Chapter - 3

VALUE STREAM MAPPING IN THE VISUAL SHOP FLOOR CONTROL SYSTEMS
3.1 Objectives
Value stream mapping is a process that uncovers waste based on the survey and background studies of the research problem and this would reveal the information needed to make a product. The objectives of the steps were described as follows:

1. Diagnose problems
2. Suggest changes
3. Make a future state map representing the improved manufacturing process
4. Implement the changes

Value stream mapping is not a one-time event. Successful Lean manufacturers are applying value stream mapping continuously to their manufacturing processes to get better results. It is all of the steps required to bring a product or service from raw state through to the customer. Value stream mapping is a Lean process-mapping method for understanding the sequence of activities and information flows used to produce a product or deliver a service [76]

3.2 Structure of the Value Stream Map
Value Stream Mapping Cycle is the diagnostic tool for various visualization activities in the manufacturing industries. It allows visualizing the activities involved in delivering customer product to another customer, from the perspective of both the product and information flow. The mapping process helps to identify every process in the flow and to differentiate value from waste.

1. Current State Map: It shows material flow, information flow, and both the order and performance of production processes. It also highlights current waste.
2. Future State Map: This is the team's vision of the ideal condition in which the wastes identified in the current state are eliminated.
3. Implementation Map: A detailed action plan prioritized according to cost and benefits that will make the future state a reality.
4 Constructing value stream mapping. Value stream maps represent material and information flows of a production from beginning to end. Value Stream maps focus on one product family at a time. A product family is a group of products that are manufactured through similar process steps.

Value stream maps arranged in a circle starting with customer demand and flowing counterclockwise until the supply of product satisfies customer demand. According to Figure 3.1, the information about the customer demand is the number of customers who purchase that family of products, pack quantity, order frequency, etc. Supplier data include lead times and frequency of deliveries. For value stream map there should be information about the cycle time, changeover time, uptime, takt time, etc.

![Value Stream Mapping Cycle](image)

3.3 Design Process of Value Stream Mapping

**Define and pick the product family**
- Define Product
- Define Product Family

**Create the current state of VSM**
- Define the scope of the Value Stream Map
- Agree upon the symbols, icons and data to use
- Build the current state of the value stream map (CSVSM)

**Future State Value Stream Mapping**

A Future State Value Stream Map helps with the larger process of developing your Lean Manufacturing Strategy.

- Agree upon the symbols, icons and data to use
- Build the current state of the value stream map (CSVSM)
- Define Product Family
As mentioned in the above diagram the design of the Visual Stream Mapping would be explained as follows

Steps involved in Value Stream Mapping

1. Define and pick the product family
2. Create the current state value stream mapping
3. Create the future state value stream mapping

Step 1 Define and pick the product family
- Define product
- Define product family

Step 2 Create the current state of VSM
- Define the scope of the Value Stream Map
- Agree upon the symbols, icons and data to use
- Build the current state of the value stream map (CSVSM)

Step 3 Future State Value Stream Mapping
A Future State Value Stream Map helps with the larger process of developing your Lean Manufacturing Strategy
Designing a Future State requires more art, engineering and strategy than Present State mapping

3.4 Computation of Time Complexities
The criteria for valuating the different options of the timing factors have been estimated according to the demand priority of the Industry. The actual level of abstract set of timing factors needs the essential evaluation process in the manufacturing process. The objectives of each time entities have been easily designed and implemented for the further growth of the Industry in this thesis. The each and every algorithm and the corresponding programming features also described briefly

3.4.1 Cycle time: It is the rate at which a unit of product exits a work process
A unit is one completed output but not always one item. For example, a unit of output might be a pallet of cylinders or a carton of eggs or an approved grant application

Algorithm 3.1: Computation of Cycle time

Input

No. of products p[i], total time taken to produce those products t[i]
Output

Cycle time \( ct[i] \)

Method

Begin

Generate no of products \( p_1, p_2, \ldots, p_n \), Total time taken for the production of products \( t_1, t_2, \ldots, t_n \) randomly

For each product \( p_i \) calculate the cycle time

That is, \( ct[i] = \frac{t[i]}{n} \),

End

3.4.2 Changeover time

The time it takes to convert a machine from one process to another. Changeover may require switching fixtures, tools, programming, and other aspects of the manufacturing process.

