BETWEEN CURRENT STATE AND PREDICTED FUTURE STATE FOR 206 SERIES GEARS

S. No:	Process	No: of Operators Per shift	Uptime %	Production Lead Time (PLT) in Days	Processing Time (PT) in Seconds
Current State Collected Data					
1.	Inspection	1	85	2	---
2.	Cutting	1	75	5	180
3.	CNC	1	85	15	495
4.	Drilling and Milling	2	85	15	550
5.	Bangalore	---	---	30	---
	TOTAL	**5**	---	**67**	**1,225**
Predicted Future State based on Calculated Data					
1.	Inspection	1	95	0.33	---
2.	Cutting	1	95	0.02	60
3.	CNC	1	95	0.135	490
4.	Drilling and Milling	2	95	0.1075	385
5.	Bangalore	---	---	8	---
	TOTAL	**5**	---	**8.59**	**935**

TABLE 2
COMPARISON BETWEEN CURRENT STATE AND PREDICTED FUTURE STATE FOR 206 SERIES COVERS

S. No:	Process	No: of Operators Per shift	Uptime %	Production Lead Time (PLT) in Days	Processing Time (PT) in Seconds
Current State Collected Data					
1.	Inspected	1	85	2	---
2.	Outsourced for machining	---	---	3	---
3.	VMC	1	85	5	416
4.	Drilling	1	85	5	485
5.	Deburring	1	85	5	90
6.	Outsourced for Phosphating	---	---	10	---
7.	VMC	1	85	5	600
	TOTAL	**5**	---	**35**	**1,591**
Predicted Future State based on Calculated Data					
8.	Inspected	1	95	0.33	---
9.	Outsourced for machining	---	---	2	---
10.	VMC	1	95	0.06	416
11.	Drilling	ELIMINATED			
12.	Deburring				
13.	Outsourced for Phosphating	---	---	5	---
14.	VMC	1	95	0.36	600
15.	TOTAL	**3**	---	**7.75**	**1,016**

5 Software Used

E-draw max, Version 5.1 was used to draw all the maps. E-Draw Max is a vector-based diagramming application with rich examples and templates. Easy to create flow charts, organizational charts, business process, UML diagrams, work flows, program structures, network diagrams, chart and graphics, mind map, directional maps and database diagrams. With pre-drawn libraries and more than 2000 vector symbols, drawing couldn't be easier! E-Draw Max includes all the libraries and examples of E-Draw product line. The key features of the software are as follows:

- E-Draw is a vector-based diagramming software, which creates flowcharts, organizational chart and network rapidly.
- Support basic flowcharts, organizational charts, business charts, hr diagrams, work flows, software diagrams, UML diagrams, maps and network diagrams.
- Powerful and easy-to-use drawing tools and many pre-drawn library objects, drawing does not need to start anew. Just drag the ready-made shapes from the toolbar and drop them on your page.
- What You See Is What You Get. Zooming, scrolling, multi selection and multi-level undo/redo supported. No artistic skill is required. Automatically aligns and arranges everything to look great.

ISSN 2229-5518

- Lots of shape templates. Offer more than 2000 shapes in common use; diagram drawing does not need to start anew.
- Gallery support. Offer the template storehouse to collect, manage various kinds of works of excellence.

The software requires the following:

- 256 MB of RAM, 20 MB of hard disk space
- Pentium III, 750MHz processor
- 1,024 x 768 or better monitor resolution Mouse and keyboard.

6 Conclusion

From the analysis and results it could be seen that the Kanban integrated VSM can be of a great help to understand the current system, to analyze the loop holes by not only showing its presence but also letting one know where exactly is the problem and helps to improve upon it to increase the productivity. From the results the following things come in clear picture:

For 206 Gears:

- There is no change in the number of workers required.
- The production lead time could be reduced from 67 days to 8.59 or approx 8.6 days i.e. a reduction of 87.16%.
- The processing time could be reduced to 935 days from 1,225 days i.e. a reduction of 23.67%.

For 206 Covers:

- The number of workers required could be reduced from 5 to 3 per shift.
- The production lead time could be reduced from 35 days to 7.75 or approx 7.8 days i.e. a reduction of 77.86%.
- The processing time could be reduced to 1,591 days from 1,016 days i.e. a reduction of 36.14%.

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