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VALUE STREAM MAP AND KAIZEN CONCEPT IMPLEMENTED IN A SHAFT MANUFACTURING CHAIN

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ABSTRACT

Nowadays, the competitiveness between companies strongly requests continuous improvement techniques of the manufacturing cycles. Companies that apply and sustain the improvements have a competitive advantage over their position on the market. Japanese quality concepts like Toyota Quality System prove their efficiency by implementation in manufacturing companies leading to time-saving, no stocks production, optimum cost, high quality products. In this sense, Value Stream Map – VSM – represents one of the tools that detects the cause of failure and has the capacity to prevent the effect of this failure on the whole manufacturing chain. The paper presents the simulation of a Value Stream Map in a virtual small enterprise before and after implementing Kaizen method. The virtual enterprise manufactures shafts and after implementing Kaizen, VSM will highlight an important development of the technico-economical performances and of the benefits.

KEYWORDS: Value Stream Map, Kaizen, shaft manufacturing

1. INTRODUCTION

The success of the Japanese automotive industry after the Second World War is due to the development of the Toyota Production System (TPS). The TPS is based on the lean thinking principles and has successfully been implemented by numerous manufacturers in many industries around the world.

Lean manufacturing or small cost production is a manufacturing philosophy that reduces time from the clients order to delivery system, by eliminating wastes. In such a competitive market, most of the companies around the world are searching for the best methods and techniques to improve the manufacturing systems, by reducing costs, time and money. One of the lean techniques that help the management in decision-making is the Value Stream Map (VSM) method that identifies all the wastes during a technological flow.

Value Stream Map is used as an improving method to progress in implementing ‘lean thinking’ and as a leading formula in the improvement activities. It is a tool that provides communication solutions for practitioners to obtain maximum efficiency and definitions of theoretical development points to become a reference among redesign techniques. As an improvement tool, VSM simplifies the measurement of times without added-value, so the calculation of lean coefficients is much easier and it is possible to improve the operative actions with strategic results.

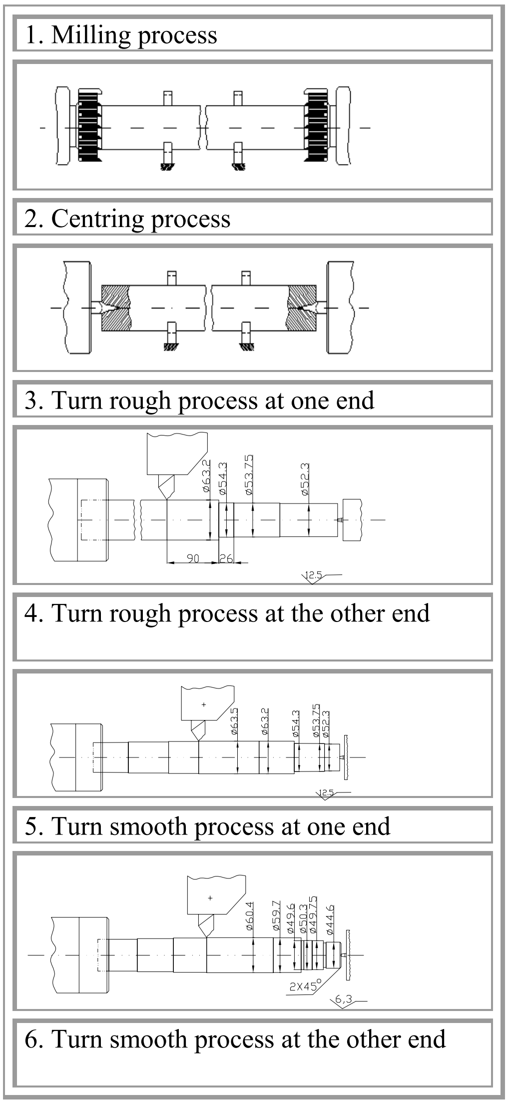
Value Stream Map is a collection of all the actions, the add-value ones, as well as the non value actions, which are necessary for a full process of a product through the technological flow, from the raw material to the client. The final aim of the Value Stream Map is to identify all types of wastes in the value flow and to eliminate all these wastes.