Algorithm 3.2: Computation of changeover time

Input

No of processes \( p[i] \), final time of first process \( ft[i] \), Initial time of second process \( it[i] \)

Output

Changeover time \( ctime[i] \)

Method

Begin

No of processes \( p_1, p_2, \ldots, p_n \), final time of first process \( ft_1, ft_2, \ldots, ft_n \), Initial time of second process \( it_1, it_2, \ldots, it_n \) is generated randomly

For each process \( p_i \) calculate the changeover time

That is,

\[ ctime[i] = it[i] - ft[i], \]

End

3.4.3 Machine Uptime

The time during which a system is working without failure, this can be achieved easily with all support of environment variables execution in systematic manner. Over and above the variation factors also real factors of
the complete time analysis future effective status of the manufacturing Industry

**Algorithm 3.3: Computation of Machine uptime**

**Input**
- No of processes $p[i]$, Initial time of $t[i]$, failure time of process $ft[i]$

**Output**
- uptime $[i]$

**Method** Begin
- No of processes $p_1,p_2,...,p_n$, Initial time of process $t_1,t_2,...,t_n$, failure time of process $ft_1,ft_2,...,ft_n$ is generated randomly.
- For each process $p_i$ calculate the changeover time
  - That is,
    $$\text{uptime}[i] = ft[i] - t[i],$$

End

**3.4.4. Lead-time**

It is the time it takes one piece to move all the way through the work process. Lead-time equals cycle time plus the time a unit of output-in-progress waits along the production line.

**Algorithm 3.4: Computation of Lead-time**

**Input**
- No of processes $p[i]$, total time $t[i]$, cycle time $ct[i]$, waiting time $wt[i]$

**Output**
- leadtime $[i]$

**Method** Begin
- No of processes $p_1,p_2,...,p_n$, total time $t_1,t_2,...,t_n$, cycle time $ct_1,ct_2,...,ct_n$, waiting time of a product $wt_1,wt_2,...,wt_n$ is generated randomly.
- For each process $p_i$ calculate the lead-time
  - That is,
    $$\text{lead-time}[i] = ct[i] + t[i],$$

End
3.5 Result Analysis and discussion

In order to evaluate the various types of time complexities the programming output have been obtained from the higher programming language with essential assumptions, proper data validation and verification. The implemented and executed each time analysis are described irrespective of time factors in the better way for the significant futuristic services of the whole research problem. Each computed time complexity with its corresponding output resulted data graphical analysis discussion mentioned as follows.

The following required data as mentioned in the Table 3.1 is considering for evaluated for the cycle time with the various parameters of Number of products and total time factors. These are practically approachable manner, with an intense of Manufacturing Industry as follows.

Table 3.1: Product Cycle Time Analysis

<table>
<thead>
<tr>
<th>No. of Products</th>
<th>Total Time</th>
<th>Cycle Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>83</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>86</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>77</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>93</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>86</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>92</td>
<td>9</td>
</tr>
<tr>
<td>9</td>
<td>49</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>21</td>
<td>2</td>
</tr>
</tbody>
</table>

For computed the cycle time for each product the time required for each product have to be noted before, while the actual time factor come into the process of Value Stream map in future usage. The clear assumptions of the computed time factor Cycle time always represent the Production turn over easily in any real time automated manufacturing Industry explosion. In order to maintain the conceptual over time is not easily come into the picture through out the production technology. The over and above actual relay of the different time complexities, cycle time is one of the essential.
The above Figure 3.2 clearly shows the actual cycle time status of the real time problem in order to reveals the next state of art of the time complexity

Table 3.2: Changeover Time Analysis

<table>
<thead>
<tr>
<th>No. of Processes</th>
<th>Final Time of First Process</th>
<th>Initial Time of Second Process</th>
<th>Changeover Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>86</td>
<td>83</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>35</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>92</td>
<td>86</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>59</td>
<td>59</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>26</td>
<td>23</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>36</td>
<td>34</td>
</tr>
</tbody>
</table>

With the over all gradation of the related data of change over time as mentioned in the table 3.2, the number of processes, time process of First and second stages easily
calculate the change over time factor. The result discussion had been mentioned in the Figure 3.3 the required time factor of Change over time as follows.

![Changeover Time Graph](image-url)

**Figure 3.3: Changeover Time Graph**

With number of series, number of processes and final state of the art of change over time provide an executive step of functionalities throughout the working environment condition. The process of various aspects of Value Stream Map considerable was having its own meritorious features in order to achieve the efficient data analysis and the real time execution programming once for all as in case of any automated manufacturing Industry. This is the actual data demonstrative working conditions of the time factor in VSM, this is perfectly matches with most of the merits in the form of viable change of preplanned working status in the real time data applications. The improvement situation is once again validated in an Industry paradigm through one of the another important timing factor called machine uptime as mentioned in the Table 3.3, the machine uptime always provides the scope of the working situation of the plant of the Industry. This would regularize number of processes, Process beginning and failure time and follows the computation timing factor of the Machine uptime. However this is one of the required representations of the timing factor in any VSM strategy for further plan of action of Visual flow control Systems.
Table 3.3: Machine Uptime Analysis

<table>
<thead>
<tr>
<th>No. of Processes</th>
<th>Process Start Time</th>
<th>Process Failure Time</th>
<th>Machine Uptime</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>86</td>
<td>83</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>35</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>92</td>
<td>86</td>
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<tr>
<td>5</td>
<td>9</td>
<td>21</td>
<td>12</td>
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<tr>
<td>6</td>
<td>2</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>59</td>
<td>59</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>26</td>
<td>23</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>36</td>
<td>24</td>
</tr>
</tbody>
</table>

