Analysis of Organization of Production Process on the Basis of Value Stream Mapping

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Abstract. This article discusses the process of identifying the problem areas of the product cycle by the value stream. Mapping value stream mapping allowed the development of a number of management solutions to increase productivity, optimize the process and improve the competitiveness of products. For the study a product manufactured by one of the industrial enterprises of the city of Samara was selected. The production process as repeatedly optimized by services of the plant, but its cycle is still and unstable. To solve these problems the pull scheme of production was proposed. The proposed method for the improvement of the production process on the basis of value stream mapping allows optimizing the production process, reducing the production cycle, improving the quality and efficiency of production. The final results were expressed in value terms. The final result showed that the use of this method allows reducing the duration of the production cycle for 42.28%, the cost of products - by 57.71%.

1. Introduction

The modern industrial enterprise encountered the problem of the production process organization manufacturing products. Even a stable production process can often disrupt because of many factors such as machine idle time, lack of discipline in the workplace, bottlenecks, and many others. To hold the position in the competitive industrial market an enterprise needs to stabilize the production process. Lean manufacturing allows achieving not only the equilibrium state in the production, but also bringing it to a qualitatively higher level.

There are many tools and methods of lean production, which is being actively used by leading industrial enterprises. One of the methods of lean production, which enables us to analyze the production process and to identify its bottlenecks is the map of the value stream [1].

Value stream Mapping (VSM) - is a simple and clear presentation of material and information flows an order in the enterprise. Two maps are compiled: a map of the value steam currant state, which placing an order to delivery and available conditions and a map of the value steam future state, which presents an option for enhancing to achieve a higher level of performance. Today, the construction of value stream mapping is widely used in the world's leading industrial enterprises of different areas [2]. This method is used to change the logic of the technological process, yet what should we do has already been repeatedly optimized by specialists of the plant, but it still remains long and unstable? This issue was the focus of our research, which involved analyzing the feasibility of the method of value steam method within a planned technological process.

2. Materials and methods

Research an item, which is manufactured in an industrial plant in Samara was selected. The research was conducted throughout the entire production cycle, starting with the end of the stream (with the operations to determine the pace of work for other operations). It is important to note that to obtain reliable information the established norms for of the run-time operations were not used; the necessary data were obtained from personal observations, recorded directly in the operation run [3].

The concept value stream includes the production flow for transformation of raw materials into the final product, as were as design from a concept to launch in the production and provision of services from taking orders to its final execution. In our case, we considered the production flow within the enterprise, from getting raw material to shipment of the product to the customer.

To display the processes the cell of processes, which indicate to the process included in the material flow were used. In this case we use the cell's to determine a segment of the flow of materials, since their use for each process will lead to clutter on maps [4].

To simplify the following data were used:

C/T - cycle time. The time interval between the outputs of finished products from the process, or the time required for the operator all the work items before repeat they;

C/O - changeover time;

The state of operability is the required length of the machine operation in state of operability. Because during the entire processing cycle is used in operation and new equipment, the percentage of serviceable condition will be quite high.

120 pieces of acceptable, products are required per year to batches processing with once a month. Given the purported defect rate 188-192 pieces per are processed year. As a result, the cycle time is calculated to complete this order on condition of two-shift. Number of working days per year is 365 days (continuous production), and the duration of lunch breaks is 40 minutes per shift. Initial data are presented in Table 1.

Table 1. Calculation of the initial data for mapping

	parameter	value
(A)	Number of shifts	3
(B)	Number of minutes per shift	480
(C)	The duration of breaks, min.	40
(D)	The number of working shift per (D=B-C)	340
(E)	Number of working minutes per day (E=A×D)	3×340=1020
(F)	The volume of the monthly order, item	16
(Ty)	Cycle time Ty=E/F, min.	63,75

Item control does not add value to the final product, however, plays a significant role in the technological cycle. Thus, when a welded joint is discovered the item is returned back in the technological cycle for correcting and re-welding. Often item control is carried out directly in the workplace using scrap materials: caliper, gauge, micrometer, etc. Yet, the technology includes x-ray control, which is a bottleneck.

3. Results

The result was a map of the value stream in the current production, which is presented in Figure 1.

