sciendo

PRODUCTION ENGINEERING ARCHIVES 22 (2018) 50-53

PRODUCTION ENGINEERING ARCHIVES

ISSN 2353-5156 (print)
ISSN2353-7779 (online)

Exist since 4th quarter 2013
Available online at www.pea-journal.eu

LEAN Production issues in the organization of the company - results

Magdalena Mazur[1], Hassan Momeni[2]

[1] Department of Production Engineering and Safety, Faculty of Management, Czestochowa University of Technology, Armii Krajowej 19B, 42-200 Czestochowa, Poland, ORCID ID: 0000-0003-3515-8302, e-mail: magdalena.mazur@wz.pcz.pl
[2] Western Norway University of Applied Sciences, full address, country, ORCID ID: 0000-0002-3535-5413

Article history
Received 01.03.2019
Accepted 31.03.2019
Available online 15.04.2019

Keywords
LEAN concept
SMED method
assembly
efficiency
quality

Abstract
The key to the functioning of enterprises in today's market is the concept of flexibility, which is mainly associated with adapting to very dynamically changing customer requirements. The basis for this approach is, among others, the realisation of serial production, products created for the customer's order in the quantity and time defined in orders. The LEAN Managemnt and LEAN production approach is a solution dedicated to meeting market assumptions. The LEAN concept, which both in the organization of production and management is focused on dynamic response to changes in the environment. The term LEAN represents numerous improvements to the organization, tools and techniques used to reduce and eliminate individual processes (or parts thereof) that are unnecessary activities. The key to analysing entire processes and defining unnecessary activities is thorough observation and selection of dedicated solutions. In the set of LEAN tools, you can find a lot of possibilities, from organization of a workstation itself, to a thorough quantitative analysis of times and process sequences, from simple facilities to complex technological solutions. The article presents the results of the assembly process analysis, indicates the point of product differentiation (marking for the client) and presents the map of organizational and preparatory activities for this process. The presented results are part of the activities within organization of the LEAN approach, currently having priority for the Research entity organisation improvement team.

DOI: 10.30657/pea.2019.22.10 JEL: L23, M11

1. Introduction

The previous article entitled "LEAN Production issues in the organisation of the company - the first stage" presented the main assumptions and plans of the research entity in the field of implementation of LEAN solutions in serial production structures. Due to activity of the research entity in the automotive industry and establishing long-term cooperation with customers (automobile concerns), the main approach is product development and full identification of the product and the quality of individual processes. The company puts the main emphasis on cooperation with recipients and joint planning of new organizational solutions, in order to identify process changes about which the recipient must be informed. Therefore, the Team for Improvement changes was created within the structures of the company. It implements plans to improve manufacturing processes and the organisation of work stations. The presented considerations relate to one of the last stages of the assembly of a snap-in element of a security system dedicated to motor vehicles. The presented process analysis and proposed changes allowed to define the possibilities of limiting the process time and increase the efficiency of the position. Implementing of improvements of the enterprise in accordance with the concept of Lean Manufacturing requires in fact all available tools, methods or ideas that are offered in this area. Unitary changes in processes force changes in the subsequent stages of processes and the very organisation of the flow of product value (Womack and Jones, 2003; Czerska, 2014).

2. Tools and techniques used in the process analysis

The essence of the SMED method is based on two main assumptions: 1 - external retooling - perform as many operations as possible outside the machine's work while it is still in operation. For example, if retooling involves exchanging a die or mould and requires heating it, pre-heating should be carried out directly before replacement. If it is necessary to replace the nozzles on the chassis and adjust them, the nozzle assembly and their adjustment should be performed on the spare chassis (during machine operation) so that the machine can only be stopped for a short time of replacing the entire equipped chassis; 2 - use "one-move" fixing where possible , using catches instead of screws or wing nuts, which will not require the use of a suitable key and speed up the tightening work (eg for fastening the cover, etc.) (Nowakowska-Grunt et al., 2005). In order to increase the efficiency and productivity of the analysed production system in order to eliminate wastage expressed in time, the basic assumptions of the SMED method were used. The methodology directly related to the issues of retooling of machines and devices, with each change of production series. SMED is a theory and set of techniques that allow you to exchange tools and equipment settings in less than 10 minutes - in other words, in a single number of minutes (single-minute). However, it has been proven that its use leads to a dramatic reduction of machine replacement times in almost every analysed case (Ulewicz and Kucęba, 2016; Bortolotti et al., 2015).

