Analyze

6.3 Value Stream Analysis

The objective of 'Value Stream Mapping' (VSM) is to reduce Lead Time and to eliminate Waste. Value Stream Mapping is a technique that is used to analyze the series of activities to manufacture a product or to complete a service. It can be applied to nearly any value chain. Very often it is the first step of each Lean initiative or improvement initiative.

Value Stream Mapping is one the most powerful Lean tools. It links all activities together in one visual representation. As such it provides the bigger picture by illustrating the complete flow and all its connections, which is not only limited to the operational process but also includes material flows, information processes and business processes. Within the visual representation it is possible to distinguish Value Added Activities from Non-Value Added Activities and to identify Waste.

Value Stream Mapping was pioneered in the 1980s by Toyota chief engineer Taiichi Ohno and Sensei (teacher) Shigeo Shingo, with the intention to gain competitive advantage. Value Stream Mapping is a Lean tool and, in principle, not a quality tool. However, Ohno and Shingo proved that reducing Lead Time and Waste also result in better product quality.

A value stream is defined as the series of all activities required to deliver a product or service. Examples for a Value stream are:

- From raw material to customer delivery.
- From product concept to product launch.
- From customer demand to delivered service.

6.3.1 Value Adding versus Non Value Adding

Like many other quality programs, Lean Six Sigma places the customer in the center of its activities. The first Lean principle is 'Value'. The definition of Value is 'What is of value to the customer'. Even more specifically, Value means 'The activities the customer is willing to pay for'. It is obvious that by using this definition, not all activities in your process will add value to the customer. So, why do it then? What is the point of doing things nobody wants to pay for?

The purpose of Value Stream Mapping is to visualize the process and distinguish the Value Adding Activities from the Non-Value Adding Activities. Let's review in a little more depth what the meaning of an 'Activity' is. Every activity in your process can be classified as:

1. Value Adding Activities (VA)	Customer is willing to pay for.
2. Non-Value Adding Activities (NVA)	Customer is not willing to pay for.
3. Necessary Activities	Necessary for the process.

A Value Adding Activity must meet the following criteria: The customer is willing to pay for the activity, it must be done correctly the first time (First Time Right) and the action must change the product or service in some way. If one of these criteria is not met, the activity is classified as a 'Non-Value Adding Activity' and therefore as 'Waste' or 'Muda', which should be eliminated. Necessary Activities are needed to keep the process running. These activities cannot be taken out of the process easily, but should be limited as much as possible. An example of a Necessary Activity is an inspection required by the customer or by the government.

6.3.2 Value Stream Mapping (Current State)

There is a big difference between Process mapping and Value Stream Mapping that can, at times, be confusing. Especially in service organizations people might construct a Process map and call it Value Stream Mapping, but this is not correct. Mapping the process is one of the steps within Value Stream Mapping. In addition, flows of material and information are visualized. Also the amount of Work in process, Cycle Times and waiting times are mapped. This is not done in a process map.

It is recommended to construct a so-called 'door-to-door' Value Stream Map, which examines the bigger picture and accounts for the connections between all processes. For this it is necessary to perform a walk along the whole 'door-to-door' value stream starting at the end of the value stream and moving upstream. Use a simple paper and pencil to construct the process along the walk. The mapping process is simple, real-time and iterative, as this method allows for simple corrections.

Figure 102 - *'Brown' paper session*

An effective way of working as a group is to cover a wall with paper and provide adhesive notes. Different colors can be used to represent different purposes. Each team member writes their tasks on individual notes and applies them to the paper in sequence. Notes with tasks can easily be moved around as other steps come to mind. The amount of 'Work in Process' (WIP) between each process step is counted. Lines are drawn between the steps to indicate the workflow. Also, lines are drawn to represent the information flows. This is also called a 'Brown paper session', although the paper can be white as well!

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The steps to perform Value Stream Mapping are listed below:

1. Define Product Family:
   Group of products with similar process steps that make use of common equipment in the value stream to the customer.
2. Construct Current State Map:
   Identify Waste in the process by mapping the current situation of material flows, work in process and information flows.
3. Construct Future State Map:
   Map the future situation and determine improvements to eliminate Waste.
4. Define Work Plan & Implementation:
   Implement future state map.