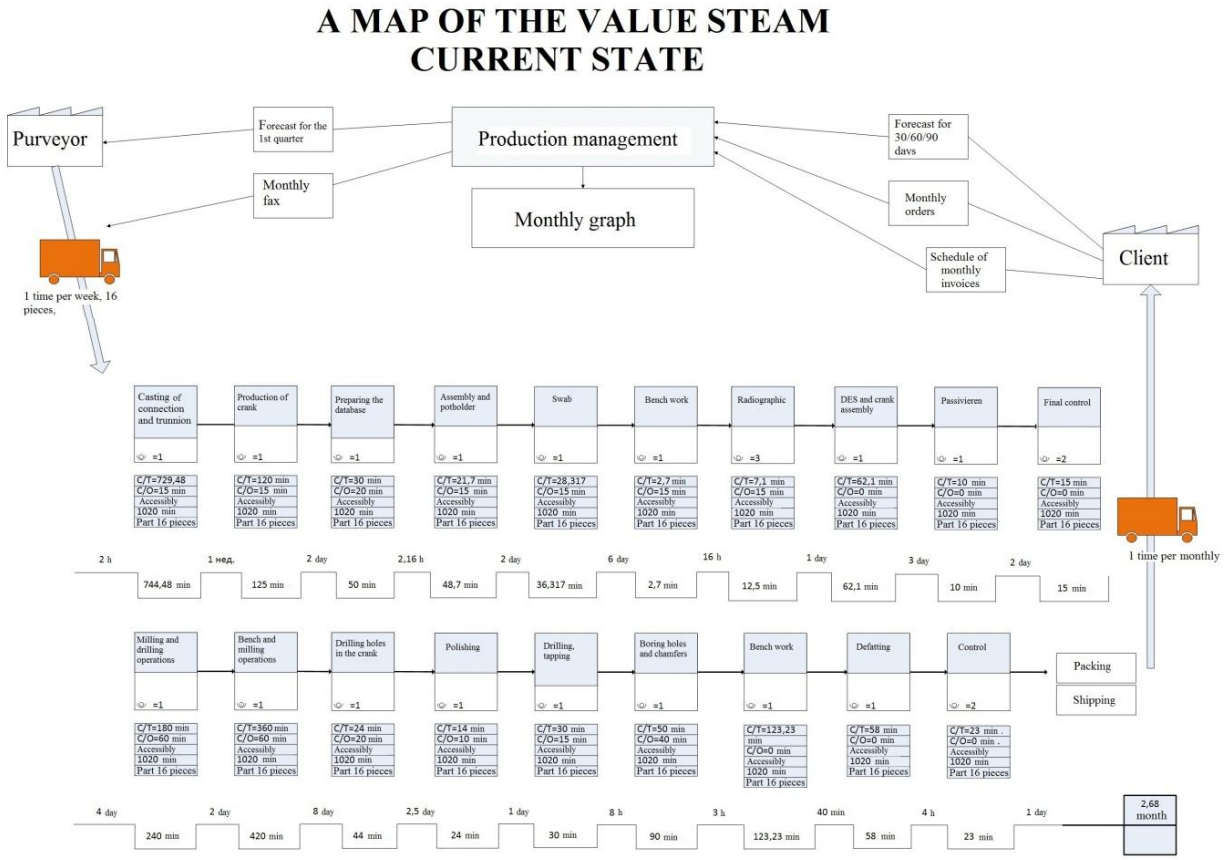


Figure 1. Map of the value stream in the current production

The study identified the bottlenecks, namely:

- X-ray control,
- Hydraulic test,
- Metallography,
- The operation of grinding,
- Other occasional problems.

Analysis of the current state showed that the cycle bath manufacture takes on average 2-3 months (in this case, the time was 2.68 months), but the time at which the cost of items is created, is 11.42 days. As we can see, about 87% of the time the value item is not created. Of course, part of this time is the time for transport, control of dimensions and geometry, etc., but even considering this, the time of "idleness" is not less than 70%. Therefore, measures to reduce the duration of queue product idleness should be taken. For this, we proposed to use the principles of smart production.

One of the main causes of downtime, in addition to mentioned above, is the problem of overproduction [5]. Before each subsequent process products transferred from the previous one are accumulated. The cause of overproduction in this case is that all manufacturing processes are isolated from each other due to the implementation of the ejector circuit. Each process produces at its own pace.

