

Lean Manufacturing in Carriage Building Press Shop using by SMED and VSM tools

M.Sivakumar

Asst. Professor, Department of Mechanical, Maharaja Institute of Technology, Coimbatore, India

T.Balasubramani

Asst. Professor, Department of Mechanical, Maharaja Institute of Technology, Coimbatore, India

M.Claret Stany

Asst. Professor, Department of Mechanical, Maharaja Institute of Technology, Coimbatore, India

Abstract- Lean manufacturing has proven to be an effective strategy to increase productivity and cost competitiveness in the manufacturing industry. These paper discusses about benefits of implementing lean concept and focuses on Value Stream Mapping (VSM) and Single Minute Exchange of Dies (SMED) in Carriage Building Press shop. 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. The current state and future state VSM are drawn to documents how things actually operated on the Carriage Building press shop. Obtained results to indicate that lead time, changeover time and non-value added activities were reduced.

Keywords – Lean manufacturing, SMED, VSM

I. INTRODUCTION

This specific process of Lean Manufacturing has been implemented and used by all types of leading manufacturing companies. Lean means "manufacturing without waste." Waste ("muda" in Japanese) has many forms. Material, time, idle equipment, and inventory are examples. Most companies waste 70%-90% of their available resources. Even the best Lean Manufacturers probably waste 30%. 'LEAN' has always been important to manufacturers. When you reduce inventories, assets, overhead, wait times and out-of-specs, you generally increase profits. The following processes carried out in the Carriage Building press shop is given below and as shown in figure 1. Phosphate coating are used on sheet metal parts for corrosion resistance as a foundation for subsequent coating or painting.



Figure 1.(a)
Shearing

(b) Pressing

(c) Phosphating

Lean manufacturing techniques used for different industry. These lean tools are reduced to non-value added activities, improve the productivity and reduced change over time. Therefore, different lean tools are implement in the Carriage Building press shop.

II. SINGLE MINUTE EXCHANGE OF DIES (SMED)

A. Single Minute Exchange of Dies

SMED (Single Minute Exchange of Dies) also called changeover reduction or rapid changeover, is a lean production technique to analyse and reduce resources needed for equipment setup, including exchange of tools and dies. It is an approach to increase output and decrease quality losses due to changeovers. The target of SMED is that the change of dies or tools takes less than ten minutes, i.e. a single digit number of minutes.

The changeover time can be divided into two parts; mechanical changeover time and adjustment changeover time. The mechanical changeover time is the time it takes to physically replace parts and dies in the machine. The adjustment changeover time is the time from when all parts and dies are in place until the first good piece has been produced.

The changeover optimization is recommended to be done in three steps shown in figure 2.



Fig.2 SMED workshop approach

1. Observation

In the first step, the team observes a changeover and documents all activities by noting them on a form and/or by filming or taking photos. All wastes should be documented and possible improvements should be written down.

2. Analysis

The analysis consists of classification of the activities that were observed during the changeover. The change over time activities are classified into one out of eight groups as shown table 1 together with the duration of each activity, and are thereafter split up into internal and external activities.

3. Optimization

ECRS means Elimination, Combination, Redistribution and Simplification. The ECRS analysis determines the improvement potential of each changeover activity, and the potential is estimated and tasks are created based on the estimations and see explanations below in table 2.

Table 1 Classifications of changeover activities

Classification	Description
Breakdowns	All breakdowns that occur during the changeover.
Control	Operator controls itself
Waiting	All times the operator / setter is waiting; e.g. for his colleague, measurement results, material etc.
Movement	All times the operator / setter has to pass distances, e.g. to fetch tools, supplies, etc.
Adjustment	All activities that support the change over; e. g. move fixtures, adjust end stops, move toward reference points
Mechanical changeover	All elementary changeover activities; e.g. unscrew fixtures, exchange parts.

Table 2 ECSR definitions

Elimination	The changeover steps can be omitted completely during the internal changeover, that means for the next changeover they are not necessary any more. This is the most difficult type of waste reduction and it requires mostly procedure changes.
Combination	By combining parallel, “rhythmic“ activities of changeover steps the internal change over time can be reduced.
Redistribution	The changeover steps are redistributed to reduce waste. This optimises the sequence.
Simplification	By modifying and/or using tools, equipment and fixtures, the changeover procedure is simplified.