VSM Current State – Example
In this section we will construct a Current State Value Stream Map, step by step. This example is based on the fictitious factory 'PEN N.V.' that is assembling pens for its client 'Walmart'.

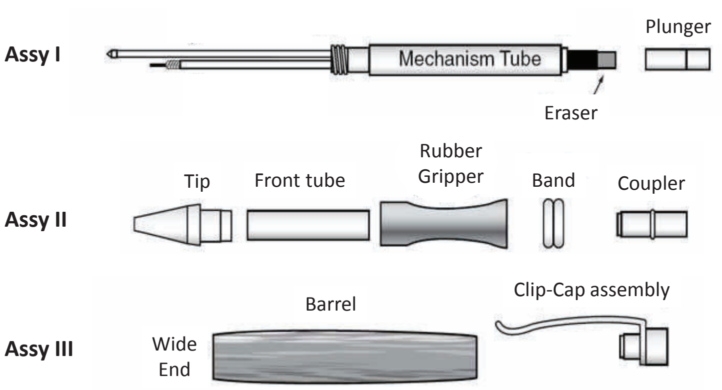

Figure 103 - *Pen assembly overview*

On the opposite page we will visualize the end-result of the Current State Value Stream Map, following the next steps:

- Step 1 – Map customer demand.
- Step 2 – Map production time.
- Step 3 – Map process flow and inventory.
- Step 4 – Add material flow between processes (Push & Pull).
- Step 5 – Add data boxes with current state information.
- Step 6 – Add information flows.
- Step 7 – Add flows for 'Raw components' and 'Finished goods'.
- Step 8 – Add timeline with queue time and Cycle Time.
- Step 9 – Determine Value Added Time.

Although constructing a Value Stream Map is a 'Pencil-and-paper'-tool, we will use a software program called 'Quality Companion' to visualize and analyze the Value Stream Map. This tool is explained in the pen assembly process example, but Value Stream Mapping can also be applied in many other sectors, such as Transactional environments, Logistics and Healthcare.

