APPLICATION OF 3MU METHOD IN PRODUCTION

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Abstract

Today the pressure of competitive struggle allows customers in supply chains push the product price as low as possible. This means that the price is no longer a sum of costs and profit. The price is fixed and determined by the customer and the organization that wants to succeed in the competition does have other choice than accept the price to maximize its profits by minimizing its cost. Expressed mathematically, price - cost = profit. Therefore, many organizations apply various methods to minimize their costs. The cost reduction can therefore be understood in the broader sense as minimizing waste and increasing efficiency. One of these instruments, which points out the waste in production is a Japanese method - 3MU. The aim of this paper is to highlight the importance of analyzing internal processes of the organization to identify waste and then eliminate it.

Keywords

Process, Waste, Downtime

Introduction

An important aspect of identifying waste is mapping all activities in the process and assesses their contribution to value creation. In the event that these activities do not add value and do not directly support other activities, it can be stated that this is an activity that does not constitute value and this is the source of waste. Such analysis of processes uses also audiovisual recording for better and deeper analysis. Any measure taken to eliminate waste should be turned into money to be able to evaluate the effectiveness of the measure.

This method is known as incorporates three Japanese words. They are (Fig.1):

- MUDA – waste,
- MURA – unevenness,
- MURI – overburdened.

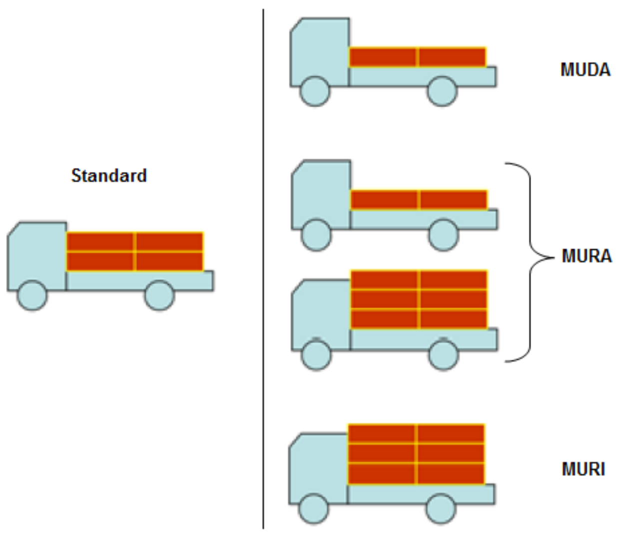

Fig.1 Principal of 3MU method

MUDA – means the status of activities in which materials, equipment and manpower do not contribute to the value of the product. Eliminating waste can result in fluency of workforce, while also creating working conditions under which employees are able to give the required long-term work performance. Expert sources define a different number of types of loss, however, there is broad agreement on seven basic types of loss - waste, identified across various organizations. It is the following types of waste [5].

MURA – diversion or unevenness, it also expresses the loss incurred by missing or incomplete concordance of capacities within the management of production. It arises where human labor lacks fluency, or the material is delivered irregularly, which for example disturbs the balance of constant material flow in production, continuous production supply and so on.

MURI – is unreasonable, unnecessary burdening of the body of an employee or performances that often result from MURA. Overburdening describes the losses incurred by high demand within the labor process. Meanwhile it is necessary to distinguish between overburdening by means of manipulation and overburdening in the manufacturing process. Losses due to manipulation occur by physical and psychological overload of employees, which is manifested by fatigue, stress, increased errors and dissatisfaction with work. These losses can be eliminated from ergonomic point of view as well. Reducing the burden on a person in work process and adjusting workplace layout by applying knowledge of ergonomics can effectively eliminate losses due to improper manipulation.

Application of 3MU method

Application of 3MU method was implemented in the production organization of mechanical engineering nature. It was an organization engaged in the production of propulsion components for three specific car manufacturers.

3MU method was applied to the assembly line. The line was used to assemble propulsion mechanisms for cars (hereinafter the product). The assembly line is divided into five successive processes. The total duration from input of material to the assembly process up to the output of final product from the assembly line was repeatedly measured to be 6:30 min. Assembly line processes, including operations which constitute them are shown in Fig.2.

The duration of individual's process on the assembly line was as follows:

Process 1 duration = 1:07 min.
Process 2 duration = 1.43 min.
Process 3 duration = 0:56 min.
Process 4 duration = 1:39 min.
Process 5 duration = 1:05 min.