Value Stream Map is method that uses a set of predefined standardized icons. The first step for creating the Value Stream Map is choosing a product or a family products that we wish to improve. Next step is drawing the current state map for the value flow which shows the present activity. The third step is drawing a future state map of the value flow, which will present the way that the system should look after eliminating all the wastes. This map becomes afterwards the base for decision-making regarding the necessary changes in the system.

This paper is focused on the analysis and use of the VSM to get improvements by means of kanban and kaizen, implemented in an efficient way in a shaft manufacturing chain.

2. MANUFACTURE AND PRODUCT DESCRIPTION

The value flow that we want to improve describes the manufacturing process of a shaft part with a frequency production process of 300 parts per month; the stocks are of 150 parts/2months. Methodology of applying Value Stream Map to this value flow is based on continuous improvement of manufacturing processes. A first design of the Value Stream Map is done according to the data collected in the manufacturing process: identifying the workstations and the key-times for each station. The technological flow of the shaft part contains the operations in Fig.1.



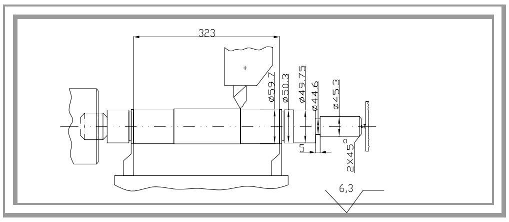


Fig.1 Flow operations for shaft manufacturing

3. CURRENT STATE MAP FOR THE TECHNOLOGICAL FLOW

The current analyse of the technological flow is being done in order to create a clear and common vision of the "target system" in the organization, related to the current state.

For drawing the Value Stream Map for the technological flow for the shaft manufacturing, after we have identified all the operations in the flow, we have to identify the most important decision-making points. For each operation in the technological flow, we have to establish which ones play an important role to the value-added raw material, to the final product. In the next step we have to identify the stocks, the productive and non-productive times for describing the manufacturing process. There are taken into consideration material flow (the external supplier sources, stocks, the production plan depending on the estimated market request, the production process, the workers and means of transportation) and the informational flow (manual and electronics information flows), that include all the participating elements in a production process.

Fig.2 shows the current state map for the shaft manufacturing process. Data collection for the material flow started at the shipping department, and worked backward all the way to the milling process, gathering snapshot data such as inventory levels before each process, process cycle times (CTs) and changeover times (CO). Production is controlled with MRP function which is the quantify planner function.
The shipping department receives a daily programmed planner from the production control department. Clients send their weekly orders to the production control department for a 30 days distribution.

The timeline at the bottom of the current state map has two components. The first one is the production waiting time (in days) which is obtained by summing all the lead-time numbers from inventories before each workstation. The total observed value for the waiting tine is around 22 days.

The second component of the timeline is the processing (or the added-value) time which is 8min and 45 sec. This time is calculated by adding the process time on each workstation in the value stream.