All improvements are defined with help of the ECRS analysis and are thereafter realized in the workshop. Following are some examples of improvements.

1. Improvement of methods and devices

2. Definition and visualization of storage areas for tools
3. Standardization of connections
4. Provide certain tools as a set

III. VALUE STREAM MAPPING (VSM)

Value Stream Mapping (VSM), also known as Material and Information Flow Mapping, is a lean manufacturing technique that is used to analyze the flow of materials and information currently essential to bring a product. It originated from the TPS and while it is most commonly used in manufacturing it is also used in logistics, supply chain, service related industries, software development, and product development. For the most part, it is used primarily to identify, demonstrate and decrease waste (any activity that does not add value to the final product), as well as create flow in the manufacturing process. The VSM method visually maps the flow of materials and information from the time products come in the back door as raw material, through all manufacturing process steps, and off the loading dock as finished products.

Basic Steps in Value Stream Mapping are,

- i. Define the boundaries
- ii. Define the value
- iii. Identify the tasks and flows of material and information between them.
- iv. Identify resources for each task and flow
- v. Create the current state map
 - a. Identify value added and waste
 - b. Reconfigure the process to eliminate waste
- vi. Visualize the "Ideal State" and create future state map
- vii. Develop Action plans and track

A-CALCULATION OF TAKT TIME

Takt Time

Assuming a product is made one unit at a time at a constant rate during the net available work time, the takt time is the amount of time that must elapse between two consecutive unit completions in order to meet the demand.

Net Time available to work per day

$$\text{Takt time} = \frac{\text{Net Time available to work per day}}{\text{Time demand per day}}$$

Total working hours per day	= 8 hours
Break time	= 30 minutes
5 days demand	= 600 components
Total available time per day	= (8 hrs-30mins)
	= 7hrs 30mins
	= 7hrs 30mins×60×60
	= 27000 Sec

$$\text{Takt time} = 7\text{hrs } 30\text{mins} / (600/5 \text{ days}) = 225 \text{ Sec}$$

B-CURRENT STATE VALUE STREAM MAP

The first step, identifying the product, pertains to choosing what product the VSM will focus on. After having chosen the product to focus on, the next step is to draw the current state VSM, also known as a Current State Map (CSM). The first step, identifying the product, pertains to choosing what product the VSM will focus on. After having chosen the product to focus on, the next step is to draw the current state VSM, also known as a Current State Map (CSM). This CSM contains all the steps and the parameters used in these steps. These parameters include but are not limited to cycle times, TAKT time, Work-In-Progress (WIP), production rate, number of operators, and waiting time. Having compiled the CSM all the information deemed necessary to perform analysis, the team then assesses the current situation.

Figure 3 shows the current state map that was constructed; the small boxes in the map represent the process and the number inside the box is the number of workers at each process. Also, each process has a data box below, which contains the process (Changeover time) CT, the number of shifts, and the (Cycle time) CO time. It should be noted that this data was collected whilst walking the CB press shop and talking to the foreman and operators at each workstation.

C-FUTURE STATE VALUE STREAM MAP

A VSM identifies where in the manufacturing process value is added and where there are non-value added steps. Upon assessing the current situation and determining where there might be non-value added steps, or wastes, the next step is to develop methods to eliminate these wastes. Upon developing these methods, a final VSM known as a Future State Map (FSM), can be drawn with these wastes removed. The future state value stream map used to reduced the non-value added activities like that change over time, lead time. The final step is to implement the changes so that the drawn FSM can be followed as closely as possible. This will in turn make a more efficient lean manufacturing process.

The future state value stream map as shown in figure 8. Its shows that kanban and kaizen activities, continuous improvement in Carriage Building press shop.