SMED's practical implementations face the barrier of operationalisation. The essence of the SMED method involves the use of a number of auxiliary methods and techniques. They can be divided into two groups: organisational and typically technical solutions aimed at changes in the design of re-equipped machines and devices. Among the most frequently used methodological solutions used in the improvement of the retooling process are: checklists, functional check, improvement of parts and machines transport, standardisation of operations, use of indirect fastening devices and improvement of storage and management of parts and tools (Czerska, 2014; Nowicka-Skowron and Ulewicz, 2016).

The first step in the preparatory stage is to create a detailed description of the studied retooling process and to record carried out activities in the form of photos / videos. It is important for the film recording to have the function of measuring of elapsed time (timer), to record the process in its typical form - without any special preparations, to determine the time of the beginning and end of the retooling process. During registration, follow the employee performing their tasks, the only condition for stopping the recording process may be only the moments of scheduled breaks (i.e. breaks for a meal) each other break is recorded and included to the retooling process. The recording is only a documentation of the retooling process, it does not constitute grounds for criticising the person who is recorded and can not be used as material against an employee. The next step is the analysis of the recorded film carried out in the presence of its direct performers. During the projection all kinds of explanations and comments are collected from machine operators regarding the course of retooling and possible suggestions for organisational changes. In order to supplement the information gathered during meetings with operators, it is possible to use the rules of an anonymous questionnaire (however group work constituting the basis of LEAN analyses does not recommend the use of such solutions). During the examination of the process, it is also necessary to collect the data on duration of both the complete retooling and its individual components. For this purpose, chronometrical measurements should be made (Walczak, 2009; Kleszcz, 2018)

3. Practical use of the SMED method

The production process is an area that gives a wide range of opportunities to eliminate quality problems as well as introduce organisational improvements and savings. The basic documents necessary to start the manufacturing process are workplace instructions, component lists and MTM analyses. This documentation is available at the workplace during the production of a given product, on the basis of which an operator prepares and performs technological operations. The assembly of the clasp which fastens the safety belt starts with checking the correctness of operation of the machines and devices available on the production line and necessary to complete the production order. This control is performed by Mistake Proofing control operations. The first element of the improvement actions was filming the process of replacing the lock head coding instrumentation. This film became the basis for the work of the retooling process improvement team, its analysis allowed to compile the times of subsequent operations in accordance with the guidelines for the current procedure of the process execution (table no. 1).

Table 1. Data form of the retooling process of the coding module in the lock assembly process

name of the workstation	Step number	Description of activities	Step time	elapsed time	Internal.	External.	Notes (problems / possibilities)
CODING OF THE LOCKER	1	Taking off the cover	14s	14s		X	all operations are performed by the operator
	2	Unscrewing the screws fixing the cube with the code and removing the cube from the socket	19s	33s		X	The ability to mount a quick-release latch
	3	Disassembly of the cube	1.34 min	2.07 min		X	Problem with capturing a hot element
	4	Change of code	46s	2.53 min		X	
	5	Assembly of the cube	2.48min	5.41 min		X	Troublesome tightening of the fixing screws
	6	Putting the cube in the socket	26s	6.07 min		X	
	7	Putting the cover back on	39s	6.46 min		X	
	8	Activation of heating	2s	6.48 min	X		Reduced heating time
	9	Code warm up time	10-11min	17.48 min		X	

The total time of retooling of the coding machine was 17.48 min. This retooling time creates a bottleneck in the production line. And the retooling operation of this workstation is performed averagely 4 times a day.

The second stage of improvement activities for retooling was the demacation of external and internal retooling. In the performed retooling only one operation is an external operation and the remaining ones require stopping the device. External retooling, i.e. that which can be done when the machine is in motion is: start-up of heating. On the other hand, internal retooling, i.e. operations that require stopping of the device, starts already at the stage of removing the encoder cover, which is imposed by the safety regulations. Other operations: undoing the screws which fix the cube with the code and removing the cube from the socket, disassembling the cube, changing the code, assembling the cube, fixing the cube in the socket, putting on the cover, code warming, are also performed while the machine is not in operation.