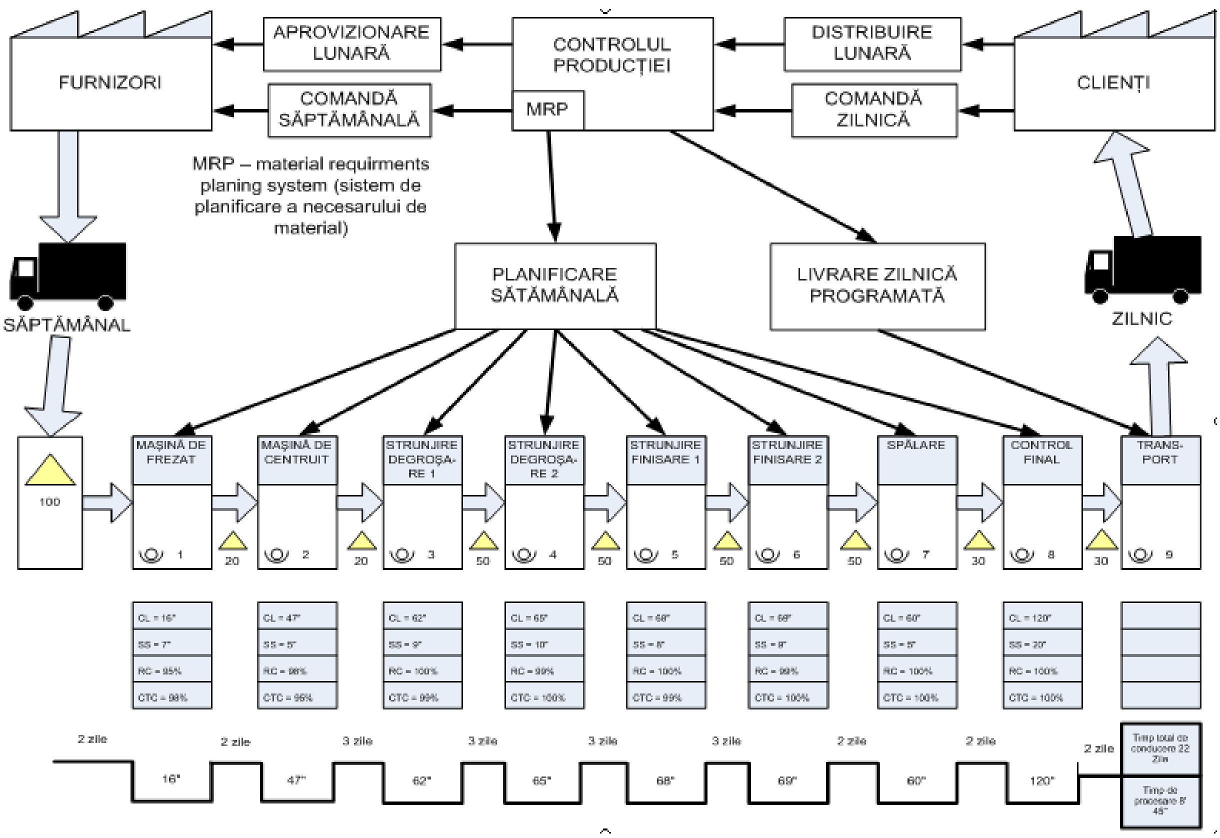


Fig. 2 Current state map of the shaft manufacturing cycle

4. FUTURE STATE MAP

Methodology for drawing the future state map is based on the continuous improvement process. For describing and defining the future state map, several target areas for improvement start to show up. Looking at the current state map there can be identified: large inventories between workstations, the big difference between the total production lead-time (22 days) and the value added time (8min 45 sec), and each workstation producing on its own schedule. The inventory and the lead-time can be viewed as two related issues since the more the inventory, the longer any part must wait for its turn to the workstation, and thus a longer lead-time.

In order to draw the future state map we have to use Just in Time production principles and to answer a series of structured questions.

The first principle, a continuous production flow, is necessary because the lot production is slow enough to answer the takt time requested by the client and leads to huge stocks.

The second principle, the pull production system, is the process where the downstream process pull form the upstream process what is necessary for the manufacturing process. The upstream processes than replace what has been taken. The pull system is triggered when the client purchases the final products, during multiple orders or during a new product order. The pull production system allows small stocks production. This way by minimizing the kanban cards on the flow and with a continuous flow production, the stocks are diminished.

Next we have to answer to a series of structured questions which will allow us to come up with the future state map that will help in eliminating or reducing different types of wastes in the current manufacturing system.

Question 1. What is the takt time?

The takt time refers to the buying rate of the customers' right form the production line, rate that is necessary accomplishing all the clients' conditions. Takt time is total available time for manufacturing on each shift/ daily customer demands. In our case the client asked for 100 parts/day. Daily programme 8 hours in two shifts, which means 480 minutes per each shift. Our takt time will be 480/50=9.6 minutes/part. If we produce faster than this time, then there will be an overproduction. If we produce slower then we won't be able to answer all the clients' needs.

Question 2. Where can we use continuous flows?

First we can identify the workstations that are really constraining the continuous production flow, the metal melting workstation and the alloy pouring, solidification and cooling workstation. This constrain takes place because cycle times on each workstation are higher than takt time. Cycle time on metal melting workstation and on alloy pouring, solidification and cooling workstation is 6 hours, 240 minutes more than takt time on each workstation. Besides this, we also have to say that these two workstations are also used in other parts manufacturing processes and that is why we cannot use them in a continuous flow. To assure the best work of the flow cells, we can keep small part stocks, so that after each step of the process, in case one workstation detects a broken part, it won't be necessary to stop the entire cell.