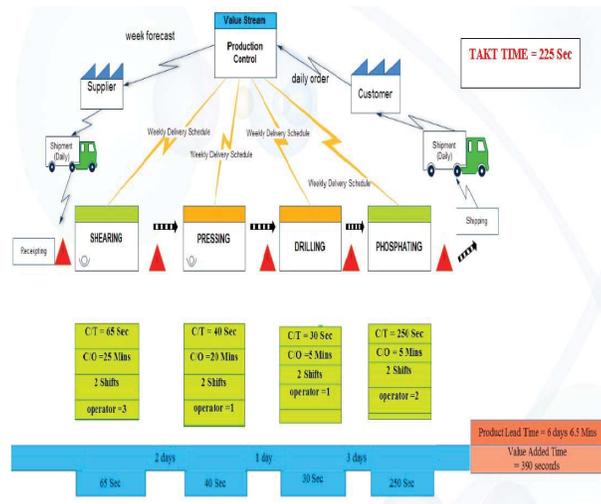


Fig.3 Current value stream map

The current state value stream map is drawn for the Carriage Building press shop. Visualizing source of waste in the current state map as shown in figure 3. The current state map has illustrated the value added activities and non-value added activities.

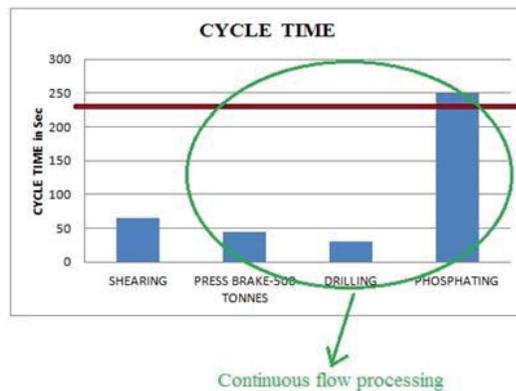


Fig.4 continuous flow processing

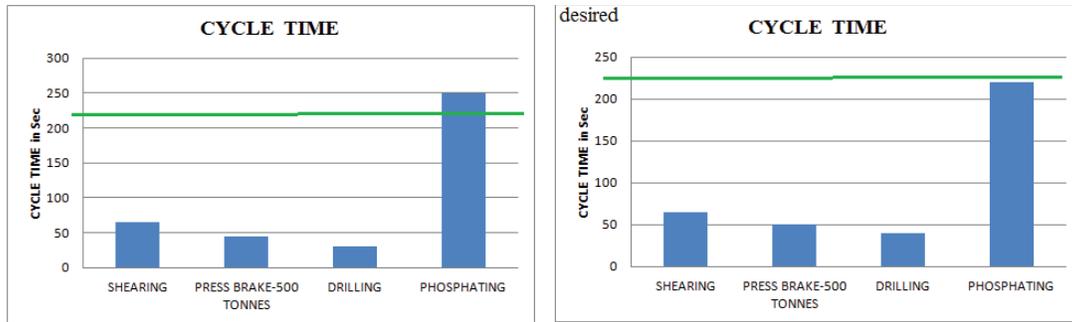


Fig.5 Unbalanced and balanced cycle time

The cycle time are reduced in phosphating process as shown in figure 4. The work content is unbalanced. We need to drive this time down so that we need faster changeover or increasing machine up time as shown in figure 5. Figure 8 shows the future state map to focus on the current state map for cycle time, changeover time and lead time. The kaizen and kanban techniques are introduced as shown in figure 6.

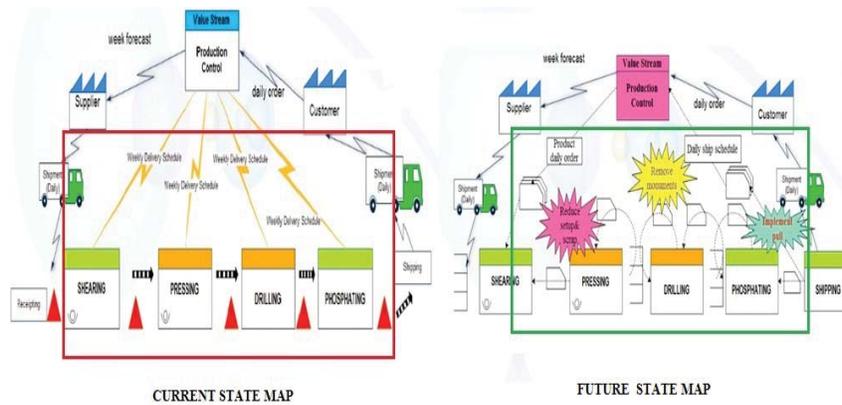


Fig.6 Kaizen and Kanban technique

The changeover time were reduced by ECRS techniques as shown in figure 7.

