VALUE STREAM MAPPING

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ABSTRACT

Value Stream Mapping

“Value stream” to be “all the actions (both value added and non-value added) currently required to bring a product through the main flows essential to every product: the production flow from raw material into the arms of the customer, and the design flow from concept to launch”.

The ultimate goal of VSM is to identify all types of waste in the value stream and to take steps to try and eliminate these. Taking the value stream viewpoint means working on the big picture and not individual processes. VSM creates a common basis for the production process, thus facilitating more thoughtful decisions to improve the value stream. VSM is a pencil and paper tool, which is created using a predefined set of standardized icons.

INTRODUCTION

A value stream is a collection of all actions (value added as well as non-value added) that are required to bring a product (or a group of products that use the same (Resources) through the main flows, starting with raw material and ending with the customer. These actions consider the flow of both information and materials within the Overall supply chain.

1. Identify the target product, product family, or service.
2. Draw a current state value stream map, which is the current steps, delays, and information flows required to deliver the target product or service. This may be a production flow (raw materials to consumer) or a design flow (concept to launch). There are 'standard' symbols for representing supply chain entities.
3. Assess the current value stream map in terms of creating flow by eliminating waste.
4. Draw a future value stream map
5. Implement the future state

Why Value Stream Mapping Is An Essential Tool?

• It helps you visualize more than a single-process level
• It provides a common language on manufacturing process
• Helps in decision making about the flow
• Ties together Lean concepts and techniques
• Forms basis of implementation plan
• Shows linkage between information and material flow.

Process data collected during VSM:
Following type of data is collected during VSM,
1. Cycle Time (C.T.): Time interval between two products on a particular Workstation performing same operation on both.
2. Changeover time (C.O): time required to change the manufacturing setting for different variety of product from earlier
3. Number of operators
4. Scrap rate
5. Time available to run the setup in a day (e.g. 2 shifts, 3 shifts etc.)
6. How data is transferred?

METHODOLOGY

Problem Definition
The problem is defined as “Enhancing Profit of the industry by improvement of present assembly operations and material handling system by using the principles of Value Stream mapping (VSM)
In the VSM consist,
- Rejection control
- Kaizen
- Implementing House Keeping.

Throughput is the total volume of production passing through a facility and throughput time for a facility is the sum of queue time, setup time, run time, wait time and move time

Formation of team
A team is formed with an objective to improve the throughput of the industry.

Problems identified in the Present system
To find out the problems in the present system, team had brainstorming session in Order to explore the possible causes of lower output. Following causes were listed down Which can be responsible for the lower output?
1. Material not available on time
2. Unskilled worker
3. Improper house keeping
4. Material rejection resulting in loss of time

The cause and effect diagram explores various causes that lead to low output of production line. It was observed by the time study sheets that there is good scope of improvement in the assembly process by eliminating wastes as no. of waste activities exist. Hence the team came to conclusion that there is very good scope to implement LEAN MANUFACTURING is VALUE STREAM MAPPING.

In order to collect the information about the fatigue levels that are affecting productivity of operators, questionnaires were prepared and information is collected. Through that data it came to know that there is high fatigue involved in some operations and there are desperate efforts required in some assembly operations. It was also visible that there is requirement of some material handling systems.
Data Collection

Present Data collection is the most important activity in order to get the clear picture of the assembly process and to know the problems associated with it and hence to define the problem.

Data collection is divided into two groups that are as under

- **Primary Data**
  Observations, personal discussion, personal in the light of the set of objectives the primary data is collected by student himself. This is first-hand information. The primary data is collected with the help of observations, personal discussion in the light of the set of objectives.

- **Secondary Data**

Table 1: showing activities involved in Assembly

The secondary data is published data, cost sheet, income statements & other relevant sources including in the secondary data.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Node</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1-2</td>
<td>Enter the Raw Material &amp; BOP to Purchase end.</td>
</tr>
<tr>
<td>B</td>
<td>2-3</td>
<td>Granule (Raw Material) to molding Assembly unit</td>
</tr>
<tr>
<td>C</td>
<td>1-3</td>
<td>Nut plate that is insect to Assembly</td>
</tr>
<tr>
<td>D</td>
<td>3-4</td>
<td>Release Parts to Store for inventory</td>
</tr>
<tr>
<td>E</td>
<td>4-5</td>
<td>Parts required for Painting.</td>
</tr>
<tr>
<td>F</td>
<td>5-6</td>
<td>Parts Transfer to Assembly operation..</td>
</tr>
<tr>
<td>G</td>
<td>6-7</td>
<td>Transferred All parts to Final Inventory.</td>
</tr>
<tr>
<td>H</td>
<td>7-8</td>
<td>Visual Inspection and testing</td>
</tr>
<tr>
<td>I</td>
<td>8-9</td>
<td>Packing of All Parts</td>
</tr>
<tr>
<td>J</td>
<td>9-10</td>
<td>Dispatch To customer end</td>
</tr>
</tbody>
</table>

Activity Process Table

![Activity Process Table](image)

Activity Flowchart

![Activity Flowchart](image)
1. Enter the Raw material and BOP parts
Raw Material and BOP parts are enters into main Assembly line are requires more time. It's highly affected on regular production system. Well solution on that is defining the station for each part in store department after taking the suggestions from some area and sort out that problem.

