ABSTRACT:
Value stream mapping will help industrial engineers, managers who still support gross manufacturing techniques of lean manufacturing. VSM is the removal of waste in manufacturing, production and business process by separating and eliminating non value added steps. VSM frames the current and future state of production process in an organization. It allows all people to know where the wastes are eliminated. People then turn the current state to future state by using lean manufacturing principles. The non value-added steps are known by their waste of resources and era. The process must be estimated to reduce and simplify the necessary actions needed. By reducing excess of time can get the proportional value added time in the process. The redesigned process is more effective and efficient than the previous one i.e. less amount of input (resources) is needed. This process is charted according to its flow in the future state with the necessary steps and information in a simplified manner. Value Stream mapping (VSM) will help engineers in the industry which follow the manufacturing philosophies of the Lean Manufacturing.

VALUE STREAM MAPPING
The use of VSM came in to existence after the success of the Toyota Company in Japan since 1980’s. It was developed by the Toyota Company between 1960 and 1970.

At the beginning VSM was used as a methodology which identifies waste time and unneeded actions occurring in the process. But now a day’s VSM is being used as a re-engineer business for identifying the unnecessary work and resources being used for the process of the operation. The main goal of lean manufacturing is eliminating the waste, i.e. muda, muri and Mura.

If we implement lean manufacturing it would decrease the waste in the industry and lead to a less input and more output state. Inventory is involved as a part of the process in the series of steps to convert required input into the output. The output may be a service or a product. Inspection through VSM can identify the improvements in the wastefulness. These are seven wastes identified by Toyota:

- Overproduction: Producing items for which there is no order.
- Waiting Time: Employee standing about.
- Unnecessary Transport: Moving materials optionally or long distances.
- Over-processing: Using more steps to produce a product than required.
- Excess Inventory: Holding unnecessary inventory between process steps.
- Unnecessary Movement: Any waste motion by man or machine.
- Defect: Making defective product.

Seven types of waste and the proposal for future state value stream mapping

<table>
<thead>
<tr>
<th>Type of waste</th>
<th>CVSM</th>
<th>Cause</th>
<th>Effect</th>
<th>FUVM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over production</td>
<td>Not found</td>
<td>Necessary, range</td>
<td>More accommodation space</td>
<td>No difference found in CVSM and FUVM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>balancing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waiting time</td>
<td>Process within the mean location</td>
<td>Plant layout and location</td>
<td>More space is needed to store the materials</td>
<td>To reduce waiting time implement line balancing</td>
</tr>
<tr>
<td>Unnecessary Transport</td>
<td>Moving materials without necessary</td>
<td>Plant layout and less space in storage</td>
<td>Spoilage of materials</td>
<td>Make the esteemed paths to store the materials</td>
</tr>
<tr>
<td>Over processing</td>
<td>Information flow</td>
<td>Manual error</td>
<td>Extra time for non value-added things</td>
<td>Attach the purchase order clearly and mention them</td>
</tr>
<tr>
<td>Excess inventory</td>
<td>Inventory materials to the buffer stock</td>
<td>Advance time</td>
<td>Capacity requirements</td>
<td>Implement JIT principles to reduce capacity requirements</td>
</tr>
<tr>
<td>Unnecessary movement</td>
<td>Motion of workers between the production</td>
<td>Plant layout and procedural problems</td>
<td>Leads to weakness</td>
<td>Alignment of bin in Y and Z direction will reduce the motion of a worker</td>
</tr>
<tr>
<td>Defect</td>
<td>Problems are less</td>
<td>Without running machines properly</td>
<td>More wastage</td>
<td>Inspection is required</td>
</tr>
</tbody>
</table>

Flow is the continuous operation of inventory from step to step in a smooth, steady level rate. Value is from the customer’s aspect, the customer being the person who gains the output. Value-adding resources are those which create value for the customer. Non value-adding is everything done in the process which afford no value for the customer but which they are forced to pay for when they buy the product. Figures (ii) and (iii) shows a situation in a manufacturing assembly process where value is added and lost for
the customer. Necessary non-value-adding are those actions in a process that must be done to make the product or service but create no value for the customer. Unnecessary non-value-adding is eliminated and necessary non value-adding is minimized to the least possible.

METHODOLOGY FOR VALUE STREAM MAPPING

For carrying out VSM we need to follow a particular process from beginning to the ending for measuring and monitoring the steps in each and every process. We record the types and varieties of resources used for each step in the production process, i.e. the range of time at which the resource is used and the amount of its usage. These variables measured in the production process are recorded in a variable block as shown in Figure (iii). By recording the variation of the variables instead of the average values would provide a great scope for improvement in the industry.

