ANALYSIS OF A PRODUCTION SYSTEM WITH THE HELP OF LEAN MANUFACTURING TOOLS

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Abstract: *In lean manufacturing waste is anything that adds to the time and cost of making a product but does not add value to the product from the customer's point of view, figure 1. Lean manufacturing is a manufacturing philosophy that shortens the time between the customer order and the product build by eliminating sources of waste. Based on the need to reduce increase the production and to reduce the non- added value activities, a study was made, that uses LEAN manufacturing tools to describe and to analyze the production system. The construction and usage of LEAN tools give us a clear vision of the present stat of the production system and shows the places that need improvement. By its simple way of synthetization of information, these succeed of being a common language, easy to understand by anyone*

Keywords: *Lean manufacturing, VSM, SIPOC.*

1. Introduction

After war what did Japan have, not much but had drive, desire Taiichi Ohno was charged with the development of a system for Toyota that would allow them to survive in what was a very tough situation for a Japanese company post war time.

Late 1800's two Toyota brothers were in the textile loom industry. The first stop the line process for this equipment. As you can imagine a machine that weaves cloth will have an enormous number of treads coming together to make the material and if any one tread were to break the fabric would be defective. Since Toyota had automated this process he found the he needed to have a person at each machine to watch these looms so that they could stop and correct any problems as they occur.

It came to him that these people were basically standing idle most of their day and he felt this was disrespectful to the employee. Thus the first name for TPS was "Respect for Humanity". This is when he came up with the first crude machine that could detect an error, in this case a broken thread on it's own with out human interaction and STOP. Then flag itself that it stopped like a "tip-up" for ice fishing when a fish is on. A person could monitor several machines at once giving this person more value both personally and for Toyota. He found that it was better for a machine to set idle waiting for the person to respond than the other way around. So Ohno, already had the genius of Toyota brothers and a true business need to drive his vision of providing the customer exactly what he wanted when he wanted using the least resources possible.

There are many models today that depict the TPS and this is only one and it comes from the UofM Japanese technology center the center for professional development, figure 1.

Toyota has 2 pillars and the other stuff is foundational. It is a system of tools and principles that lead an organization in all its endeavors.

Figure 1. *Toyota house*

LEAN represents a strategy of management that has as objective to increase the added value to the client, which is applied with success in many fields. As it can be seen in the next figure, the LEAN system has the tendency to eliminate lost that have place from receiving the order from client to the delivery to him. If in a usual business, in an enterprise that does not apply LEAN, the time between order and delivery is big (cause of lost), in an enterprise that applies LEAN, this reduces considerably [Bicheno, 2004], [Sahoo, 2008].

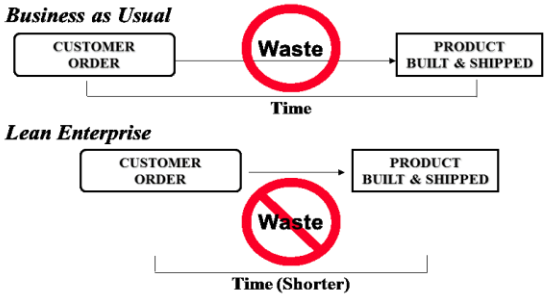

Figure 2. *Lean thinking*

The activities in an enterprise can be classified depending of the value they have, as following:

- Value added activity - is any activity that transforms raw material or data into the shape that the customer requests and is willing to pay for;
- Non-Value added activity is work or time that may or may not be required but it does not transform the data or material in any way other than it allows us to maintain our current process.

Non-value activities are divided into two categories:

- Necessary Work - Business Value:
- Unnecessary Work - not working.

In case of a physical product, the ration between the times for the 3 activities types and the total duration of the production cycle, for an average production company is: 5% VA; 60% NVA si 35 % NNVA.

LEAN represents a systemic approach to identify and eliminate wastes (NVA), by continuous improving of the product production flow, considering the client demand and aiming for perfection. The main instruments used by Lean Manufacturing to identify NVA activities are:

- SIPOC analysis;
- Lean evaluation questionnaire;
- Value stream map.

1.1 SIPOC analysis

SIPOC is an instrument that makes the sum of entries and exists of one or more processes in a single table (http://wikipedia.com). The SIPOC acronym, comes from: S=Suppliers I=Inputs P=Process O=Outputs C=Customers [http://wikipedia.com].

SIPOC analysis is used for three reasons:

- To give a general view, for persons that are not familiar with the analyzed process;
- To help in defining a new process;
- For those that are familiarized with the system helps to visualize the changes.