The total duration of product assembly = 6:30 min.

Due to objective analysis, the individual processes and their activities were repeatedly measured in terms of time duration and recorded on camcorder with respect to the analysis of operators' movement. Individual activities were analyzed by Yamazumi method. By this means the activities were analyzed in terms of significance and evaluated as an operation:

- with added value,
- necessary
- with no added value.

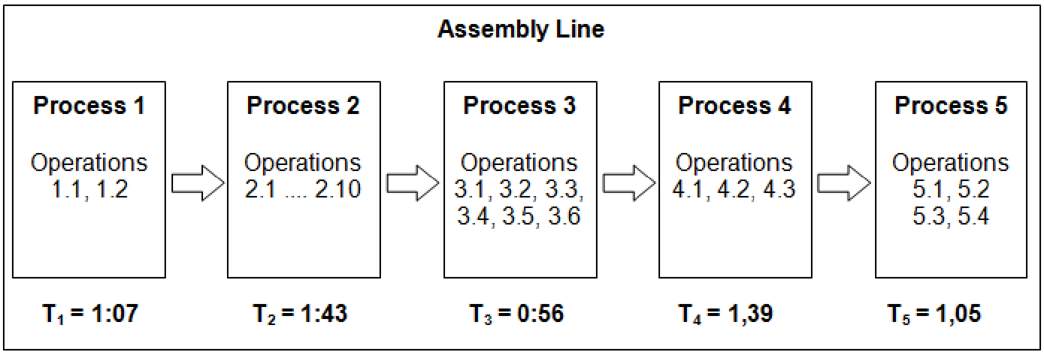

Fig.2 Scheme of assembly line

Process yield of the assembly line was determined to value of 30 assembled products per hour. One operator worked in the process 1 and 2 before introducing changes. By means of observing the site and subsequent analysis of repeated video recordings it has been found out that their workload is severely unbalanced compared with each other.

In *Process 1*, waste has been identified - waiting of the operator (Fig.3). This process is largely automated what caused the operator wait until the automatic operation was completed. The average measured duration of the process was 1:07 min.

Waiting time amounted to 49 seconds (up to 73%! of the total duration of the process is represented by the waiting time of the operator). During this time the employee did not perform any other work.

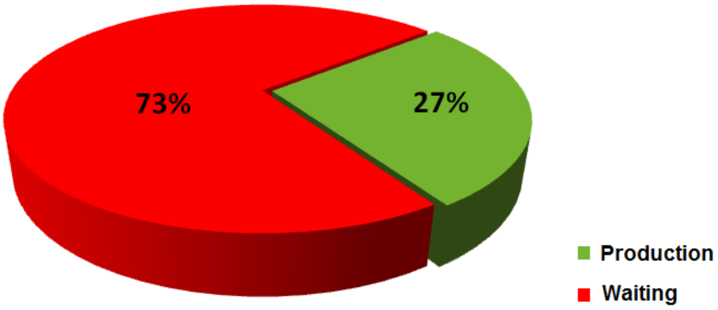

Fig.3 The proportion of working time in the Process 1

The total time duration of this process is limited by the production capacity of automated equipment. Analysis arrived at the conclusion that the time of operator is not effectively used.

In Process 2, heavy workload on the operator has been identified. In Figure 1 it can be seen that Process 1 is formed by two operations, while Process 2 is formed by ten. The analysis of the process has found that there was no waiting time of the operator, he was permanently burdened. The measured duration of time showed 1:43 min. This confirms the argument that the unevenness (Mura) and overburdening (Muri) are the source of waste (Muda).

Given that Processes 1 and 2 are directly related to successive workstations, the aim was to evenly burden the two operators in order to minimize the waiting time of the operator in Process 1 and reduce the level of workload of the operator in Process 2.

In *Process 3*, the analysis of on-site observation and repeated video recording showed waiting time, but it was caused by the follow-up process. The average duration of the process was measured in value 0:56 min. Waiting time in this case (Fig.4) amounted to 15 seconds (i.e. 27% of the total duration of the process). The operator of the process is the operator of the following Process 4.