According to the schedule of the retooling process, the most time-consuming activity is heating the code (operation no. 9). The numbering device, which is responsible for heating the code is made of non-alloy steel, which causes its long heating up time. In addition, it has a quadruple fixing which is an additional difficulty during the assembly and disassembly of the element. These elements prolong the machine downtime and numerous fixing problems, which does not have a positive impact on the entire production. According to the assumptions of the SMED method, the working group assumes reducing the required retooling time to a period expressed in minutes with a one-digit value.

The first idea of improvements in the retooling process was the reduction of duration of the longest operation, i.e. the time of heating the code, for which the numbering device is responsible. Analysing all aspects of the retooling, it was concluded that the numbering device should be replaced and the method of its fixing should be changed. Quadruple fixing has been changed to one-sided fixing, which allowed faster replacement by shortening the time necessary for fixing. Another proposed solution was production of a numbering device from a different construction material. The new model of numbering device was made of brass, which shortened the time required to heat it.

The introduction of the proposed improvements made it possible to shorten the retooling time from 17.48 min to 10.48 min, thus time saving amounted to 7 minutes fo each of the necessary retoolings. Thanks to the use of a brass numbering device, it was possible to shorten the time of heating the code, which was undoubtedly the weakest point of the retooling process of the analysed device. Attention was also paid to the appropriate preparation of the necessary tools that are used during the retooling process. A "check list" was constructed, containing the necessary equipment prepared for use before stopping the device. Tools in accordance with the check list guidelines are delivered to a station together with a new code for the next production series. Due to the fact that the coder cover needs to be unscrewed, all subsequent operations are performed in a sequence that already progresses when the device is stopped. The solutions mentioned above are included in table no. 2.

Table 2. Data form of the retooling process of the coding module after application of changes

name of the workstation	Step number	Description of activities	Step time	elapsed time	Internal.	External.	Notes (problems / possibilities)
CODING OF THE LOCKER	1	Taking off the cover	10s	14s		X	all operations are performed by the operator
	2	Unscrewing the screws fixing the cube with the code and removing the cube from the socket	19s	29s		X	The ability to mount a quick-release latch
	3	Disassembly of the cube	1.34 min	2.03 min		X	Increasing the number of numbers will eliminate the assembly time of the cube
	4	Change of code	46s	2.49 min		X	
	5	Assembly of the cube	2.48min	5.37 min		X	Troublesome tightening of the fixing screws
	6	Putting the cube in the socket	26s	6.03 min		X	
	7	Putting the cover back on	27s	6.30 min		X	
	8	Activation of heating	2s	6.32 min	X		
	9	Code warm up time	**4 min**	**10.32 min**		X	The use of brass

4. Summary and conclusion

The SMED method was used to improve the flexibility of the analysed production line. The main interest in the analysis was focused on the retooling operation of the machine coding the head of the installed lock. The retooling of the coding machine was a weak point on the PSA 11600 line, which was its bottleneck, which was escalated by the necessity of frequent retooling. Considering that the machine's retooling occurs four times a day, it generated a high cost of machine downtime. The total retooling time of the coding machine was 17 min 48 seconds. The application of the improvement proposals resulted in a reduction of the machine's downtime to 10 minutes and 32 seconds. By reducing the retooling time by more than 7 minutes, the retooling time was improved by 41%, which resulted in limiting the bottleneck of the assembly process. The obtained result also significantly influenced the improvement of the overall machine performance and its efficiency.

Shortening the retooling time of the analysed machine was achieved by introduction of the following changes:

- Replacement of the numbering device made of non-alloy steel, of which heating time was 10-11 min, with brass numbering device, which requires only 4 minutes to heat to the assumed level. The design change saved the process time by 7 minutes.
- The use of quick fasteners in exchange for screws securing the cover of the machine which codes the lock head, of which unscrewing and tightening during retooling was quite troublesome. Thanks to this change, a total of 30 seconds was saved on average, but also troublesome fastenings that required improvement and adjustment of even tightening.
- Replacement of the cover with standard openings, causing too long assembly and disassembly of the cover, with the cover with pear-shaped openings. Thanks to this change, 16 seconds were saved.