The most important aspects of the SIPIC analysis are:

- The suppliers can be intern or extern of the organization;
- Entries and exists can be material, services or information;
- The accent is put on capturing the set of entries or exists more than on the individual steps of the process.

The table that must be filled after the SIPOC analysis is shown in Tabel.1

Tabel 1. *SIPOC analysis*

S Suppliers	I Inputs	P Process	O Output	C Customers
-	-	-	-	-

1.2 Lean evaluation questionnaire

The questionnaire includes a list of activities, and to define them questions are asked on different categories of interest. Depending of the answers a grade is given and a total is calculated on a scale from 0% to100%. The evaluation is on:

- Stocks (the size of stock of products or raw material, etc.);
- Team (organization type, payroll system, staff fluctuation);
- Process (types of process, range of process)
- Maintenance (the frequency of breakdown, the existence of preventive maintenance etc.);
- Location and handling (the level of cleanliness, percentage of space used for location and parts handling);
- Suppliers (the average number of suppliers for each raw material or bought components, specific contractual conditions for supply);
- Equipment tuning (the average duration of adjustment for the most important equipment, existence of a working procedure);
- Quality (the percentage of workers that were educated to use statistical control techniques, the general ratio of noncompliance);
- Visual-management (information panels, presence of data displays in the enterprise);
- Planning/ Control (percentage of production in a LEAN flow, direct from one operation to another, the degree of respect of delivery delays).

The results of the questionnaire are presented in form of a radar diagram.

1.3 Value stream map

Value stream mapping is a paper and pencil tool that helps you to see and understand the flow of material and information as a product or service makes its way through the value stream. The power of value stream mapping lies in walking the plant floor, talking to workers, and closely observing how a product is actually made from start to finish. A value stream involves all the steps in a process, both value added and non value added, required to complete a product or service from beginning to end.

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. Lean practitioners use value stream mapping to:

- Identify major sources of non-value added time in a value stream;
- Envision a less wasteful future state; and
- Develop an implementation plan for future Lean activities.

Building of the current value map – in this stage one accomplishes the following:

- One gathers information from customers – the number of ordered products, the quantities, the carry time up to the customer, the production forecast time, how many days before the stable order is performed.
- One defines (describes/designs) the manufacturing cells.
- One gathers data concerning the processes inside the cell and at the levels of inventory – the name of the operation, the time of the production cycle (C/T), the number of machine men (operators), the size of the manufacture lot, the changing time, the available time, the available machines number etc.
- One identifies the papers whereby the commodity is delivered to the customer.
- One gathers information about the suppliers.
- One designs the information flow.
- One designs the production process time.

Once you collect data for the materials line, you may notice large differences between the amount of material used and the amount needed for the product. This can help you target Lean improvement efforts on the largest sources of waste.

Rother and Shook have found that the most useful aid for drawing the future-state map is the following list of questions:

1. What is the takt time, based on the available working time of the process closest to the customer?
2. Will you build to finished goods supermarket from which the customer pulls, or directly to shipping?
3. Where can you use continuous flow processing?
4. Where will you need to use supermarket pull systems in order to control production of upstream processes?
5. At what single point in the production chain (the "pacemaker process", which is the process that will run at takt time) will you schedule production?
6. How will you level the production mix at the pacemaker process?
7. What increment of work will you consistently release and take away at the pacemaker process?
8. What process improvements will be necessary for the value stream to flow as your future-state design specifies?

Based on the answers to these questions the ideas are marked directly on the current state map in red pencil. Once the future-state thoughts have been worked out in this way, the future-state map is drawn [Rotaru, 2009], [Rother, 2003],

2. Description and analysis of a production system with the help of Lean Manufacturing tools

To present the production system targeted by Lean demarche it was used the SIPOC analysis. The result is presented in table 2.

Tabel 1. *SIPOC analysis*

S	I	P	O	C
Supplier	Wire	Welding	Plase	Custemer cell

LEAN evaluation was made with the help of evaluation questionnaire, and by it an initial status score was obtained. The results of the questionnaire are presented in figure 3 and 4.

