# Improvement of Process cycle Efficiency by Implementing a Lean Practice: A Case Study

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**Abstract**

'Lean' is an established industrial paradigm with proven track record in various sectors of the industry (Womack and Jones, 1996). World-Class multinational companies such as Toyota (second biggest global car manufacturer), Porsche's (most profitable Global OEM), Boeing (largest global aerospace business) and Tesco (third largest global retailer) have adopted Lean at the Corporate level. It is an applied methodology and step by step technique that results work tasks in a process to be performed with the least involvement of non-value adding activities greatly resulting in reduced process time, wait time, queue time, operation time, move time, administrative time and other delays. This paper addresses the implementation of Lean Manufacturing in a small scale production industry. The main objective of this practice was to minimize the waste on the shop floor. This paper shows the application of Value Stream Mapping (VSM) in detail. By identifying the waste and its sources the present and future states of value stream maps are developed to improve the production. This improvement technique focuses the benefits of Lean production techniques in various stages of V.M. Auto Parts Pvt. Ltd. and results 6-7% potential cost saving reduction in cycle time and increase in cycle efficiency is guaranteed. The flow process or cycle time was enhanced thus minimizing various non value added actions and times such as bottle necking time, waiting time, material handling time, etc. More generic approach to design lean environment can be developed by this case study.

## 1. Introduction

Lean Manufacturing is based on the Toyota Production system developed by Toyota which focuses on eliminating waste, reducing inventory, improving throughput and encouraging employees to bring attention to problems and suggest improvements to fix them(Womack et. al.1991). The basic definition of Lean Manufacturing can be stated as a formal approach to manufacturing that seeks to reduce the cycle time to processes, increase the flexibility and improve quality. The basic concept of Lean manufacturing is maximizing customer value while minimizing waste, there by achieving manufacturing excellence through the creation of more value with fewer resources. The core idea of lean is to eliminate waste from the manufacturing process. The collection of tips, tools and techniques is the other way to look at Lean Manufacturing that have proven effective for driving waste out of the manufacturing process. Many manufacturers are implementing lean principles rather than depending on processes and procedures used in past for eliminating the waste and increase the efficiency.

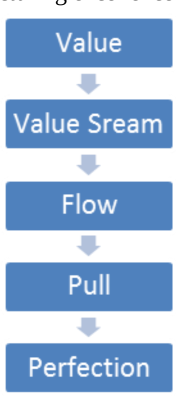


**Fig: 1.** Guiding principles of Lean

The foundation for the successful implementation of Lean in a facility is guided by five continuous cycle improvement steps of Lean.

1. **Specify Value-** Identify the value of a specific product from the customers perspective. Value can only be designed by the ultimate customer, although it must be created by the producer.
2. **Identify the value stream–** Identifying the entire value stream for each product will almost always reveal time three types of actions along the value stream including steps that create value, steps that create no value but are unavoidable with the current technologies and production assets and non value-adding steps that can be eliminated.
3. **Create Flow–** Once value has been precisely specified and the value stream for a specific product fully mapped, making work elements flow continuously with minimal queues and no rework or stoppages in the next step in a Lean transformation.
4. **Establish Pull–** After wasteful steps have been removed, and flow has been established the ability to deliver only what is wanted by your customer and only

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when they want it, is the fourth principle of lean thinking: pull. Allowing customers to pull a product through the process is indicative of the organization's ability to be responsive to a customer's needs.

5. **Seek Perfection–** As organizations bring their processes through the initial four principles-accurately specifying value, identifying the value stream and removing wasteful steps, creating flow, and letting customers pull value from the enterprise-the fifth principle, perfection, becomes attainable.

Whether it is small scale or a large scale industry, due to recent manufacturing trends it is easy to form a assembly line. When the takt times are calculated for every part manufactured in the industry through different part movements, and then the problem of locating machines on the shop floor occurs when it is a job type production unit. To eliminate these problems, a proper method is required to achieve a rhythm in manufacturing lean assembly line by identifying value adding, non value adding and non value adding activities through an optimum feasible takt time.