The actions of the non-value adding steps are analyzed to find the opportunity to minimize through some cost-saving and time-saving improvements. Another benefit of recording the time across the process is to find the bottleneck steps. These bottleneck processes can be redesigned to improve their capacity which finally increases the rate of output for the whole process. This redesigned process is made on a new chart named as ‘future state map’. This shows the different steps and information and material flows in the reengineered and efficient process.

The process is drawn in form of a flow diagram according to the information collected by gathering the data. The flow diagram shows the resources and delay of times at each step each step of the process. The diagram or map providing the above information is called as ‘current state map’. An example of current state map is shown in figure (v). The ‘current state map’ of figure (v) is for the manufacturing process of the metal doors using the metal (stainless steel and galvanized iron) sheets in clean rooms. A bundle of metal sheets are off-loaded from the trucks into the racks of the stores. These sheets are to be sheared and punched into required dimensions. Ones the required sheets are punched they are moved to bending which is done with the help of CNC machines. After that they are sent for assembly and after assembly they are sent for gluing. After gluing, puffing and painting are the most time taking events. Product is packed and put into racks till it is dispatched into the trucks.

In the figure (v) to use of ‘variable blocks’ is shown to capture relevant information of the process from each step. ‘I’ inside a triangle represents the inventory movements between each step. We noted the range of times (longest, quickest, and average) below the inventory symbol which will take to move. The value added and non value added are noted across the line which is at the bottom of the page. The line is up when there is a value adding process and normal when there is a non-value adding process. Each and every step in the current state map is analyzed to identify whether the functions performed in the process add ‘customer value’ or not.

VSM spends time in the work area by collecting the details of man-power, machine and product movements. It is mandatory to record the time for each process steps in ongoing operation. It is necessary to maintain records similar to the process in order to machine breakdown, absenteeism, delays, operating decisions, raw materials, job cards, rework etc that shows the bounce on the operation is analyzed. The analysis made by them is the undoubtable facts obtained from the documentary evidence. They are recorded from observation of site in any investigation.
INVESTIGATION
VSM spends time in the work area by collecting the details of man-power, machine and product movements. It is mandatory to record the time for each process steps in ongoing operation. It is necessary to maintain records similar to the process in order to machine breakdown, absenteeism, delays, operating decisions, raw materials, job cards, rework etc that shows the bounce on the operation is analyzed. The analysis made by them is the undoubtable facts obtained from the documentary evidence. They are recorded from observation of site in any investigation.

ANALYSIS
Analysis of VSM becomes apparent in this phase. Once a manufacturing or business process is mapped as a series of steps and explained them in numerical, built in irregularity and variance becomes visible. Analysis is to achieve the customer effective process by a ratio of customer value added time to process time. This ratio comes in single digits. The design without having customer pleasure may cause a low ratio of customer value adding process. From non-customer point of view there is a great scope to chop heavy amounts of waste and cost from them in the process. In this analysis we must identify instability in the good and bad performances in each step of process. Poor inventory brisk is a signal of too much work in progress not even to the blog rate. Variability denotes an unstable and uncoordinated practice which needs to be up to dated. In variability the good aspect is not spending more money in improvements which cause the good or bad performance and changing practices. Procedures which do better and reduce the bad processes are required. There are several statistical techniques which are applicable to analyze the collected data during the investigation. Pareto chart, fish bone diagram, pie charts, cause and effect diagrams are the easy tools and methods to apply in analyzing data. The questions arise in the process are computed in terms of costs and customer non value adding time they share. By allowing money value to waste and the non value we have able motivate the business to makes necessary changes.

IMPROVEMENTS
After the analysis is completed the improvements are readily presented. While developing the proposals it is ideal that the users of process are identifying the solutions such that they take the ownership for the implementation in the future. The analysis brought out the simplifications and changes in the procedural steps which tend to stop the wasted actions. The selected improvements have been included in the future state map. By checking the current state and future state we can find out the changes or improvements made. The current state map shows the total non-value added time as 565 min where as the future state map shows the non-value added time as 465 min. The inventory speed has been reduced to 2-3hrs in the future state map. This is a further benefit of labor savings.
REFERENCE

1. Abbett D., Payne V. (1999), Gulfstream value stream tour; presentation at 1999 Lean Summit.


5. The many faces of Lean Maintenance, Bruce Hawkins, CMRP, CPMM, Life Cycle Engineering