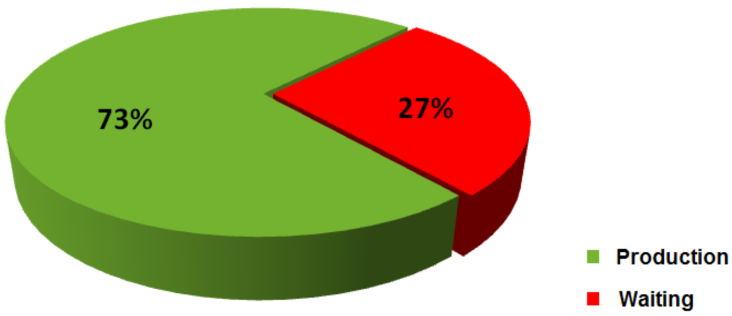

Fig.4 The proportion of working time in the Process 3

In analysis of *Process 4,* no waiting time was identified. The average duration of the process was measured in value 1:27 min. Analysis of the video recording, however, identified unnecessary movements of the operator (Fig.5) that consumed 35 seconds of the total time of the process. In this case, unnecessary operator movements were caused by improper layout of the workplace and accounted for 40% of the total time of Process 4!

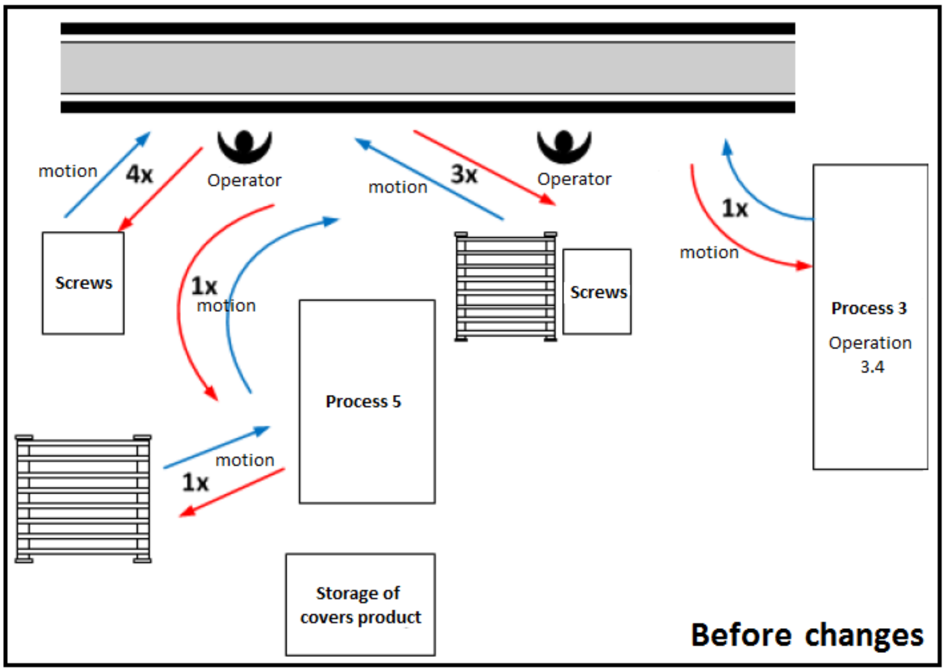

Fig.5 Operator movement at assembly production line

Analysis of *Process 5* did not identify any downtime of the operator, or any other types of waste. The average duration of the process was measured at 0:55 min.

Conclusions of the analysis of processes of the assembly line were as follows:

- three out of five processes on the assembly line included waste,
- the first process involved waste of operator's time waiting for the end of automated operations
- in the second process heavy burdening of the operator (up to 10 operations in the process) has been identified,
- possibilities to reduce wasted time and looking for evenly distributed burdening of operators of process 1 and 2,
- the third process involved waste due to waiting for the end of the previous process,
- the fourth process involved waste due to unnecessary movements of the operator due improper layout of the workplace,
- no waste has been identified in the fifth process.

Proposal of measures

The analysis of the individual processes shows that no waste due to unnecessary waiting and movements has been identified in Process 3 and 5, as it was in processes 1, 2 and 4. Therefore, the proposed measures focused primarily on shortening waiting times, even the workload of workers as well as the elimination of unnecessary movements of the operators.

Processes 1 and 2 are subsequent processes, whose working environment is represented by one common space. Proposal of measures was based on this knowledge and was therefore designed to find a solution that on one hand minimizes waiting of the operator in Process 1 while reducing workload of the operator in Process 2. Getting familiar with these processes during the on-site observation was an incentive to change the workload of operators of both processes in such way that the three operations of Process 2 operator have been moved into work of Process 1 operator. After mutual evaluation and measuring the times the following measures have been introduced (Tab.1).