2. Nut Plate and Housing Assembly
In this activity, eight no. of nut plates are screwed to the housing Drive shaft Assembly.

3. Assembly of Release parts for inventory
In this activity release box is assembled to the outcome of activity D i.e. Drive shaft assembled in the housing. Also mechanism and handle is assembled in this activity.

4. Parts transfer for painting
After molding operation parts shifts for painting operation by automatic conveyor, most of parts can send without inspection its causes lots of rejection. In most of plant painting facility are not available.

5. After Assembly Inspection and packaging
In this process, inspection was done by quality people after Visual Inspection, mV/HV testing and packing of the parts respectively. The detailed operation sequence can be viewed in time study.

6 Customer requirements and Output data for MOLDED parts
Following table gives the data about the customer requirements that are provided as targets and actual achieved production from the period of June-2007 to December-2008 for MOLDED .

<table>
<thead>
<tr>
<th>Period</th>
<th>Requirement</th>
<th>Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>June-2007</td>
<td>1000</td>
<td>800</td>
</tr>
<tr>
<td>July-2007</td>
<td>1200</td>
<td>1100</td>
</tr>
<tr>
<td>August-2007</td>
<td>1400</td>
<td>1300</td>
</tr>
<tr>
<td>September-2007</td>
<td>1600</td>
<td>1500</td>
</tr>
<tr>
<td>October-2007</td>
<td>1800</td>
<td>1700</td>
</tr>
<tr>
<td>November-2007</td>
<td>2000</td>
<td>1900</td>
</tr>
<tr>
<td>December-2007</td>
<td>2200</td>
<td>2100</td>
</tr>
</tbody>
</table>

As we can see for all of the months, the targets i.e. market requirements are not satisfied by the assembly line as seen in fig. Hence it is therefore determined there should be some changes required to fulfill the demand.

Following table gives the data about the customer requirements that are provided as targets and actual achieved production from the period of June-2007 to August-2008 for molded parts.

Though comparison chart is showing steady growth in the output of the product, the present set up is not capable of satisfying the future increasing demand, which is forecast at 2000 molded parts per month. Hence the problem is accepted as a special project work by management of the company.
Time Study

In order to get the time required for each operation a detailed time study was carried out. The summary of the time study is as shown in table.

Questionnaires answered by Operators
To collect the information about the fatigue levels that are generated during the assembly operation, questionnaire is prepared which focuses on the issues of fatigue levels. The operators rated the fatigue levels that are generated for their work area by their own experience. Also there are some suggestions given by operators, which are also considered.

Summary of questionnaires
According to the questionnaires, operators are facing difficulties mostly in material handling during some operations and also during carrying from one workstation to other. Operators have rated the operations from 1 to 5 which are the weightings for the Rejection generated. Avg. rejection levels for various operations that are rated as follow,
1. Enter the Raw Material means during logistic= 1.8
2. Granule (Raw Material) to molding Assembly unit = 1.8
3. Nut plate that is insect to Assembly = 3.7
4. Release Parts to Store for inventory = 2
5. Parts required for Painting =2
6. Transferred All parts to Final Inventory. = 2.9
7 Visual Inspection and testing =3.25
8. Visual inspection=1.25
9. Packing=2

All above these rating are finalized by eight days inspection in various shifts.