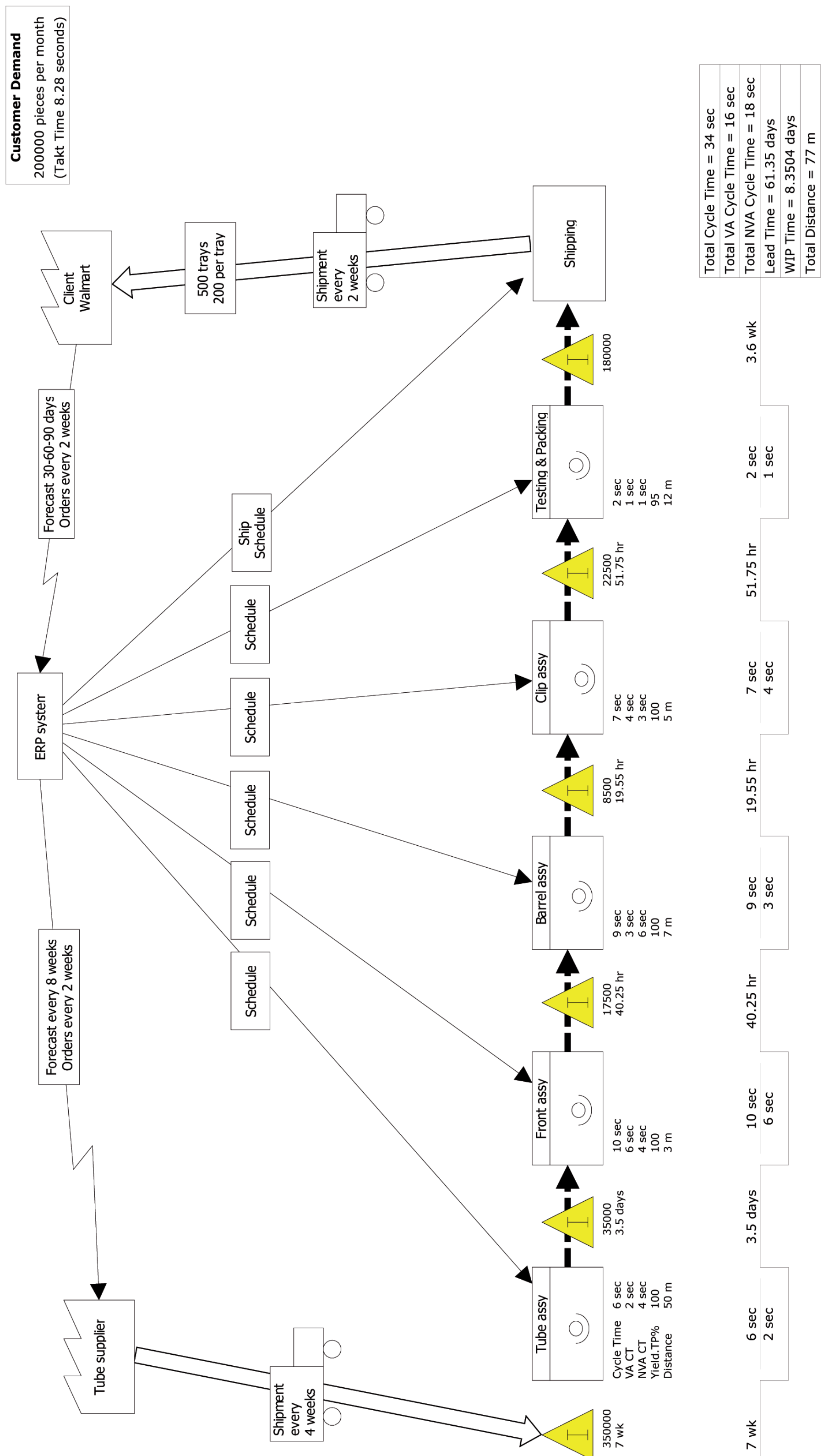

Figure 104 - *Value Stream Map Current State*

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Step 1 – Map customer demand:
Our client Walmart is ordering 200,000 pens per month.

- Customer: 'Walmart'
- 200,000 pens per month
- 500 trays per pallet / 200 pens per tray

Step 2 – Map production time:
The factory plant is producing in three shifts, with an average of 20 days per month.

- 3 shifts per day
- 8 hours per shift
- 20 minutes break per shift
- 20 days/month (avg.)

Taking into account the customer demand of 200,000 pens per month, this results in a Takt Time of 8.28 seconds.

$$Takt\ Time = \frac{Available\ Work\ Time}{Customer\ Demand} = \frac{3 \times (8 - \frac{1}{3}) \times 20 \times 3{,}600}{(200{,}000)} = 8.28\,\text{sec}\ per\ part$$

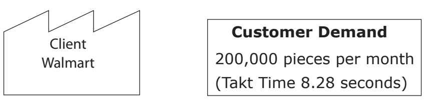

Figure 105 - *Customer Takt Time*

Step 3 – Map process flow and inventory:
We will map the process from 'door-to-door', starting at the end of the line and taking the most expensive part (the Mechanism Tube) into account. This results in the following illustration. Triangles represent the inventory levels or Work in Process level (WIP), between two process steps.

The production process consists of the following five steps:

1. Assembly I : Tube Assembly (Tube, eraser, plunger).
2. Assembly II : Front Assembly (Tube assembly, tip, front tube, gripper, band, coupler).
3. Assembly III : Barrel Assembly (Front assembly, barrel).
4. Assembly IV : Clip Assembly (Barrel assembly, clip/cap assembly).
5. Testing & Packing.

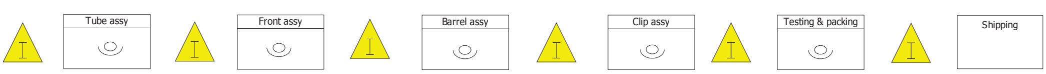

Figure 106 - *Process Flow Map*

Step 4 – Add material flow between processes (Push & Pull):
In this step we will add the material flows between processes. Depending on the way materials are delivered to each process step, we will use different symbols. In our case we only use the Push-arrow.