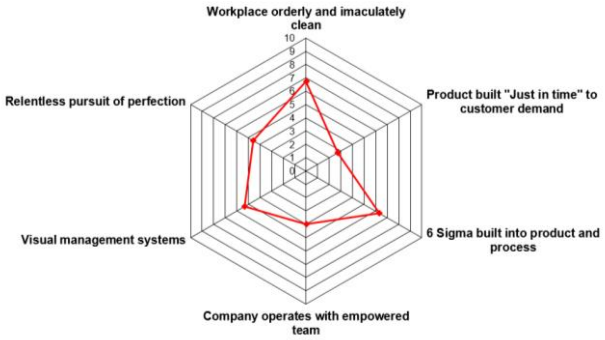

Figure 3. *Lean Overview*

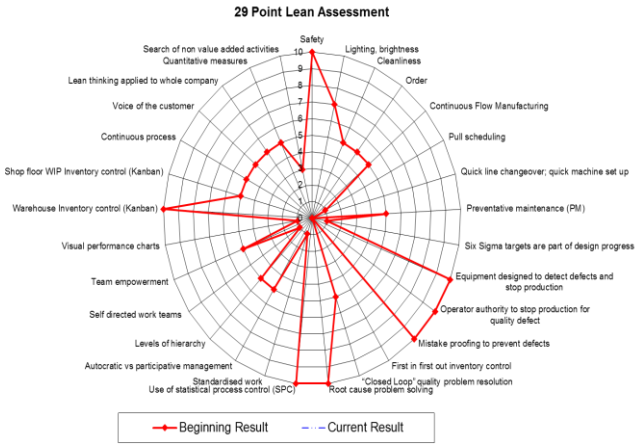

Figure 4. *Lean Assessment*

To make the Value stream map for the present situation were used the following steps:

- Step 1 – details about choosing the VSM team, choosing the thematic and the SIPOC analysis;
- Step 2 – details about analysis of transport mode of row material, components and finished products;
- Step 3 – details about process sequence;
- Step 4 – details about analysis of material flow;
- Step 5 – details about analysis of information flow;
- Step 6 – details about analysis of loss and observations on them;
- Step 7 – details about objectives, opportunities and improvements.

Value stream map in present state is shown in figure 5.

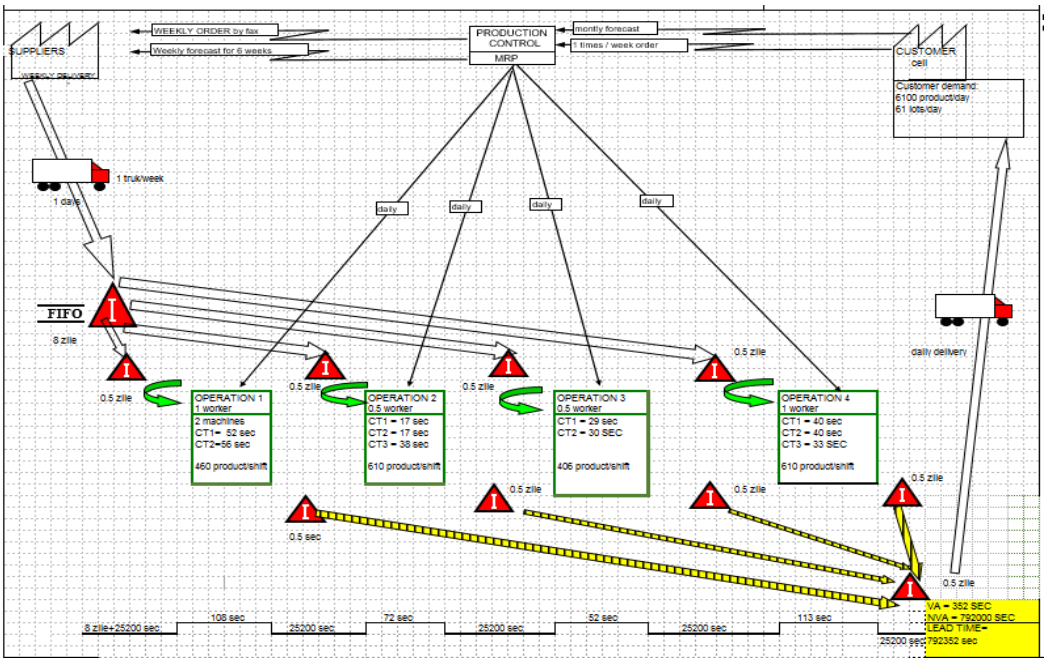

Figure 5. *Curent value stream map*

After construction of VSM were identified the duration of VA/NNVA activities and also the duration of NVA activities, as following:

- Duration of VA/NNVA activities is 352 sec;
- Duration of NVA activities is 79000 sec

Starting from the information in VSM were identified possibilities of improvement of the production system, as following:

- To make a finish products stock as supermarket type;
- Application of 5S;
- Standardization of operations;
- Standardization of supply method with finished products of the RBT cell and with row material of SPOT workstations;
- Optimization of conditioning method of row material in boxes, figure 6.

