Continuous improvement of engineering activities of the organization with use of cards of stream of value creation

A L Akhtulov¹, L A Ivanova² and E B Charushina²
¹ Omsk Tank-automotive Engineering Institute, 644098, 14 military town, 119, Cheremushki vil., Omsk, Russia
² Omsk State Technical University, 644050, pr. Mira, 11, Omsk, Russia

E-mail: ahtulov-al1949@yandex.ru

Abstract. The article describes measures to improve the organization's activities by developing value stream maps as a basis for building lean production. Evidence is provided that the construction of a value stream map is a tool that has significant advantages over other similar tools for describing processes, with which it is possible to describe in detail how the organization should work in order to create a continuous flow.

1. Introduction
When describing the process, one or another method of data visualization is used [1-5]. One such method is to map value streams [6-9].

Value stream [6] is a set of all actions that are required to make a certain product or service (or together) passed through three important stages of management: problem solving (from concept development and design to production), management of information flows (from receiving an order to drawing up a detailed project schedule and delivery of products), physical transformation (from raw materials to the consumer's hands will be products).

At Toyota, [10] the method of mapping value streams is known as "mapping material and information flows." In Toyota, this is not a training method or even a process visualization tool. In the Toyota production system, it is used by professionals to depict the present and future (ideal) States in the development of implementation plans when establishing a lean production system.

2. Formulation of the problem
The value stream map is such an important tool because [11]:

- map helps to see not only the individual production process, such as Assembly, welding, etc., and allows you to see the entire flow;
- the map helps to see not just losses, but sources of losses in the value stream;
- the map is a single language in which you can discuss production processes;
- map makes many decisions related to flow clear, understandable and easy to discuss;
- map shows the relationship between information and material flows. No other tool provides this.

But first of all, the map [3] is the basis for drawing up a plan for the introduction of lean production in the organization. By helping to plan the entire flow – which is often overlooked in many attempts to
introduce lean manufacturing – the value stream map becomes the blueprint for implementing lean manufacturing, as well as for the construction of the house need his drawing.

3. Theory
A map is much more useful than many quantitative tools and schemes that count steps that do not add value, lead time, travel distances, inventory volumes, and so on. Building a value stream map is a qualitative tool that you can use to describe in detail how your organization must work to create a flow. Figures are relevant in determining urgency and before or after measurements. Mapping of the value stream it is useful to describe what is actually need to do to affect those numbers. The steps for creating a value stream map are shown in figure 1.

Before you begin to build maps, you should find out exactly which product family you should focus on. Consumers are interested in a particular product, so you should not reflect on the map all the flows that pass through the organization. If an organization produces one type of product, it is possible, otherwise consideration on one map of all flows will be too difficult.

The next step, describing the current state, is done by collecting information. This process involves obtaining the information needed to build a future state. Note that the arrows between the current and future States go in both directions, showing that the actions to develop the current and future States are partially the same. Ideas about the future state will appear in the process of building a map of the current state. Similarly, the description of the future state will reveal important information about the current state that has been omitted.

The last step is to prepare and actively use an implementation plan that describes on a single page how you plan to achieve the future state. Then, when the future state becomes a reality, it is necessary to start a new map of the future state. This is the process of continuous improvement at the level of the value stream. There must be a map of the future state at any given time.

Mike Roter and John shook [6] give some tips for building maps:

- always independently collect information about the current state, moving along the actual paths of material and information flows;
- first, quickly walk along the entire value stream path to get a sense of flow and understand the sequence of processes. After a quick passage of this path go back and collect information where each process is performed;
- start at the end-with the shipment-and go upstream; do not start with the receipt of raw materials (and further down). Thus, you will start with the processes that have the closest...
relationship with the consumer and that should determine the pace for other processes upstream:

- bring a stopwatch and don't rely on time standards or information you haven't personally received.

Figures in documents rarely reflect the actual current state. The data in the files may reflect periods of time when all the process went fine, for example three-minute readjustment of the equipment at the beginning of this year.

- map the entire value stream build yourself, even if several people are involved in the process. The purpose of the map is to understand the value stream as a whole. If different people build different segments, no one will be able to comprehend the whole.