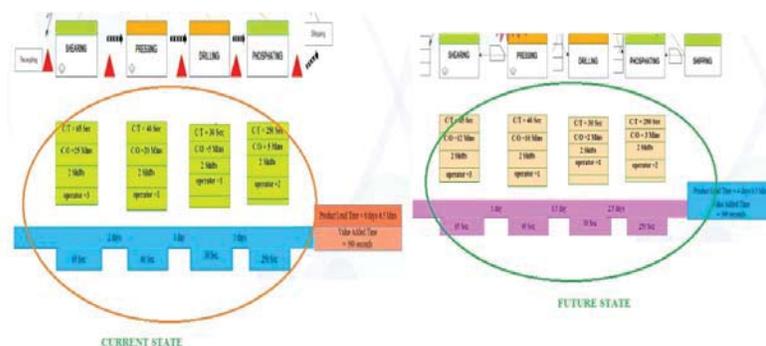


Fig.7 Changeover time in current and future state map

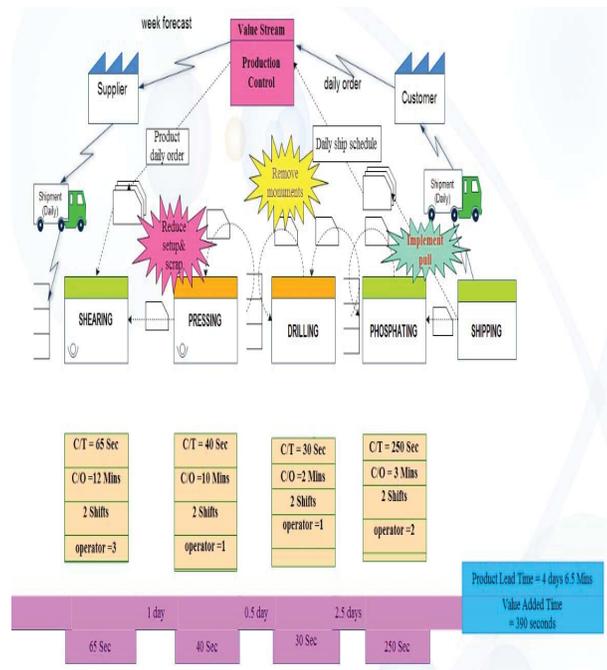


Fig.8 Future state value stream map

Figure 8 shows the future state map that was constructed; the small boxes in the map represent the process and the number inside the box is the number of workers at each process. Also, each process has a data box below, which contains the process CT, the number of shifts, and the CO time for the future state. The change over time and lead times were reduced.

The SMED technique used to reduced the change over time. The change over time was 44.16% decreased from an average change over time of 98 minutes to 60 minutes.

Table 3 Initial and after duration for changeover time

CLASSIFICATION	INITIAL DURATION (HRS:MINS:SEC)	AFTER IMPROVEMENTS (HRS:MINS:SEC)
Movements	00:15:55	00:01:15
Documentation	00:03:20	00:01:50
Adjustment	00:04:50	00:14:39
Control	00:00:30	00:00:37
Mechanical changeover	00:48:47	00:33:14
Transports	00:66:23	00:03:25
Cleaning	00:03:23	00:01:00
Waiting	00:17:40	00:05:00
TOTAL duration	01:38:30	00:55:00

Initial and after duration for changeover time is shown in table 3. Initially total duration is 5910 Sec, after improvements is 3300 Sec. The changeover time was 44.16 % reduced. The before and after change over time activities as shown in figure 9.

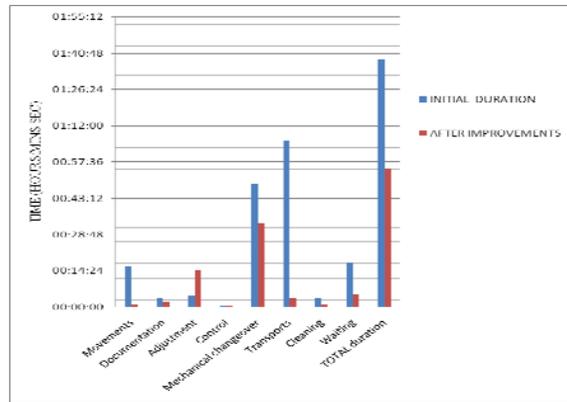


Fig.9 Before and after changeover time

IV.CONCLUSION

The project presents a significant amount of the time products spend on the production system usually was waiting and non-value added. Quantitative evidence showed that many of the Lean manufacturing tools have an expected impact related to the reduction of this waiting time. The current state VSM is drawn for the Carriage Building press shop. The SMED techniques used to reduce the change over time. The change over time was 44.16% decreased from an average change over time of 98 minutes to 60 minutes.