This paper presents a case study of hub manufacturing unit and the problem as stated above. This paper addresses the implementation of Lean manufacturing in the industry, with highlights on the activities of manufacturing line which should have a proper rhythm of assembly line, minimizing wastages like bottleneck time, waiting time, material handling time, etc. The lean tool value stream mapping (VSM) applied as a method to load the activities.

## 2. Literature Review

Currently, assembly lines are still fundamentals to get the smoothing of production system (Mienburg, 2001) and they are studied under several operative perspectives seeking its flexibility (El-Maraghy, 2005; Calvo et.al.2007). The TPS founder Ohno (1988) and Shingo (1989) concentrated on the Production engineering point of view and both described in depth the tools and techniques. According to Womack and Jones (2003) the most important tool is the value stream map (VSM) which they call the second principle Lean.

A VSM is a simple diagram showing every step involved in the material and information flows needed to bring a product from order to delivery and is therewith indispensable as a technique for visually managing process improvements. Mapping a process gives a clean picture of waste that inhabits flow (Tapping, Luyster, Shuker, 2002).

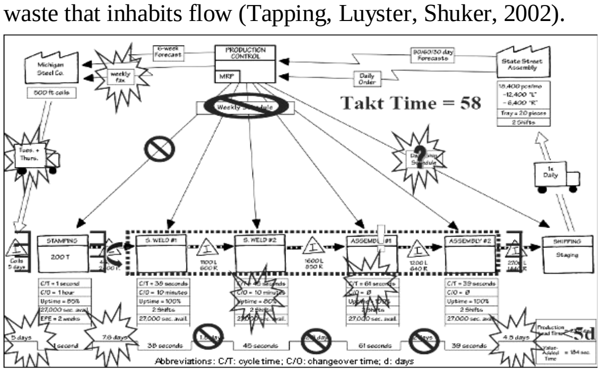



**Fig: 2.** Value Stream Map (VSM) based on Rother and Shook (2000)

Due to high level of icon standardization a VSM provides a common language for all personnel as the bottlenecks and inventory are located and problem areas as well as wastes are identified (red kaizen focuses in figure). As all relevant process data (number of machines and operators, machine cycle time, changeover time, scrap and rework and machine availability etc.) are additionally presented in data boxes, a Kaizen team gains inside into how the operation is truly running that day.

Afterwards mapping the current state, a future state, which identifies the opportunities to design a more efficient and waste free value stream is created.

This paper minimizes several gaps and it shows how value stream transformation actions can achieve high levels of performance in a short time and in industry, inside a context of an assembly line with a small space and that it requires flexibility.

## 3. Problem Statement

The problem deals with the end to end perspective of reducing cycle time and lead time at a production line of a hub production unit.

Cycle time can be defined as total elapsed time to move a unit of work from the beginning to the end of the physical process. In simple word cycle time is nothing but the time required to complete an entire operation on one part from entering in the machine to exit of machine.

Reasons for such a longer time are stated as-

1- Failed auto loading of the part.
2- Higher takt time.
3- Complicated CNC part program.
4- Rough valve running.
5- Higher setup time.

The thorough study and observations has resulted using VSM tool to,

1. Reduce the cycle time and setup time of 1st side finish on CNC machine.
2. To reduce cycle time and setup time of 2nd side finish on CNC machine.
3. To eliminate final Inspection process.

The time consuming tasks where loading and unloading, rough turning, 1st and 2nd side facing and inspection.

Certainly all these factors lead to high production lead time. In the existing conditions the arrange production lead time is found to be around 43.2 days for hub and the cycle efficiency is found to be 4% which is not sufficient.

## 4. Lean Implementation

A tasks group of different faculties of the organization all having rich knowledge and information pertaining to process, production planning is formed for implementing the lean principles. The adopted methodology is given in figure.