<table>
<thead>
<tr>
<th>No.</th>
<th>Operation</th>
<th>Total time(min.)</th>
<th>operation time(min)</th>
<th>Movement (min.)</th>
<th>Inspection time(min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Enter the Raw Material &amp; BOP to Purchase end</td>
<td>38.8</td>
<td>33.73</td>
<td>4.51</td>
<td>0.56</td>
</tr>
<tr>
<td>2</td>
<td>Granule (Raw Material) to molding Assembly unit</td>
<td>8.67</td>
<td>6.9</td>
<td>1.67</td>
<td>0.1</td>
</tr>
<tr>
<td>3</td>
<td>Nut plate that is insect to Assembly</td>
<td>12.84</td>
<td>7.91</td>
<td>3.4</td>
<td>1.53</td>
</tr>
<tr>
<td>4</td>
<td>Release Parts to Store for inventory</td>
<td>25.25</td>
<td>17.55</td>
<td>2.01</td>
<td>5.68</td>
</tr>
<tr>
<td>5</td>
<td>Parts required for Painting</td>
<td>22.9</td>
<td>17.91</td>
<td>3.4</td>
<td>1.53</td>
</tr>
<tr>
<td>6</td>
<td>Parts Transfer to Assembly operation..</td>
<td>11.5</td>
<td>7.13</td>
<td>3.2</td>
<td>1.16</td>
</tr>
<tr>
<td>7</td>
<td>Transferred All parts to Final Inventory.</td>
<td>65.25</td>
<td>57.55</td>
<td>2.01</td>
<td>5.68</td>
</tr>
<tr>
<td>8</td>
<td>Visual Inspection and testing</td>
<td>4.0</td>
<td></td>
<td></td>
<td>4.0</td>
</tr>
<tr>
<td>9</td>
<td>Packing of All Parts</td>
<td>20.3</td>
<td>17.3</td>
<td>2.63</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>209.51</td>
<td>165.98</td>
<td>22.83</td>
<td>20.57</td>
</tr>
</tbody>
</table>

Time Study
Value Stream Mapping

All data for the current state map is collected according to the approach carried by. Data collection started from our plant workstation to customer workstation and included data like inventory levels after each workstation, process cycle times (CO), changeover time (CT), available time (no. of shifts) and no. of operators. The timeline at the bottom of the current state map in fig has two components. The first component is the production waiting time (in seconds), which is obtained by summing the lead time numbers from each inventory triangle before each process. The time for one inventory triangle is calculated by dividing the inventory quantity into the customer requirements per second which is estimated at 2000 molding parts per month according to the marketing department.

E.g. Waiting time between ‘Release and housing assembly’ and ‘a testing’ is calculated as total inventory between two workstations (i.e. 6.04) divided by avg. demand per second of MOLDED (i.e.0.00243), which comes as 2486.3 seconds.

Total value added time (including wastes during the operation)
= 4094+1371+3915+1449+1249+1238+1216=14532 seconds = 242.2 min.= 4.03 hrs.

Total waiting time=1697.5+2486.3+462.98+925.9+908.7+1271.4
=7752.79seconds = 129.2min = 2.153 hrs.

Total throughput time= 4.03+2.153= 6.189 hrs.

From the results it can be seen that total waiting time per breaker is about 34.8% of total lead time, which shall be reduced in order to reduce the lead time.

Waiting Time of component between the two workstations=Total Inventory between two workstations/Average demand per second of product

Findings of VSM

1. Total value added time (including wastes during the operation)
= 4094+1371+3915+1449+1249+1238+1216=14532 seconds = 242.2 min.= 4.03 hrs.

2. Total waiting time=1697.5+2486.3+462.98+925.9+908.7+1271.4
=7752.79seconds = 129.2min = 2.153 hrs.

3. Total throughput time= 4.03+2.153= 6.189 hrs.

4. By referring VSM, it is clear that bottleneck operation is having largest waiting time and hence largest inventory of all and the following workstation i.e. “Over travel measurement and assembly” is starving.

5. Total waiting time is forming a share of 35% of total lead time which gives very high scope of waste reduction

6. Each process is producing its own schedule that means there is ‘Push production’ existing in the system

7. To summarize the VSM, it is showing presence of at least six wastes in the form of
   a) Transport
   b) Inappropriate processing
   c) Unnecessary inventory
   d) Unnecessary motion
   e) Defects

Standardization of Process

Standard work establishes clear procedures for the proper performance of jobs. The goal of TPS is to create an efficient production sequence that emphasizes human motion and the elimination of waste. Focused around human movements, standardized work outlines efficient, safe work methods and helps eliminate waste while maintaining quality.
Standardized work is the foundation for Kaizen, or process improvement, in production. It organizes and defines worker movements. This is important because, when the work sequence is different each time and/or if the motions are disorganized, there is no baseline for evaluation. The first step in kaizen is standardization.

Standardized work ensures that each job is organized and is carried out in the most effective manner. No matter who is doing the job the same level of quality should be achieved.

At Toyota every worker follows the same processing steps all the time. This includes the time needed to finish a job, the order of steps to follow for each job and the parts on the hand. By doing this one ensures that line balancing is achieved, unwarranted WIP inventory is minimized and non-value added activities are reduced.

