Portál pre odborné publikovanie ISSN 1338-0087

Comparison of traditional VSM and VSM analysis based on simulation parameters

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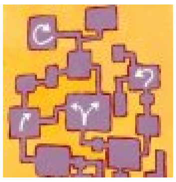
13.09.2010



This article discusses the Value Stream Mapping analysis and of different approaches to it. VSM analysis and indicators of WIP, LT, VAindex are also used in simulation projects. They are used to compare simulation outputs with the classic VSM analysis of the real process. The simulations are possible alternative approaches to VSM analysis as an example in demo SW Witness ValueStream.mod. The author extends the model of the VSM analysis with classical input data and discusses the differences of these approaches.

1 Introduction

To write this article I have been inspired by questions of customers and students regarding production indicators in the field of industrial engineering. Among often discussed production indicators belong WIP, LT, VAindex, OEE, PPM etc. Respective simulation project also other indicators can be followed or to select other approaches see the ValueStream.mod. Students at lectures are questioning this demonstrative example ValueStream.mod (Fig. 1), that is a part of installation of Witness situation software.

To my students I always stress: *„The correctness of outputs depends on quality of input data, plus simulation also reflects validity and detail of model. Selection of control indicators plays an important role."* Thus we often discuss this demo example and classical VSM map and data collecting in practice.

The aim of this article thus is to point out the differences and possibilities of various approaches to production process evaluation using VSM indicators.

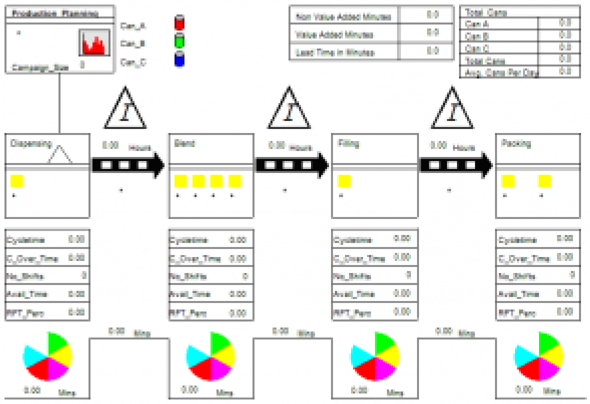


Fig. 1 Demo example VSM – WITNESS Power with Ease 2.0 ValueStream.mod

2 Value Stream Mapping - VSM

VSM is a simple visualisation tool for the controlled process analysis. It is a visual demonstration of the continual order flow in the process. The key stones of the VSM map are (Fig. 2):

1. Outputs are VAindex and „value added axis“
2. Information blocks – basic information about the process
3. Production order flow in the process
4. From supplier to the first process flow
5. From the last process to the customer flow
6. Control and management system
7. Information flows

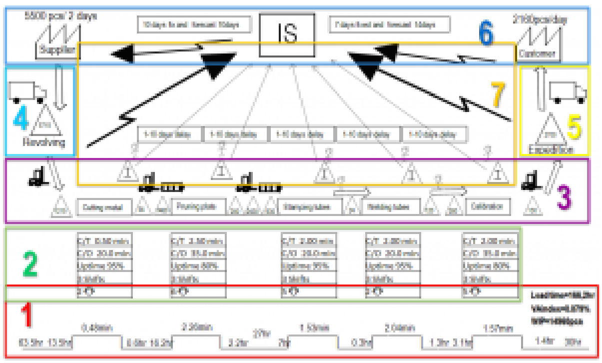


Fig. 2 VSM key stones – Value stream mapping

As already anticipated part of VSM map is „Timeline of Value added activities and indicator LT – Lead time, WIP – Work in process, VA_{index} – Value Added index (ration of times whwn the value added VA and total lead time)- These indicators make projects measurable.

That’s why VSM is used as the input analysis for: simulation, optimization projects, for changes in organization of work, reduction of stock, cutting down the lead time, product change audit, management change and new process proposal. Nevertheless the major benefit is visual display of order flow course through the process. Visualisation is carrier pulse for detection of wasting – activity „Non Value added” (NVA). The aim is t create a new flow. That is to see and focus on localities with potential for improvement. It is to create flow from the ideal view point or at least to improve the status.

Outline for creating VSM

Data for creating VSM maps are directly in gemba – in production process. Monitored is information and material flow.

Quantities of stock are physically counted on each locality of the flow. It is advisable to realize stocktaking in successive steps from the expedition to the entry. As for time management reasons only selected representative is observed – part type or a family of similar products.

The representative is selected e.g. based on Pareto analysis of volume of production, process intensity, for innovated part etc.

Important is also time period for data collection. VSM map is usually indicated by its creation date as it visualizes production status in a particular time "point" (certain date). We recommend selecting the representative and observed section so that the data (stocktaking and VA time measures) would be possible to collect in one max. three days.

Volume of stock is than recounted respective customer cycle from part to a time period. It corresponds to a time period covering customer consumption (most often in days). Thus we obtain major part of NVA times. In majority of cases are other NVA constituents e.g. manipulation and adjustment neglected.