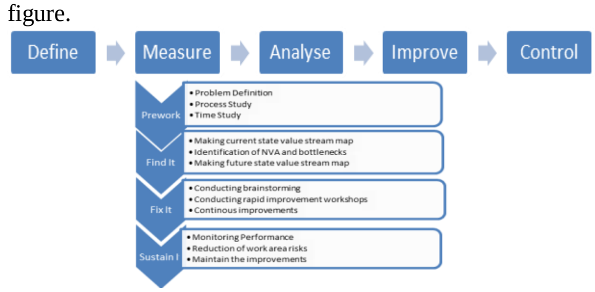



**Fig: 3.** Methodology for Lean Implementation

The basic objectives of operations were

1- To reduce the non value activities present in any form by implementing the various lean tool .
2- To reduce the overall process time of the production line.
3- To introduce a material handling or carrying trolleys.
4- To increase the cycle efficiency.

## 5. Current State Value Stream Mapping

To construct the current state value stream map, relevant information was collected by interviewing people on the hub production unit. As a pre work, process and time study was performed at the production line with their processing time. Data relevant to the customer such as a quality to be delivered, delivery time were observed and information related to assembly line, such as processing time, inventory storage, inspection, rework loops, number of workers and operational hours per day were collected and documented properly. To complete the value map, a timeline is added at the bottom of the map recording the lead time and value added time, eventually the value stream map for the current state is constructed as shown in the fig.

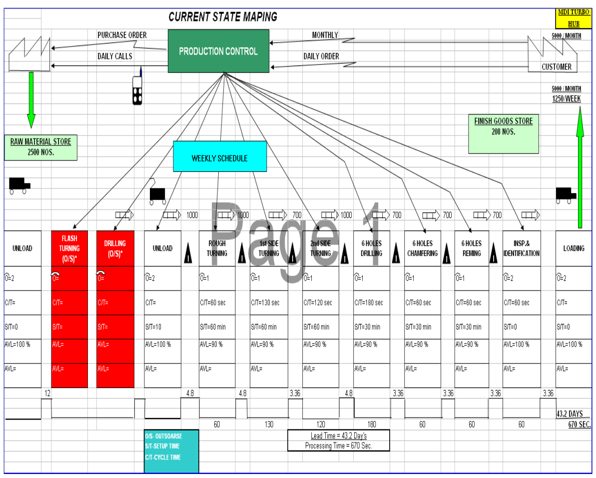



**Fig: 4.** Current State Value Stream Map. (V.M. Auto Pvt. Ltd.)

As observed from the value stream map, various value added activities present in the flow line, bottlenecks are identified and quantified in time.

Current state hub production line process and processing time:

**Table: 1.** Current State Process Lead Time (days)

| Sr. No. | Name of Process | Lead Time (Days) | Percentage |
|---|---|---|---|
| 1. | Flash Turning | 12 | 27.7% |
| 2. | Rough Turning | 4.8 | 11.1% |
| 3. | 1st Side Turning | 4.8 | 11.1% |
| 4. | 2nd Side Turning | 3.36 | 7.77% |
| 5. | 6 Hole Drilling | 4.8 | 11.1% |
| 6. | 6 Hole Chamfering | 3.36 | 7.77% |
| 7. | 6 Hole Reaming | 3.36 | 7.77% |
| 8. | Inspection & Identification | 3.36 | 7.77% |
| 9. | Loading | 3.36 | 7.77% |
| | **Total** | 43.2 | 100% |

**Table: 2.** Current state VA/NVA Time Analysis

| Name of Process | % VA | VA Time (sec) | NVA Time (sec) | Average Processing Time(sec) |
|---|---|---|---|---|
| Rough Turning | 67.66 | 40 | 20 | 60 |
| 1st Side Turning | 69.21 | 90 | 40 | 130 |
| 2nd Side Turning | 66.66 | 80 | 40 | 120 |
| 6 Hole Drilling | 72.20 | 130 | 50 | 180 |
| 6 Hole Chamfering | 58.32 | 35 | 25 | 60 |
| 6 Hole Reaming | 66.66 | 40 | 20 | 60 |
| Inspection & Identification | 83.33 | 50 | [illegible] | [illegible] |
| **Total** | | 465 | [illegible] | [illegible] |