- First-In-First-Out: 

- Push: 

- Supermarket: 

- Pull: 

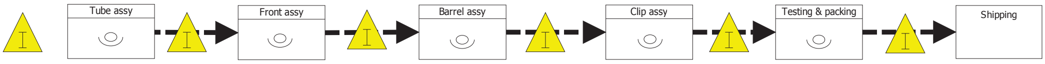

Figure 107 - *Material flow*

Step 5 – Add data boxes with current state information:
For each operation step we will collect Current State information by observing the operation with a stopwatch for 15 minutes. The Total Cycle Time is calculated by dividing the operating time (15 x 60 sec.) by the number of pens assembled during this time. The Total Cycle Time consists of Value Added Cycle Time and Non-Value Added Cycle Time. The difference can be calculated by comparing the number of pens assembled during the 15 minutes with the number of pens assembled during the entire operating time of one shift. The difference is caused by activities like walking, searching, waiting etc. These activities are called ‘Waste’. We will review examples of Waste in the next sections. The time that is not used to assemble pens will be represented in the Value Stream Map by ‘Non-Value Added Cycle Time’.

Current State information:

- One employee at each process step.
- Total Cycle Time (measured during 15 minutes).
- Yield-% at assembly processes is 100%.
- Yield-% at the testing station is 95%.
- The amount of sub-assemblies in front of each process step is counted.
- All distances between the operation steps are measured.

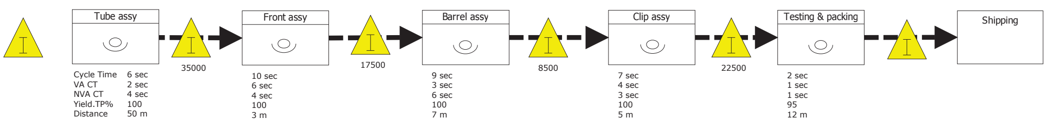

Figure 108 - *Data boxes*

Step 6 – Add information flows:
We will now map the existing information flows and scheduling.

- Volume of each process step is scheduled by the business system.
- We receive a 30, 60 and 90 days forecast from our client Walmart.
- Orders by the client are given every 2 weeks.
- A forecast to the supplier of the Tubes is given once every 8 weeks.
- Orders for Tubes are given to the supplier every 2 weeks.

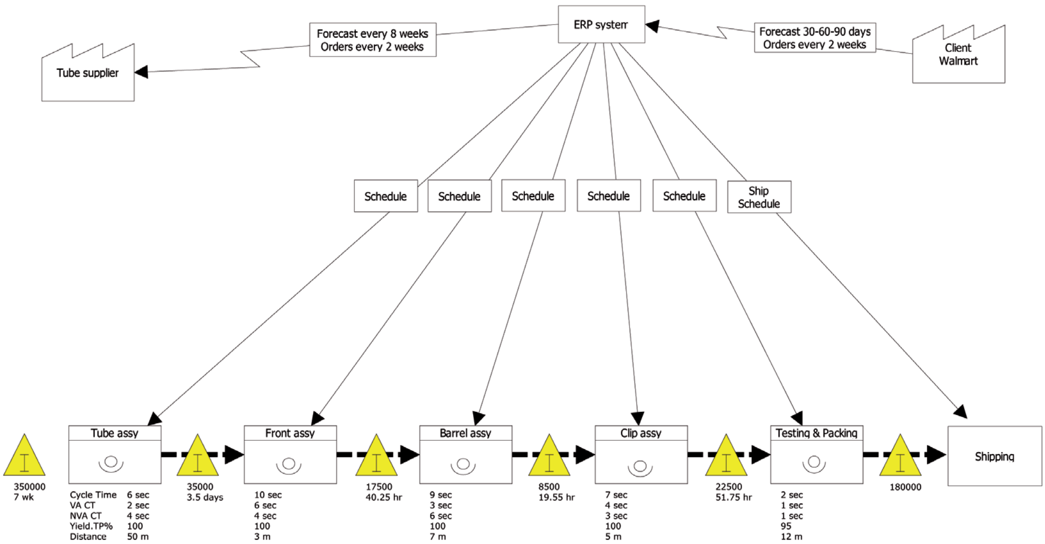

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Figure 109 - *Information flows*

Step 7 – Add flows for ‘Raw components’ and ‘Finished goods’:
We will now add the logistic information of the delivery of raw components to the line and the delivery of finished goods to the customer.