With the help of the above data the over all machine uptime is easily computed according to plan of action, the executed related data of this graph as described in the following Figure 3.4 This time factor would be computed with the effective parameters with number of processes, process start time, process failure time can be easily evaluated, and this usual procedure makes the level of abstraction in positive manner based on Industry demand and effective performance of whole state of art

![Machine Uptime Graph](image)

Figure 3.4: Machine Uptime Graph
The whole procedure may once again provides an efficient key factors of the including process, with an average total time, cycle time and waiting time always makes the perfect way of approach for computing the lead time, as mentioned in the Table 3.4 according to the program execution based on the Industry demand

**Table 3.4: Lead Time Analysis**

<table>
<thead>
<tr>
<th>Processes</th>
<th>Total Time</th>
<th>Cycle Time</th>
<th>Waiting Time</th>
<th>Lead Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>83</td>
<td>8</td>
<td>62</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>86</td>
<td>8</td>
<td>27</td>
<td>35</td>
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<tr>
<td>3</td>
<td>77</td>
<td>7</td>
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<td>97</td>
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<tr>
<td>4</td>
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<td>1</td>
<td>59</td>
<td>60</td>
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<tr>
<td>5</td>
<td>96</td>
<td>9</td>
<td>63</td>
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<tr>
<td>6</td>
<td>35</td>
<td>3</td>
<td>26</td>
<td>29</td>
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<tr>
<td>7</td>
<td>86</td>
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<td>40</td>
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<td>72</td>
<td>76</td>
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<tr>
<td>10</td>
<td>21</td>
<td>2</td>
<td>36</td>
<td>38</td>
</tr>
</tbody>
</table>

This computational timing factor provides an efficient timing factor in all aspects of the program, in order to achieve with the over all combination of programming paradigm. However most of the actual relay of data with various parameters like an average total time, Cycle time, Waiting time easily succeed the performance level of the lead time. The condition of this time factor provides the exceptional behavior of the whole set of data execution once for all. The concise graphical analysis as mentioned in the Figure 3.5 for calculation of Lead time. With this easily come to a conclusion that, all timing factors are very essential through out the session of the manufacturing process, which conditionally matches value added techniques in order to achieve the goal.

The related parameters were significantly consider through out the working state of art in terms of leading parameters like Number of processes, total time, cycle time, waiting time and final computational of the lead time. This shows the real analogy of the various timing factors were essential in case of processing the VSM, for the future improvement of the automated Industry. So, that lead time factor is one of the important manageable resource timing analyses as in case real time Industry.
The final stage of the VSM timing factor is one of the essential timing analyses of the whole state of art of conditional events.

### 3.6 Conclusion

All state of art computations relates the manufacturing process to supply chains, distribution channels and information flows. Integrates material and information flows. This will links Production Control and Scheduling (PCS) functions such as Production Planning and Demand Forecasting to Production Scheduling and Shop floor Control using operating parameters for the manufacturing system using takt time, which determines the production rate at which each processing stage in the manufacturing system should operate.

The various timing factors unify several IE techniques for material flow analysis, such as Production Flow Analysis (PFA), Business Process Reengineering (BPR), and Process Analysis and Improvement (PAI). Provides important descriptive information for the Operation and Storage icons that, to date, has not been captured in standard Flow Process Charts used by IE’s. Forms the basis for implementation of Lean Manufacturing by designing the production system based on the complete dock-to-dock flow time for a product family.
Value stream mapping is a Lean process-mapping method for understanding the sequence of activities and information flows used to produce a product or deliver a service. Value Stream Mapping is used in all types of organization. From underground gold mining to outer space, and everything in-between, Value Stream Mapping has produced true system wide benefits to cost, quality, lead times, and flexibility.

Here, Value stream mapping typically focuses on a single product family, but choosing only one product family may not be appropriate in a service organization. For example, in banking, the customer may choose channels such as online, email or telephone banking. The value stream mapping methodology can be used to focus on the multiple product family lead the successful goal of the different relationship modules in any automatic manufacturing Industries.

The related result analysis source code had been described in the Appendix - B. The figure and facts of complete data values are taken from the programming results. This value stream mapping carried work as the part of beginning stage of contribution work. These are going to provide literal data for the efficient utilization of the productivity in the automated manufacturing Industries.

The contributed work factors of the time complexities are trigger performance of the value based production. Such a viable system is always yield the process of efficient usage of all types of raw materials for the automated manufacturing Industries.

In this context, value stream mapping in the shop floor control systems is effective visible one of the value stream added technique. Structural specification of the VSM pictorially represents design conceptual view for the shop floor control systems.

The various parameters of time complexities also provide an exclusive nature of the working conditions for the future enhancement of the shop floor activities. The possible state of an art is precise time factors always look for the fast regular utilization of the resources in the automated Industry.

So, the contributed work of the various item specification of this research work provides an exclusive work done for the further improvement of the productivity. The over and above these time complexities so, for only definition, the final view of the computerized work through the higher level language of C - programming is highly practical approachable. The over all computed, contributed various time complexities always make a perfect evaluation of automated manufacturing Industries.