Consequently operation ties are re-measured and evaluated. I recommend comparing these measurements with the standards and the method of conducting the work with technological procedure. Thus we discover auxiliary work that I consider NVA activities. Theses detailed analyses are usually not conducted as for lack of time.

This simplification can be tolerated with regards to general application of VSM as an initial analysis for prime introduction to the process.

Creation of the map itself follows. Overall observation of production processes is performed and recorded to VSM map. While we stress the often omitted information flow, that is only reflected in the material low. Time sequence is followed only to the point of information flow but its form, source, and process requirements which they employ. In demo – example (Fig.1) the author confines to Outputs; are NVA, VA, LT and „Timeline value added", Information blocks, Production order flow in the process, From supplier to the first process flow.

In the demo-example is thus already left out also the next step, when the map is completed by notes to the possible improvement localities as indicated on the scheme (Fig. 3) with comments bellow.

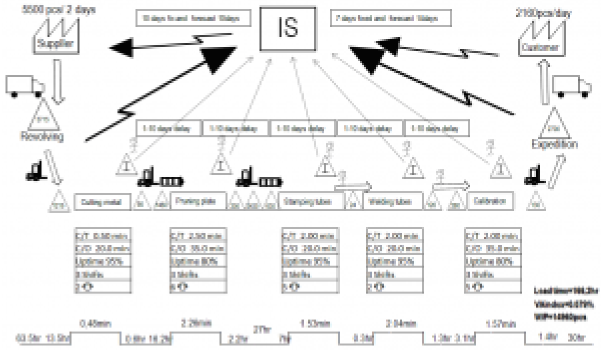


Fig. 3 Classic VSM in production process

VSM map is completed by numbered commentaries see the example bellow.

1 Operation buffers stock respective planning accuracy – lack of space in production.

2 Non conformed FIFO – conducted shop plan optimization respective adjustment

Input data for VSM classical indicators

As already mentioned among VSM basic responses belong the WIP, LT, VA_{index} indicators WIP – Work in process

$$WIP = \sum Q_i \quad [pcs] \tag{1}$$

$Q_i \quad [pcs]$ – quantity of pieces of the followed part in particular stock; or before/ on or blind particular work station of the observed process.

LT – Lead time

$$LT = \sum VA_i + \sum NVA_i \quad [day] \tag{2}$$

$\sum VA_i \quad [day]$ –Value-adding action time. Usually follows:

$$\sum VA_i = \sum \frac{CT_i}{N_i} \tag{3}$$

CT_i – Cycle time N_i – device multiplicity or number of parallel work stations $\sum NVA_i \quad [day]$ – non-value-adding action timeUsually stock transformed to time due to customers cycle $CuT \quad [pcs/day]$. Customer cycle time (Forecast per Day, Demand per Day)

$$NVA_i = \frac{Q_i}{CuT} \quad [day] \tag{4}$$

VA_{index} – Value Added index

$$VA_{index} = \frac{\sum VA_i}{\sum NVA_i + \sum VA_i} \quad [-] \tag{5a}$$

$$VA_{index} = \frac{\sum VA_i}{\sum NVA_i + \sum VA_i} * 100 \quad [\%] \tag{5b}$$

3 „Alternative“ VSM from simulation

The data for creating this VSM map are collected from the production process simulation model. There is primary material (information) stream generated in the model.

Within the simulation there are discrete events registered for individual model elements
(Parts, Machine, Buffers etc.). From the discrete event record is in the Witness SW created a wide scale of responses. This function offer employed also the author of the demo-example; *ValueStream.mod* on installation CD WITNESS Power with Ease 2.0.

Due to the simulation tools we have got available online model responses within experiments. Promptness and availability of wide scale of responses enables to online evaluate VSM indicators also for selected number of product types at a time.

Time period for data collection is perceived from a different view point than within conventional approach when we feel the delay between obtaining input data from various sectors of the observed process.

Under the time interval for data collection within the simulation we understand the period the experiment is running with regards to the volume of data file used for statistic evaluation. There are also other standard principles of simulation experiment to be considered such as „Warm-up time“ – period for feeding the model after starting the simulation.

Input data for „alternative“ VSM indicator

As stated above, among essentials VSM responses belong WIP, LT, VAindex, VA, NVA. To gain indicators the model *ValueStream.mod* (Fig. 1.) uses a different approach employing integrands.