Question 3. Will production be delivered directly to shipping or to a finished goods supermarket?

The value flow is always wanted to be pulled inside the enterprise. We wish to create one continuous flow cell and this why in the rest of the process we have to introduce some supermarkets to stop overproduction and to send the next order without any delay. In our manufacturing flow we have to introduce 6 supermarkets: before the milling machine, between the milling machine and centring machine, The milling machine and the first flow cell, the first flow cell and the second flow cell, the second flow cell and the third flow cell, the third flow cell and the shipping department.

On each supermarket it will be introduced the kanban system, because it follows the rules of a pulled inside the enterprise system of the value flow. Implementing the kanban system answers the need to reduce costs by regularizing them between workstations. The kanban card system is an economical and efficient solution of control on the raw material in different processes. In each supermarket there will be some special shelves, called kanban shelves where parts will be placed when they have to be deposited.

Each lot will have a kanban card with: name and reference of the lot, destination of lot, number of parts in each lot and the total number of cards. These cards are placed in special plastic boxes that are attached to each shelve, for each lot. Because this is a flexible manufacturing system, introducing the kanban cards is possible to regularize the stocks between the work stations.

We have to say that the number of kanban cards depends on the quantity of each lot and on the necessary stock. Each lot received from the supplier has a kanban card and is deposited on first supermarkets' shelves. Materials follow the FIFO method (first in-first out), that means first lot deposited is the first lot that gets to be processed. Implementing the kanban cards system develops the manufacturing orders that always determine the same cards, avoiding any other unnecessary paper and solving any other administrative problem.