- always build the map manually with a pencil. Start making a rough draft of the flow just after the passage of the stream when analyze the current state. Then correct it also by hand, with a pencil. Resist the temptation to use a computer.

The model parameters of each process to which you should pay attention to include: cycle time; changeover (a changeover time of equipment); availability (availability to start working at any time); volume of shipments; number of operators; the number of variants of products; volume of packaging; working time (all the time minus breaks); the percentage of defects.

However, the current state map and the steps to create it are pure losses if you do not immediately begin to develop and implement a future state map that will eliminate the sources of useless costs and increase the value to the consumer.

Mike Roter and John shuck [6] found that following a certain list of questions would be most useful in mapping the future state. As you develop the concept of the future state, make a rough draft of the answers to these questions in the order below. Based on the answers to them, mark the main ideas of the future state with a red pencil directly on the map of the current state. As soon as the vision of the future state is analyzed, it is possible to proceed to the construction of a map of the future state.

Key issues for transition to a future state:

- Tact time. To do this, you must examine the available working time of the downstream processes that are closest to the consumer.

- Will you create products for the supermarket of finished products, from which it is pulled by the consumer, or directly transfer it to shipment? The answer to this question depends on several factors, such as the products purchased by the consumer, the reliability of your processes and product characteristics. Production of products directly for shipment will require either high reliability and short lead time, availability of flow from order to delivery, or large insurance stocks:

- The possibility of using continuous flow processing.

- Where will you need supermarket pull systems to manage production processes upstream?

- At what single point of the production chain (the rhythm of the process) will you make a schedule of production? Keep in mind that the movement of all materials downstream of the rhythm-setting process should be carried out in the form of a stream.

- How will you align production flows (product range) in the rhythm-setting process?

- What volumes of finished products will you consistently produce and ship in the rhythm-setting process?

- What process improvements will be needed to ensure that the value stream is formed in accordance with the established requirements for the future state project. Here we must notice the places where you will need any improvements of equipment and procedures, such as reducing changeover times of equipment or reduce downtime.

4. Results
Here is an example of using map the value stream from the book of James Vomacka and Daniel Jones [2]. The map shown in figure 2 shows the information flow from the top right to the left, from the consumer to the various parts of the production process. Orders from the consumer come to the computer, which plans the need for materials. Once registered as inventory, orders wait until a weekly production schedule is drawn up for the following week. When the managers of the shops to discover the shortages or the consumer demand suddenly changes, it is necessary to accelerate the flow of information.

In the lower half of the map shows the material flow moving from left to right: from raw materials to the consumer. Flow map allows you to bring together the characteristics of all five stages, to show the existing level of inventory between stages, to compare the time (very short), during which the value is created, with the entire time of the order (extremely long). The map helps managers to see what Kaizen activities should be carried out first to significantly reduce the time of the process, eliminate unnecessary steps, deal with quality, flexibility, readiness and adequacy. The main indicators of the current state of the process are shown in table 2.

![Value Stream Map](image)

**Figure 2.** Current status of the value stream.

**Table 1** Main indicators of the current state of the process.

| Indicators                        | Current states                          |
|-----------------------------------|-----------------------------------------|
| Total execution time of the order | 23.5 days                                |
| Value creation time               | 184 seconds                              |
| Changeover time                   | 10 minutes - for Assembly and 1 hour – for stamping |
| Machine time utilization ratio    | 80% in weld / Assembly                   |
|                                   | 85% - for stamping                       |
| Marriage / conversion             | 5%                                      |
| Reserves                          | 17130 pieces                             |
| Each detail is made in time each  | 2 weeks                                  |

5. **Discussion of results**

Visualizing the state of the process through a map and a scorecard should encourage managers to move to a significantly improved future state of the process (figure 3). To put the process in this state, it is important to mark the areas where the Kaizen flow and Kaizen process activities should start on the future state map.
What needs to be done is to improve reproducibility (quality first time), availability (machine time utilization factor), flexibility (readjustment time) of the four stages of the welding and Assembly process, eliminate stocks that interfere with flow movement, while performing all four stages in one cell (in addition, now only one operator is needed.) This significantly reduces the setting time of the stamping press, which allows you to make smaller batches and keep fewer stocks.