In the case of defects in any of the sections, the defective item will be located in the reserves until its transfer to the next process, and the cause of the defect which is not corrected, continues to exist, resulting in increasing the volume of defective items production. Such moment is present in the map of the value stream at the stage of the operation "weld on" when the assembly DES and the lever does not pass control, the item is sent to the re-assembly, welding, etc., at increases the manufacturing cycle. To resolve the problem of overproduction it is necessary to introduce a pull circuit (Figure 2), and this, in turn, will require the use of tools of smart production, which include:

1) The organization of production in accordance with the cycle time;
2) The organization of a continuous flow;
3) The use of supermarkets to control processes, fine adjustment by kanban;
4) Submission of the customer schedule only at specified process;
5) Alignment of production and regulation of product lines;
6) Regulation of the volume of production.

When analyzing the current state map was identified the following problems:

- Isolation of processes;
- long time fulfillment of an order compared to the time of processing;
- problems associated with machine idle time;
- shortage of workforce;
- lack of resources (steam and air under high pressure).

Introduction of the mentioned principles of intelligent production [6] resulted in creating a map of value stream future state (Figure 2).

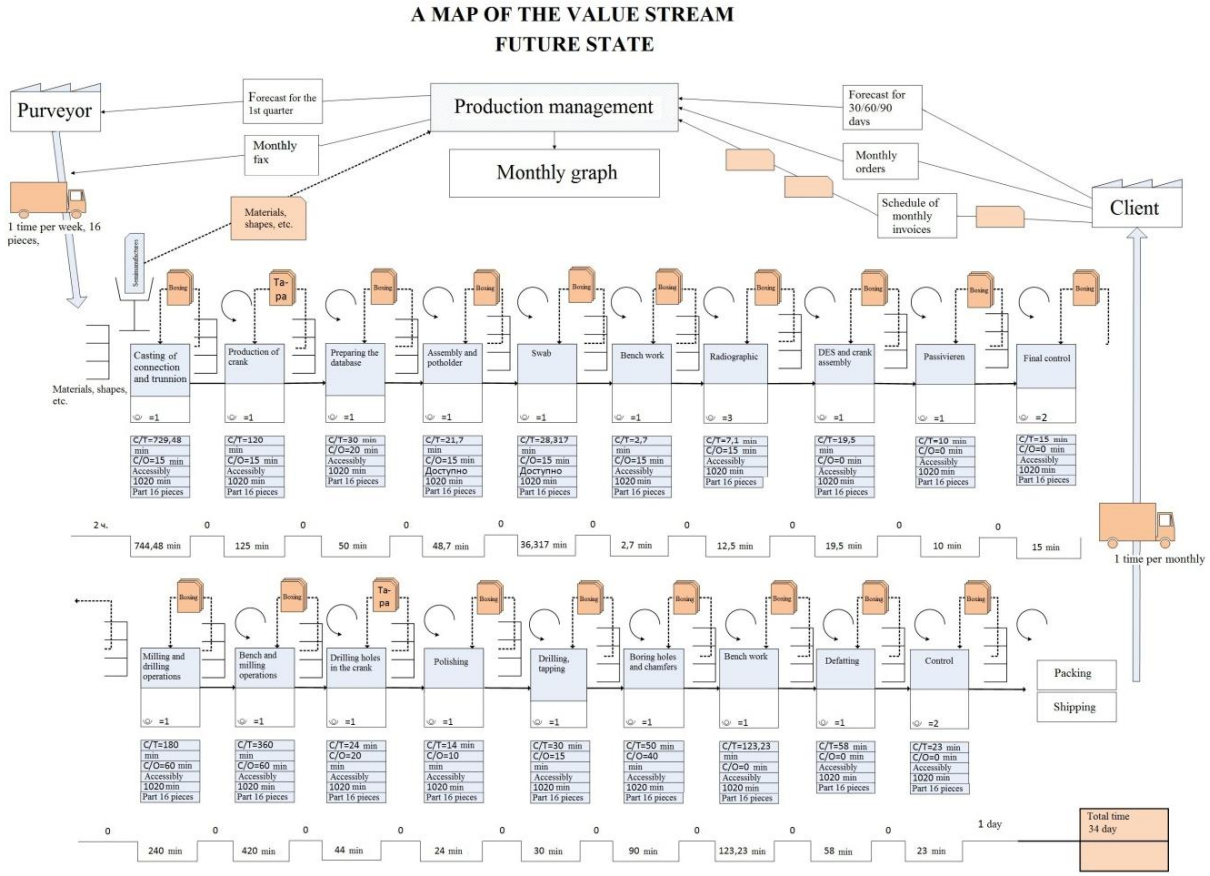


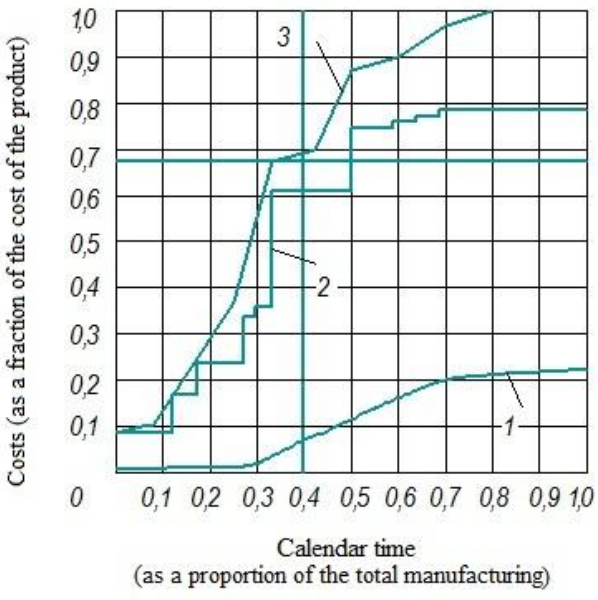
Figure 2. Map of the value stream future state

We note that the cycle of the item under investigation was repeatedly optimized. As a result, a change in the trajectory of the value stream by introducing a working cell and rational allocation of equipment is impractical. However, there are opportunities to reduce the item manufacture time by reviewing existing technologies [7]. The bottleneck, marked in the map of the current state as "casting nozzle and trunnion" could be eliminated by hiring qualified staff, and the total time stamping arm may be reduced by search intradepartmental reserves and reduce downtime.