**Standardization of MOLDED Assembly process**

According to the supervisor of the shop, workers many times doesn’t follow the standard procedures of assembly and every time the same process steps are not followed+. They use their own methodologies to assemble the job. This is one of the causes identified in ‘Cause and Effect diagram’. When operators were asked their opinion through questionnaire, they responded on the grounds of fatigue levels that are occurring in the process. To summarize the questionnaire, the operations involved higher level of fatigue which is resulting in the productivity loss of the operator. According to almost all operators, the fatigue levels are very high in operation and according to them. Because of that Rejection control is very important. Hence it was this issue that needed to be attacked first. Hence a team meeting was organized and the issue was discussed. Then different Solutions were short listed such as follows;
1. Change in the working procedure.
2. Development of fixtures
3. Full automation of the line.

Option 2 was not feasible because anyhow the current profile of machineries could not be changed and the weight of the injection molding machine is factor because of which there would have been no difference by changing the assembly procedure. Option 3 Full automation would have cost much more therefore it was the “Worst” option. Hence in order to standardize the assembly process, it was decided that keep inspecting working procedure for recycling..

**Small Improvements (Kaizen)**

1. **Reduction in time entering the parts**
   
   Now that the bottleneck of testing is removed, the second bottleneck was searched which was found out to be ‘Receiving end’ with 36.8 min. When the operation was carefully analyzed, it came to know that the activity for inspecting is very long time reason behind that is improper communication between logistic people and quality people compared to total operation time. Hence it was decided to explore the process further.

2. **Need of Inspecting people at supplier end**
   
   In the Inspecting of BOP parts and small parts which are used for assembly purpose is provided by various suppliers. Which parts having large complexity is necessary to inspect at supplier end. Before that both side logistic was paid by industry itself its required some modification on that means logistic charges shifted towards supplier end for that make some changes in Purchase order.
3. **Final Inventory**

Inventory at our end is three days and major business deals with company -X. But according to VSM dig. Company -X kept inventory for one day main thing is molded parts required for last workstation in company -Xassembly unit and there is no more distance between company -X and plant (20 Km) therefore reduce the inventory level from three days to two days it’s become highly cost saving task for enhancing profit.

4. **Improvement**

When team carefully analyzed the problem, it came to know that there is no need To do the such changes there was modification in the mold and now there is not necessity of Before modification time required for operation= 38.8 min After modification time required for operation= **23.5min**

**House Keeping**

Housekeeping is a process where in everyone in the company is committed and involved in upkeep of the work place and information, cleanliness of machine, material etc. such that only needed material and information is kept and its fastest accessibility Is insured.[12]

1 What is housekeeping?

Systematic approach to a better work place. Involves segregation, arrangement, cleanliness and maintenance of standards & discipline.

Assigns a place for everything and ensures everything is in its place. Is everybody’s responsibility? Is the starting point of any improvement activity?

2 Why housekeeping?

Employees feel good if the work place is clean Searching is avoided time wasted in handling reduced.

- No unnecessary materials
- Less rejection/rework
- Less machine downtime
- More usable space
- Passage ways are neat and clean
- Abnormalities noticed at a glance
- Eliminates accidents
- Productivity improvement

3 “5s” Principles of Housekeeping

1. SEIRI (Sorting out)- Sort out unnecessary items in workplace and discard them
2. SEITON (Systematic arrangement)- arrange necessary items in good order so that they can be easily picked for use. A place for everything and everything at its place.
3. SEISO (Spic and span): Cleaning the workplace
4 SEIKETSU (Standardization): Maintaining high standards of housekeeping and workplace organization at all times.
5. SHITSUKE (Self Discipline): Train people to follow good housekeeping discipline autonomously.

**Result**

Following results occurred due to Rejection control, small improvement and proper House-keeping.
Direct Benefits
1. Reduction in Total Value added time = 209.51 - 177.03 = 32.48 min = 15.50% of total time.
2. Per-shift output before improvements (excluding defectives and in-process time) = (8x60)/65.25 = 7.35
   Per-shift output after improvements (excluding defectives) = (8x60)/23.66 = 20.28
3. If 35% reduction is considered due to defects,
   Monthly output before improvements (2 shifts/day) = (7.35x2)x0.65x25 = 238
   Monthly output after improvements (2 shifts/day) = (20.28x2)x0.65x25 = 340

In Direct Benefits
1. Reduction in operator’s in-process fatigue and Material Handling fatigue due to rejection control.
2. Increase in employee morale

CONCLUSION

A. The outcomes of different methods which were used to enhance the current Assembly line are given below
1. Reduction in Total Value added time = 209.51 - 177.03 = 32.48 min = 15.50% of total time.
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