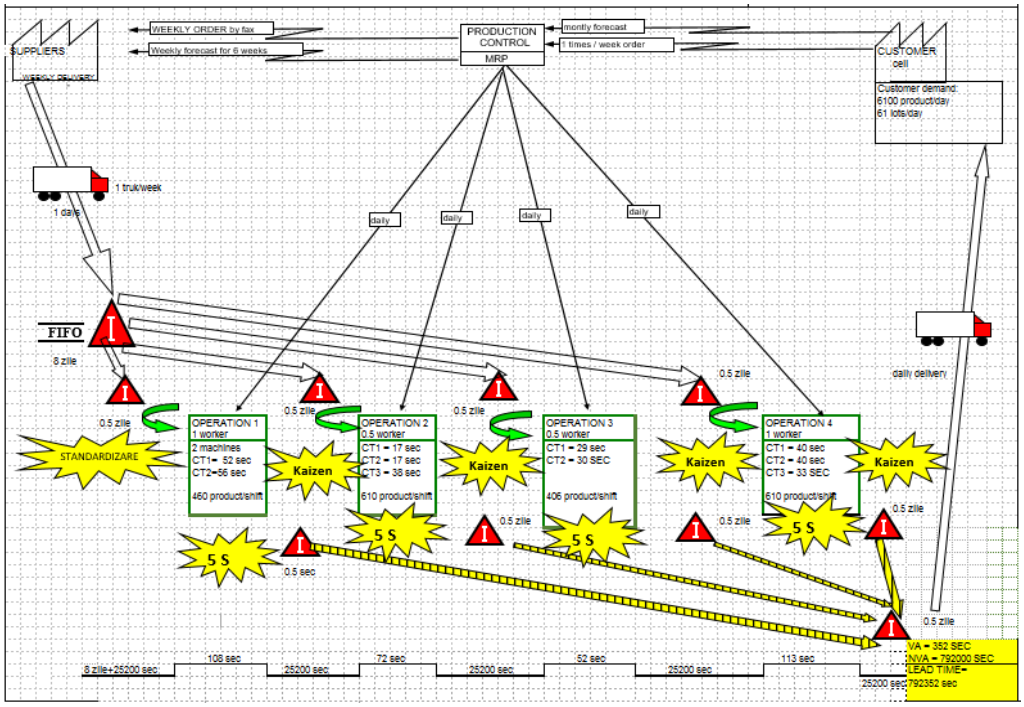

Figure 6. *Future value stream map*

Re-analyzing the production system with the Lean questionnaire highlights the evolution of the production system, figure 7 and 8.

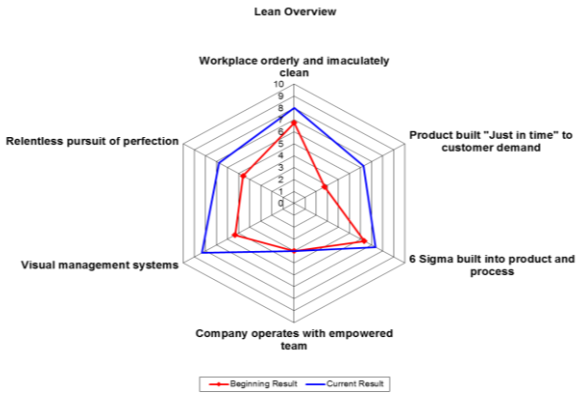

Figure 7. *Lean Overview finals*

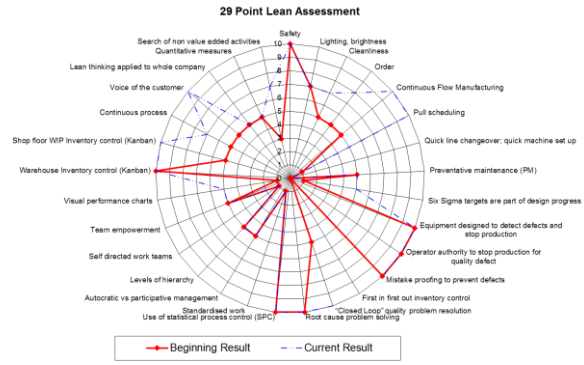

Figure 8. *Lean Assessment*

3. Acknowledgments

The construction of value stream map helped to visualize the initial status and also to find problems on the analyzed area. Therefore decision for improvement of production process were taken.

The construction and usage of LEAN tools give us a clear vision of the present stat of the production system and shows the places that need improvement. By its simple way of synthetization of information, these succeed of being a common language, easy to understand by anyone.

4. References

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