The establishment of the future state map was found that the entire cycle of the kit of parts can be reduced to 34 days, i.e. at 42.28%. To evaluate the effectiveness of the work carried out, the results were evaluated in monetary terms. For this used cyclic schedule was, which is the most important document for inter departmental operational planning [8]. In our case, the cyclic graph of product assembly was built without considering payload on the basis of the cycle time of assembly and each assembly operation, taking into account the duration of the cycles of assembly and operation implementation.

4. Discussion

At the end of the study it was found that in a total manufacturing cycle, which stretches over 2.68 months, the manufacturing cost of the trunnion is 216 675,59 rubles. After the introduction of the principles of "smart" production it became possible was able to reduce the production cycle to 34 days. From the ratio, we can see that the cost of item manufacturing would be 95 407.85 rubles, i.e. it was to reduced the for 57.71%. Figure 3 shows the increase in total costs (cost of work in progress), and separately shows the material costs and wages, along with workshops and plant costs, determined by the cyclic schedule [9].



1 - manufacturing wages, along with workshops and overall plant costs; 2 - material costs; 3 - all costs.
Figure 3. The enlarged graph of increase of expenses on the trunnion

The value stream mapping is a proven tool that helps eliminate waste. This method can be used for the widest range of industries and processes, it is ideal for positive organizational change in companies, helps to develop optimal management solutions to reduce cost, improve the quality and flexibility of processes. Mapping helps to see and present a set of operations in a particular sequence in the future value stream. Research has shown that the application of the method of value stream mapping enables not only to significantly improve the existing system of item manufacturing, but also to reduce the

final cost of the product. Further investigation in the present direction will help to optimize existing processes without violating the strict sequence of operations what is necessary in certain production cycles [10]. Even simple, at first glance, perfections can lead to radical improvements in the final result.

These studies were conducted on the equipment of CAM technology common use center (RFMEFI59314X0003).This work was supported by the Ministry of education and science of the Russian Federation in the framework of the implementation of the Program "Research and development on priority directions of scientific-technological complex of Russia for 2014-2020".

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