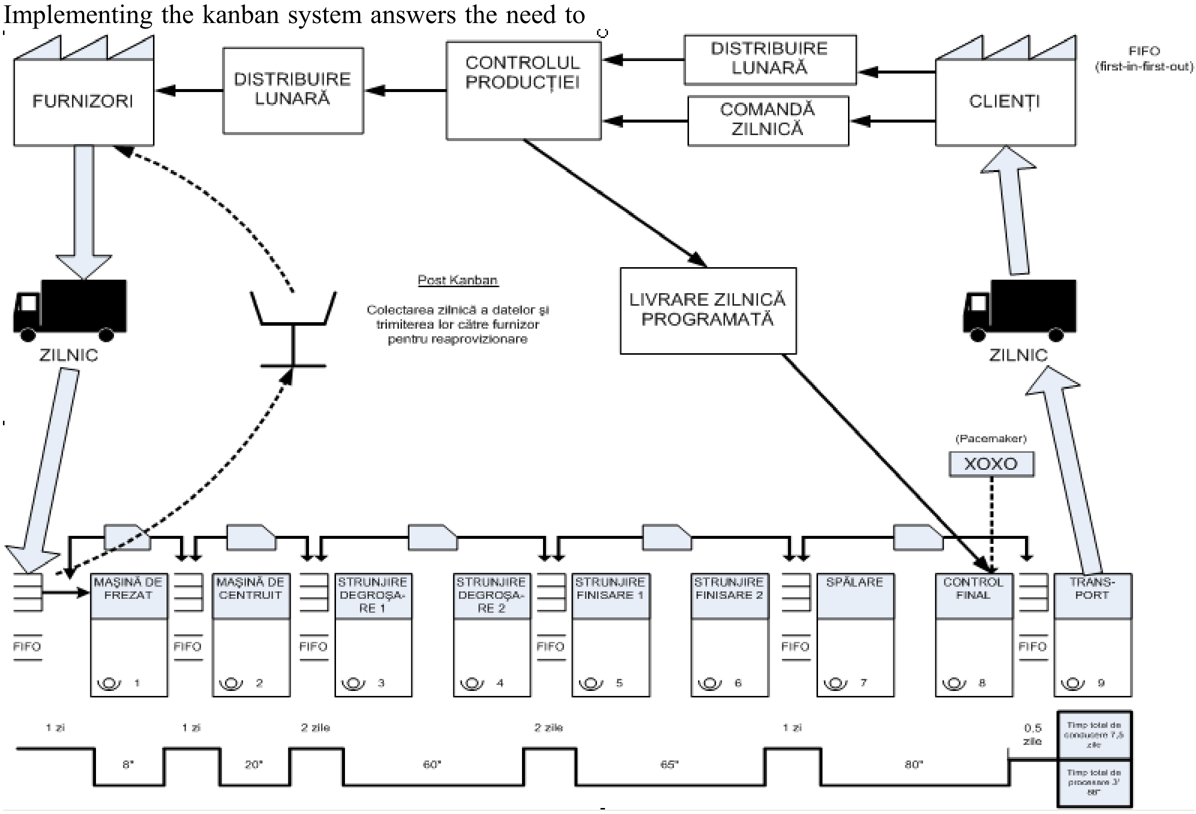


Fig.3 Future state map of the shaft manufacturing cycle

Question 4. In what singular point of the manufacturing system can the enterprise do the planner programme?

To stop overproduction in any workstation from the value flow, just a single point from the value flow supplier-client needs to be planned. This point is called pacemaker process because this point sets the manufacturing speeds for all the upstream processes and ties down the upstream processes with the downstream ones. Each workstation from the upstream reveals a return signal from the next downstream process, and the downstream flows from the pacemaker have to appear in a continuous manner. In our case we will set the pacemaker cell at the final test worktstation. This cell will receive at every few minute's the next order that is generated by the kanban cards. Optimal work of pacemaker cell has to be done in the best conditions in order to assure a high viability level and a reduced changeover time for each workstation, so that the takt time to be much closer than the changeover time.

Question 5. How do we have to improve the manufacturing process so that we could draw the future state map?

As we showed before, the manufacturing process is being improved with different methods. We set up 6 supermarkets and we created one flow cell inside the value flow. Introducing the kanban cards in the value flow leads to reducing useless costs and to a much more continuous manufacturing flow, without having to stop the workstations. The changes that we made have showed better changeover times and uptimes.

In Fig.3 you can see future state map with all the improvements and optimization methods that we applied, and we can see that total lead time was reduced from 22 days, in the current state map, to 7.5 days, in the future state map. Processing time was reduced from 8min 45sec, in current state map, to 3min 8sec in the future state map.

5. RESULTS AND DISCUSIONS

After applying Value Stream Map in the value flow for a cast part, we can see important improvements that took place in the manufacturing process. In figure 4 we can see the cycle times on each workstation, before and after applying Value Stream Map. There are significant changes between the two cases. On the workstations where flow cells where implemented, the time has significantly been reduced.

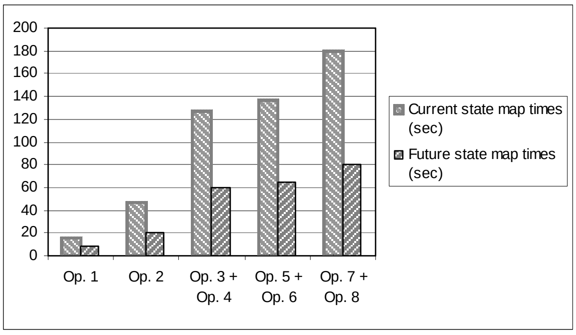


Fig.4 Cycle times on each workstation

6. CONCLUSIONS

This paper presents the redesigning of a shaft manufacturing chain, and tries to connect the informational data with the operational ones. This redesign is done by focusing the operations on eliminating non-added value time and on decreasing the intermediate stocks.

Stocks have been reduced through VSM which identified the improvement points and kanban cards which eliminated administrative inefficiencies. By implementing the kanban cards wastes of unnecessary inventory were reduced, excessive transportation and idle times applicable to every production and layout design.

To obtain a continuous flow, Value Stream Map needs to be applied at least every two months in order to eliminate any potential wastes and to improve the manufacturing process. Application of all these improving methods helps to enhance the materials flow in the assembly line in a short time. Also by introducing the supermarkets and the kanban shelves, the storage space will get much smaller and that will eliminate any unnecessary operations between the workstations

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