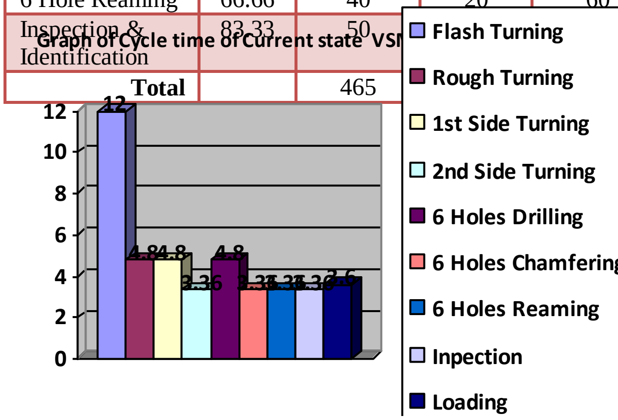



**Fig: 5.** Graphical Representation of Current state VSM

A. Takt Time

It can be defined as the ratio of effective time to the customer demand. It is the time required for producing one unit of daily salable quantity. Cycle time should generally be less than takt time. It is calculated based on machine available time and the required number of units. Mathematically,

T=Ta/D

Where,

T= takt time

Ta= Net time available to work

D= demand (customer demand)

The procedure followed to determine takt time for the current production (taken as running production during study) is as follow-

Available working time/shift (excluding lunch and tea break) = 1260 minutes

$$Takt\ time = \frac{\text{Operating hours}}{\text{Customer demand}} = \frac{1260}{400} = 3.15\ min$$

Customer demand/day = 400 pieces

It is concluded that one unit of product must come out during every 3.15 min.

### B. Total Cycle Time and Cycle Efficiency

The improvement process is a production system is to reduce the lead time continuously. The production lead time for the current conditions was first calculated while studying the problem. The lead times for various components were identified separately and different practical strategies are adopted for improvement. The various components associated in general with the lead time of any production process are,

(i) Waiting time before process
(ii) Setup time
(iii) Process time
(iv) Waiting time after process
(v) Transfer time

Also the total cycle efficiency involved in the process is found to be approximately 3.2%. In order to reduce total cycle time and increase the cycle efficiency, various steps such as problem identification, data documentation, motion and time study, improvements made, operation sheet review and continuous monitoring are adopted.

Initiatives taken to increase the efficiency are,

1- Standard work sheet is prepared.
2- Production line was made feasible.
3- Implementing 5S or TPM.
4- Material handling.
5- Training of workers.
6- Setup time reduction.

## 6. Future State Value Stream Mapping

The future state map is obtained thinking about only producing what the next process needs and only when it needs it with the goal of moving product faster through the production system by eliminating wastes. These wastes are

### A. Overproduction

The reasons for the overproduction is making more or earlier or faster than is required by the next process.

### B. Inventory

The following can be reasons/causes for the excess inventory

(i) Protects the company from inefficiencies and unexpected problems
(ii) Poor market forecast
(iii) Unbalanced workload
(iv) Unreliable shipments by suppliers.

### C. Defects

Weak process control, poor quality, product design, customer needs and understood, and inadequate education/training/work instructions are the cause of defects.

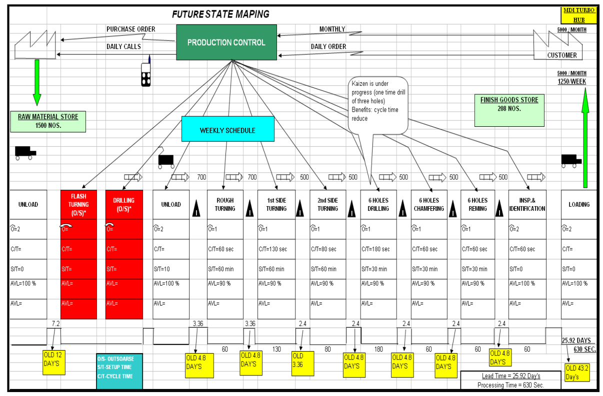
### D. Over Processing

Causes of processing wastes are as follows,

| Name of Process | % VA | VA Time (sec) | NVA Time (sec) | Average Processing Time(sec) |
|---|---|---|---|---|
| Rough Turning | 83.30 | 50 | 10 | 60 |
| 1st Side Turning | 84.61 | 110 | 20 | 130 |
| 2nd Side Turning | 81.25 | 65 | 15 | 80 |
| 6 Hole Drilling | 83.33 | 150 | 30 | 180 |
| 6 Hole Chamfering | 75 | 45 | 15 | 60 |
| 6 Hole Reaming | 83.33 | 50 | 10 | 60 |
| Inspection & Identification | 91.6 | 55 | 5 | 60 |
| Total | | 525 | 105 | 630 |