- Shipment of finished goods to client by truck every two weeks.
- Delivery of Tubes is done once every four weeks by supplier.

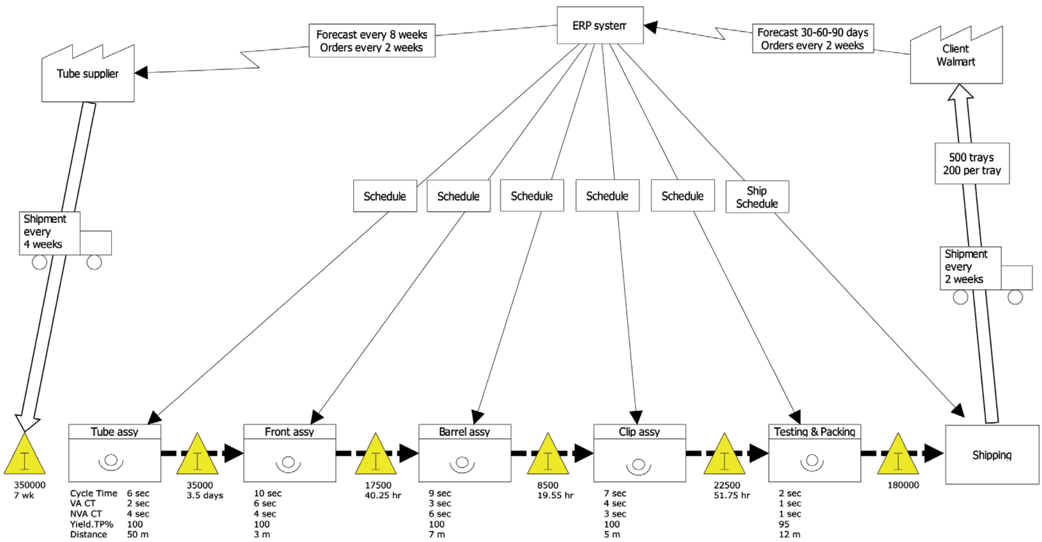

Figure 110 - *Raw components & Finished goods*

Step 8 – Add timeline with inventory times and Cycle Times:
In this step we will construct a timeline along the process. This is sometimes called the ‘Lead Time Ladder’. For each process step we will note the ‘Cycle Time’ (at the bottom of the timeline), which is the Cycle Time that was collected in step 5. For each inventory location we will calculate the ‘WIP time’, based on the Customer demand. We will place this time at the top of the timeline.

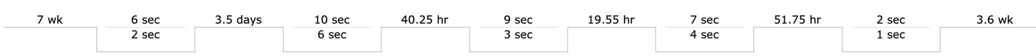

Figure 111 - *Lead Time Ladder*

Step 9 – Determine Value Added Time:
In this step we will add up all processing times. This is the 'Total Cycle Time', which is the sum of all 'VA Cycle Times' and 'NVA Cycle Times'. We will also add up all inventory times. This is the 'WIP Time'. The 'Total Lead Time' is the 'Total Cycle Time' plus 'Total WIP Time' plus the 'Inventory Times' of the warehouse and courier.

Description	Value
Total Cycle Time	34 sec.
Total VA Cycle Time	16 sec.
Total NVA Cycle Time	18 sec.
Lead Time	61.35 days
WIP Time	8.35 days
Total Distance	77 m.

In our example the Value Added Cycle Time is 16 seconds. The Lead Time is 61.35 days. Based on these measures we can calculate the 'Value Adding Percentage':

$$Value\ Adding\ Percentage = \frac{VA\ Cycle\ Time}{Lead\ Time} = \frac{16}{(50.783 \times 24 \times 3{,}600)} \times 100\% = 0.00036\%$$

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The conclusion is that only 0.000016% of the time components value is added to the Tube. The rest of the time subassemblies are sitting idle and no Value is added. This sounds extreme, but these numbers are not strange. Try it at your own organization for a certain product group. On the up-side, it means that there is huge opportunity for improvement. We will discuss this in the following sections where we will review a number of tools and techniques to reduce the Non-Value Adding times, waiting times and inventory times. At the Improve-phase we will compose a Future state of the Value stream.