Summing up the profits obtained from shortening the retooling time using the SMED method, it can be safely stated that the changes brought significant savings, both in terms of time and organisation. This improvement can also be used in other assembly lines of the analysed company. Thanks to the introduced changes in the lock assembly line, the production is more flexible and adapted to the customer's needs, whereas the machine coding the head of the lock is used to a much greater extent. The introduction of SMED method solutions has streamlined the production process, without the need for significant investment expenditures.

The SMED method is directly related to the concept of flexible production systems. Fast retooling of machines allows for scheduling of production in compliance with current needs according to orders. The particular significance of the method is the improvement of efficiency of the machines producing short manufacturing series. The SMED method is a scientific approach that is applicable in all enterprises with regard to universal machines.

By analysing and controlling, and thus controlling the production process (at each stage), the company becomes a predictable business partner. For there is a certainty that a properly controlled process will ensure the desired products in the shortest time and of adequate quality, and, what is important, according to the previously estimated schedule. On the other hand, the current and accurate analysis of the process control allows to detect possible irregularities in the production process. Detection of disturbances allows to initiate procedures which streamline and improve the production process. The analysed company applies the philosophy of continuous improvement according to the principles of Kaizen, constantly improves and controls processes to make them more smooth and flexible, and thus maintains a high reputation and position on the market.

Reference

Bortolotti, T., Boscari, S., Danese, P., 2015. *Successful lean implementation: Organizational culture and soft lean practices*, Int. J. Production Economics,160, 182-201.

Czerska, J. 2014. Podstawowe Narzędzia Lean Manufacturing. LeanQ Team, Gdańsk.

Kleszcz, D., 2018. *Barriers and opportunities in implementation of Lean Manufacturing tools in the ceramic industry*, Production Engineering Archives, 19, 48-52, DOI: 0.30657/pea.2018.19.10.

Koziar, B., 2005. *Warsztaty SMED jako najlepszy sposób redukcji czasu przezbrojenia maszyn i urządzeń*, Zarządzanie Jakością, 2.

Nowakowska-Grunt, J., Sałek, R., 2010. *SMED Method Analysis as a Factor Supporting Enterprise Management*. Advanced Logistic Systems, Theory and Practice, 4.

Nowicka-Skowron, M., Ulewicz, R., 2016. Problems In the implementation of lean concept in the metal industry companies, Brno, Czech Republic.

Ulewicz, R., Kucęba, R. 2016. *Identification of problems of implementation of Lean concept in the SME sector*. Ekonomia i Zarzadzanie, 8(1), 19-25. Retrieved 22 Jan. 2018, from doi:10.1515/emj-2016-0002.

Walczak, M., 2009. *Techniki organizatorskie w strukturze metody SMED*. Zeszyty naukowe Akademii Ekonomicznej w Krakowie, 713.

Womack, J.P., Jones, D.T., 2003. *Lean Thinking: Banish Waste and Create Wealth In Your Corporation*, Simon & Schuster, UK.

LEAN公司组织中的生产问题 – 结果

關鍵詞

精益概念
精益生产
安装
效率
流程组织

摘要

当今市场中企业运作的关键是灵活性的概念，这主要与适应非常动态变化的客户需求有关。此方法的基础是生产批量生产，根据订单中定义的数量和时间为客户订单创建的产品。致力于满足市场假设的解决方案是精益管理和精益生产方法。精益概念在生产和管理的组织中都侧重于对环境变化的动态响应。在LEAN这个术语中隐藏了许多改进，用于减少和消除构成不必要活动的个别过程（或其中部分）的组织，工具和技术。分析整个流程和定义不必要活动的关键是仔细观察和选择专用解决方案。在LEAN工具池中，您可以从工作站本身的组织中找到很多可能性，以及从简单设施到复杂技术解决方案的时间和过程顺序的全面定量分析。本文介绍了动机过程分析的结果，指出了产品差异化的点（为客户标记），并提供了该过程的组织和准备活动的地图。所呈现的结果是LEAN方法组织的一部分，目前是研究组织改进团队的首选。