$$VA_i = \sum \frac{OutputTime - InputLastTime}{No.OutputParts} \quad (6)$$

$$LT = \sum VA_i + \sum NVA_i \quad [day] \quad (2)$$

$$WIP = \sum Q_i \quad [pcs] \quad (1)$$

- NVA_i – Time Non Value Added actions – *ATIME* fiction was employed of Buffers element for each i-th stock. The *ATIME* function returns a real value, containing the time-weighted average of the time that parts have spent in a buffer.
- VA_i – Time Value Added actions – identical philosophy has been chosen as for obtaining time of NVA activities. Though Witness functions were not available, the value has been calculated as an average time of time data difference of the output part from the work station (a group of parallel workplaces) and the input part to the work station.
- Original model employed the script:AverageProcessTime(2) = AverageProcessTime(2) + TIME-ProcessTime$mins = \frac{AverageProcessTime(2)}{AverageProcessTime(1)}$ Note: Original model variables´ indication is ambiguous. *TIME* – time of the part leaving workplace *ProcesTime* – time when the part entered the workplace *ProcesTime(1)* – quantity of parts finished at the workplace
- LT – Lead time (production maintained time)
- The author has aso completed the Model by WIP response
- WIP – Work in process

$Q_i \quad [pcs]$ – is the quantity of pieces of the monitored part in particular stock. It is possible to use integrand.

NPARTS2(element_name, part_name, mode). The *NPARTS2* function returns an integer, containing the number of the specified type part in the specified element (buffer).

WIP- returns as its response also *NWIP(part_name)function*

The *NWIP* function returns an integer value, containing the number of parts of the specified type that are still progressing through the model.

4 Comparison of the VSM indicators

The author of this aticle completed demo-model by variables and functions, that enable obtaining the VSM indicators based on the conventional approach, see chapter 1. Comparing results of experiments realized on completed model VSM_Witness.mod (Fig. 1) confirm a significant influence of input data and the selection of parameters on nature of output data.

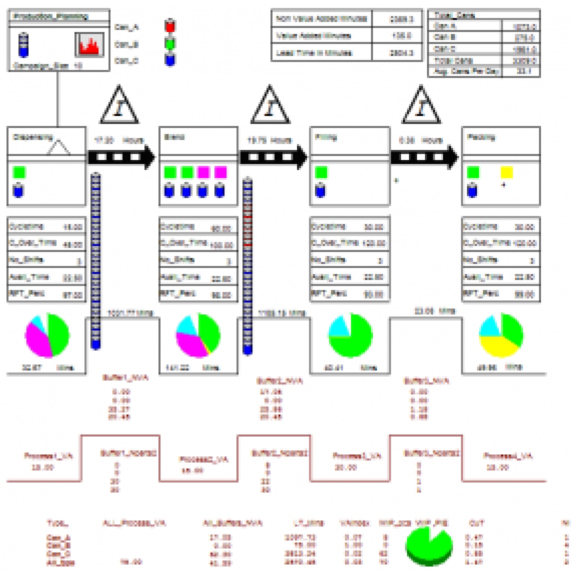


Fig. 4 Completed VSM model – WITNESS Power with Ease 2.0 VSM_Witness.mod

In the chart (Chart 1) are listed times of VA and NVA activities for the whole range of products in order to compare the VSM demo simulation approach and classical VSM. In the chart (Chart 1) you can see significant differences between these two approaches. Most evident is the difference at process 2. In the simulation approach the time for retyping has been indirectly calculated in the VA activities. Value-adding time VA is according to chapter 2 received from time difference when a part leaves the process and the time the last part enters the process. Thus with the growing number of production failures at multiple work places (function Quantity of the element Machine) cause by machine retyping, grows average maintained period of parts via this group of machine (sub process). Thus respective the setup time at Process 2 there is evident increase of VA to 141.22 min/pcs. Against classical approach it is based on set cycle time and max. number of in parallel worked parts, see Chapter 1. NVA activity times show different approach to input parameters. In simulation demo example is the NVA value determined from the average part storage time without regards to Customer cycle time. Classical approach is based on actual volume of stock recalculated in accordance with customer cycle, see Tab.No1.

Table 1 – Responses of VSM_Witness.mod, Time VA and NVA activities

[min]	VA Proces1	NVA Invertory1	VA Proces2	NVA Invertory2	VA Proces3	NVA Invertory3	VA Proces4
Simulation All type	32.67	1031.77	141.22	1185.15	40.41	23.08	49.95
Classic All type	15.00	1227.00	15.00	1227.00	30.00	40.80	15.00

These VA and NVA time differences VA a NVA are obviously reflected also in LT and VA_{index} values (Tab. 2).

Table 2 – Responses of VSM_Witness.mod, VSM indicators

VSM indicators	NVA [min]	VA [min]	LT [min]	WIP [pcs]	VA_{index} [%]
Simulation All types	2240.00	264.25	2504.25	-	0.18
Classic All types	2494.80	75.00	2569.80	70.00	0.05

Conclusion

Comparing both approaches creating simulation model (input parameter definition) are evident significant dissimilarities. I personally do not recommend seeking and application of alternative calculations of this nature. This approach, using nonstandard data sources and there derived calculations, for commonly used indicators would only cause incorrect results interpretation.

Compared to generally crated VSM (that is paper and pencil) the simulation approach may offer a great number of additional information. For example time course of these indicators, while in reality we have got available (recorded one moment in the system) only one status in particular time. Nevertheless this is no more the aim of this article.

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