REFERENCES

- [1] Christian Becker, Armin Scholl (2006) A survey on problems and methods in generalized assembly line balancing, *European Journal of Operational Research* 168 . pp.694–715.
- [2] Eric Molleman et al (2012) The evolution of a cellular manufacturing system – a longitudinal case study, *Int. J. Production Economics* 75 (2002) 305–322.
- [3] Fawaz A. Abdulmalek, Jayant Rajgopal (2007) Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study, *Int. J. Production Economics* 107 ,pp.223–236.
- [4] Haeryip sihombing , Kannan rassiah and Parahsakthi chidambaram (2011) Line balancing analysis of tuner product manufacturing, *International Journal of Engineering Science and Technology (IJEST)*, ISSN : 0975-5462, Vol. 3 No. 6 June 2011.
- [5] Hosseini Nasab , Aliheidari bioki , H. Khademi Zare (2012) Finding a probabilistic approach to analyze lean manufacturing, *Journal of Cleaner Production* 29-30. pp.73-81.
- [6] Hubert k Rampersad and anwar EI Homsy (2008) *TPS Lean and six sigma book*, sara books private limited, value stream mapping, pp.28-33
- [7] Kulak, M.B. Durmusoglu, S. Tufekci (2005) A complete cellular manufacturing system design methodology based on axiomatic design principles, *Computers & Industrial Engineering* 48. pp765–787
- [8] Matthias Holweg (2007)The genealogy of lean production, *Journal of Operations Management* 25 .pp.420–437.
- [9] Mikell P Groover , *Automation, production systems and computer integrated manufacturing* , third edition,pp. 525-528.
- [10] Nils Boysen , Malte Fliedner , and Armin Scholl (2007) A classification of assembly line balancing problems, *European Journal of Operational Research* 183 . pp.674–693 .
- [11] Nuchsara Kriengkorakot ,Nalin Pianthong (2007) The Assembly Line Balancing Problem :Review articles, *KKU Engineering Journal* Vol. 34 No .2 , pp.133 – 140
- [12] Rachna Shah ,Peter T. Ward (2003) Lean manufacturing: context, practice bundles, and performance, *Journal of Operations Management* 21, pp.129–149.
- [13] Rahani A, Muhammad al-Ashraf (2012) Production Flow Analysis through Value Stream Mapping: A Lean Manufacturing Process Case Study, *Procedia Engineering* 41,pp.1727 – 1734.
- [14] Ravikumar Marudhamuthu, Marimuthu krishnaswamy,and Damodaran Moorthy Pillai (2011) The Development and Implementation of Lean Manufacturing Techniques in Indian garment Industry, *JJMIE*, Volume 5, ISSN 1995, pp. 527 – 532.
- [15] Sule Itir Satoglu, M. Bulent Durmusoglu ,Ibrahim Dogan (2006) Evaluation of the conversion from central storage to decentralized storages in cellular manufacturing environments using activity-based costing, *Int. J. Production Economics* 103 ,pp.616–632.
- [16] Suresh kumar, S. Syath (2012) Productivity enhancement by implementing lean tools and techniques in an automotive industry,*international of engineering*, pp.1584-1590.
- [17] William G. Sullivan, Thomas N. McDonald, Eileen M. Van Aken (2012), Equipment replacement decisions and lean manufacturing, *Robotics and Computer Integrated Manufacturing* 18 ,pp.255–265.
- [18] Yashwant R.Mali Dr. K.H. Inamdar (2012) Changeover time reduction using smed technique of lean manufacturing, *International Journal of Engineering Research and Applications (IJERA)*, Vol. 2, Issue 3, pp.2441-2445.
- [19] Yang ,PaulHong, SachinB.Modi (2011) Impact of lean manufacturing and environmental management on business performance: An empirical study of manufacturing firms, *Int. J. Production Economics* 129, pp. 251–261.