Tab.1 The results achieved in the Process 1 and Process 2

	Before changes			*After changes*		
	Number of operations	Process duration	Waiting time	Number of operations	Process duration	Waiting time
Proces 1	2	1:07 min.	0:49 min.	5	1:07 min	0:17 min
Proces 2	10	1:43 min.	0:00 min.	7	1:24 min	0:00 min

Proposal of measures influenced *Process 4* as well. Floor plan layout of the workplace has been changed – relocation of the assembled components in the workspace in order to eliminate unnecessary movements of the operator (Fig.6).

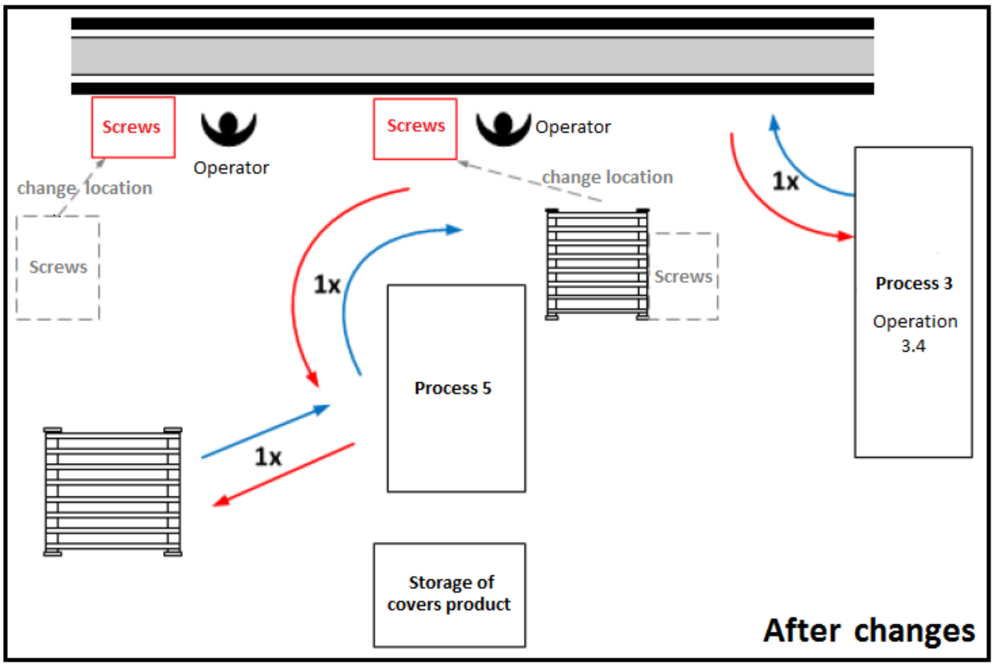

Fig. 6 Operator movement after changes

After repeated analysis of introduced changes the average process time was measured in value 1:04 min. This shortened the duration of the process by 13 seconds. This is not only with regard to saving time but also the reduction of the ergonomic burden of operator by elimination of unnecessary movements. After the introduction of changes in the workplace the following changes occurred:

Tab.2 The results achieved in the Process 4

	Before changes			*After changes*		
	Number of operations	Process duration	Waiting time	Number of operations	Process duration	Waiting time
Proces 4	3	1:39 min.	0:35 min.	3	1:04 min	0:17 min

Conclusion

When analyzing the processes, waste in processes must be seen from a broader perspective. Proposed measures may sometimes cut across numerous processes that can bring a comprehensively positive effect, as was the case in the above mentioned two processes (Process 1 and 2). Also, it should be borne in mind that not every waste of time of operator in the process can be removed, because it can be caused by, for example its level of automation. However, it is possible to look for the possibility of using operator’s labor pool for other actions as far as the nature of work and the specificity of the process allow. With regard to preservation of the anonymity of the organization and not disclosing sensitive economic data, the following assessment can be made. After calculation of the proposed savings, the assembly line will save more than twenty thousand Euros each year. This article points out the fact that even the seemingly small imperfections in the process may be the source of great waste in long-term perspective. It is therefore necessary to identify the weaknesses in the process, analyze and introduce measures that will bring the effect in the form of savings. Organizations are offered various tools, application of which can improve processes and thereby increase overall production efficiency often with negligible investment, which on the contrary, can bring significant savings.

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