(i) Product change without process change
(ii) Just in case logic
(iii) Lack of communication
(iv) Over processing to accommodate downtime
(v) Redundant approvals.

### E. Waiting




Unbalanced work load, unbalanced maintenance, Long process set up times, misuse of automation, no structured routines and unleveled scheduling are the reasons for waiting waste.

### F. Underutilized People

The old guard thinking, Politics, business culture, poor hiring practices, Low or no investment in training, Low pay, high turnover strategy are the causes of people waste.

### G. Motion

Any movement of people or machines that does not add value to the product or service, Poor people/machine effectiveness and inconsistent work methods are possible reasons for motion waste.

### H. Transportation

Poor plant layout, poor understanding of the process flow for production, Large batch sizes, long lead times and large storage areas give rise to the transportation waste

**Fig: 6.** Future Value Stream (V.M. Auto Pvt. Ltd.)

**Table: 3.** Future State Process Lead Time (days).

| Sr. No. | Name of Process | Lead Time (Days) | Percentage |
|---|---|---|---|
| 1. | Flash Turning | 7 | 27% |
| 2. | Rough Turning | 3.36 | 12.96% |
| 3. | 1st Side Turning | 3.36 | 12.96% |
| 4. | 2nd Side Turning | 3.36 | 12.96% |
| 5. | 6 Hole Drilling | 2.4 | 9.25% |
| 6. | 6 Hole Chamfering | 2.4 | 9.25% |
| 7. | 6 Hole Reaming | 2.4 | 9.25% |
| 8. | Inspection & Identification | 2.4 | 9.25% |
| 9. | Loading | 2.4 | 9.25% |
| | **Total** | 25.92 | 100% |

Finally, the future state value stream map is constructed as shown in fig. which reported a considerable depletion in non value added time. A drastic reduction in time for 2nd side turning is observed. Furthermore, the process lead time is reduced to 25.92 days from 43.2 days as illustrated in figure.

**Table: 4.** Future state VA/NVA time analysis

Table outlines the value stream analysis report for the future state. It is found that about 525 sec or 83.3% out of 630 sec were value added activities compared to 105 seconds or 16.66% of non value added activities. Comparing the value maps it can be concluded that a 100 sec reduction in non value added activities and 17.28 days reduction in Lead time is achieved. Figure depicts the various benefits made after the implementation of lean.

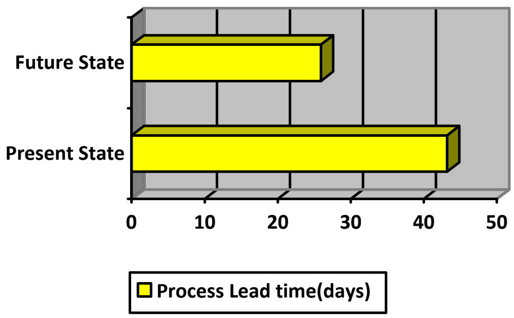



**Fig: 7.** Reduction of Process Lead Time

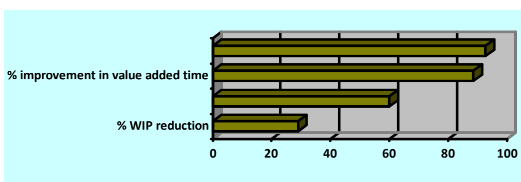



**Fig: 8.** Improvement after Lean Approach

## 7. Conclusion

This present work provides a case study of the improvement of a hub manufacturing process by eliminating the non value added activities by means of lean tools. It focuses the revamp of operations by eliminating the non value added time and improving cycle efficiency through VSM. It can be concluded that VSM is an effective tool for identifying the process.