6. Summary and conclusions

Finally, the material requirements planning (MD) subsystem, which previously issued production orders for each operation in the process, is allocated. Instead, it creates a simple system of pulling, sending precise intervals the signal Kanban from the box of heijunka (device, leveling demand) to welding and Assembly cell, which sets the pace for the entire system. Additional "pull loops" are arranged between the welding and Assembly cell and the stamping machine, as well as between the stamping machine and the steel roll supplier. As a result, the whole process of information flow management is significantly simplified and transformed from the ejector to the pulling one. The comparative results of the current and future state of the system are shown in table 2.

![Diagram of the value stream](image)

**Figure 3.** Future state of the value stream.

**Table 2** current and future status of the process: key indicators.

| Indicators                        | Current states | Future state |
|----------------------------------|---------------|--------------|
| Total execution time of the order| 23.5 days     | 4.5 days     |
| Value creation time              | 184 seconds   | 169 seconds  |
| Changeover time                  | 10 minutes - for Assembly and 1 hour – for stamping | 0 minutes – for Assembly and 10 minutes – for stamping |
| Machine time utilization ratio   | 80% in weld / Assembly 85% - for stamping | 100% - for welding / Assembly 99% - for stamping |
| Marriage / conversion            | 5%            | 0.5%         |
| Reserves                         | 17130 pieces  | 3250 pieces  |
| Each detail is made in time each | 2 weeks       | 8 hours      |
The process map clearly shows that if you implement and capture the results of a few Kaizen processes and flows, you can achieve revolutionary achievements in the field of quality.

Learning to build maps of the value stream, you can learn to see the organization from the point of view of lean manufacturing. It is only necessary to keep in mind that the essence of lean production is not limited to the construction of the map, the map is only a tool. It is important to create a value stream. And to create this flow, it is necessary to "see" it. Building a map helps to do this and focus on the flow with a vision of an ideal or at least improved state.

References
[1] George M L 2007 Lean manufacturing + six Sigma" in the service industry: Combining the quality of six Sigma with the speed of lean manufacturing (Moskow: Alpina Business Books) p 360
[2] Vumc J P and Jones D T 2005 Lean manufacturing. How to get rid of losses and to achieve prosperity of your company (Moskow: Alpina Business Books) p 473
[3] Davydova N S and Klochkov Y P 2012 Model of management of implementation of the system "Lean production" at the enterprise Vestn UDM. UN-TA. Ser. Economics and law 4 32-5
[4] Vladykin A A and Gershanik A 2016 The system of "lean production" as a mechanism to improve the competitiveness of the enterprise (Perm: Publishing house Perm. NAT. research. Polytechnic. UN-TA) p 180
[5] Akhtulova L N and Tashmagambetova S T 2009 Measuring the effectiveness of the quality management systems is one of the tools for improving the organization’s activities in the field of quality Innovative technologies: production, economics, education: materials of the All-Russian Scientific and Practical Conference ed G V Leonova (Biysk: Altai State University) pp 114–5
[6] Roter M J 2017 Learn to see business processes. The practice of mapping of the value stream (Moscow: Alpina Business books: CBSD, business skills development Center) p 136
[7] Whitey K V and Davydova N S 2015 Algorithm of mapping of the value stream in an industrial plant Vestnik Udmurt. University 25 pp 7–13
[8] Vladykin A A and Oborin Y 2015 Map the value stream" as a key element of the process of reducing the length of the production cycle of the enterprise Economics, management, Finance: materials of the IV international science Conf. Perm: Zebra pp 159-67
[9] Akhtulov A L, Akhtulova L N and Stodolsky T I 2013 Use of cards of stream of value creation as means of constant improvement of the organization's activities Omsk scientific Bulletin 5 (122) 40–6
[10] George M L 2003 Lean Six Sigma for Service: How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions (McGraw-Hill Companies Inc.) p 401
[11] George M L, Maxey J, Rowlands D T and Price M 2004 The Lean Six Sigma Pocket Toolbook: A Quick Reference Guide to 100 Tools for Improving Quality and Speed (McGraw-Hill Companies Inc.) p 225