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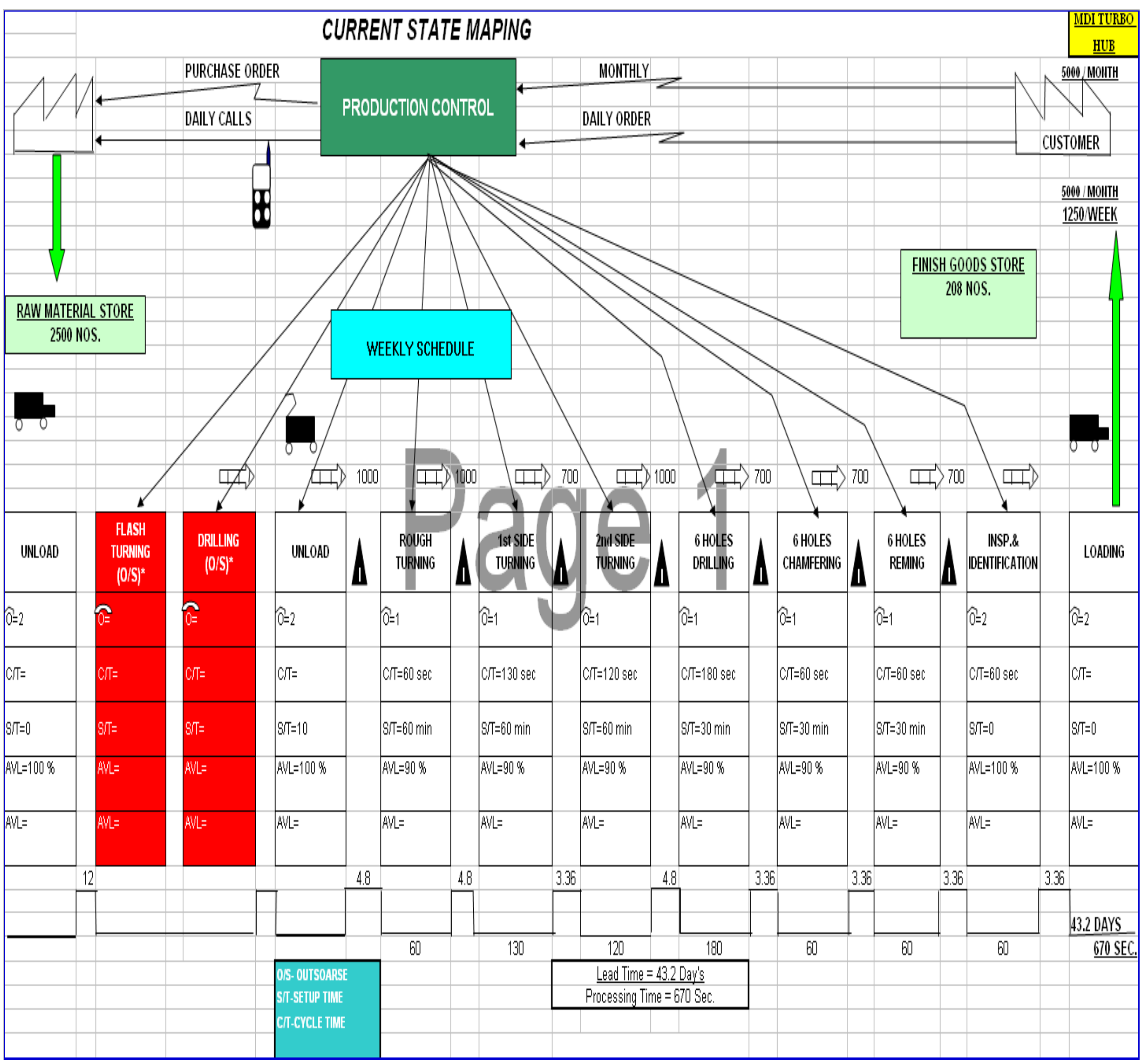
**Appendix: 1.** Current State Value Stream Map



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**Appendix: 2.** Future State Value Stream Map