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Management of development of basic structures of technological systems of machine-building production

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Abstract. The organization of production is based on technological preparation processes and subsequent tests for certification of a new product line. The existing methodology for organizing production is based on the basic structures of production technologies that include heterogeneous technological systems with a control superstructure and pronounced standard group elements that make up the integrity of any technology: personnel, equipment, materials and processes. Changing the standard element will change the state of the technological system; therefore, the introduction of the SMED methodology for the technological preparation processes of organizing new production or the optimization of existing production cycles will lead to a reduction in typical losses and a decrease in production cycle costs.

1. Introduction
The basis of all procedures related to the technological preparation of production includes calculations of the load on the main equipment that performs all the processes associated with machining the surface of the part, with the installation processes and the processes of creating new elements of the assembly. The essence of the optimization of the entire production consists in a clear sequence of streamlining the working procedures by time intervals. Separation of operations is very important for maintaining the pace and tact of the entire production, in mass production and often large-scale production. Thus, the costs associated with overproduction, waiting for flow, defects in parts and many other widely known losses associated with the production cycle will be taken into account and controlled. The main tasks solved in the process of technological preparation are reduced to a quick reconfiguration of equipment.

2. Problem area
The essence of the domestic quick changeover is the use of long-known methods of organizing technological production processes, including route-operation maps, which indicate the characteristics of the process and operations. Therefore, the first moments associated with the introduction of any optimization techniques, both in the workplace and in the production cycle, should be based on the concept of the basic structures of the production cycle. The basic structures of the technological cycle
are complex technological systems interconnected with each other having a typical clock basis, calculated on the basis of the workload of production and its capacity. However, the management of such technological systems causes problems associated with the diagnosis and correction of inappropriate results obtained during the operation of such systems, which create prerequisites for the introduction of a wide automation of not only the equipment of the technological cycle, but also the workplace.

Therefore, for complete control of basic technological systems, it is necessary to provide a chronology of development of both the product produced and the production cycle organized at the enterprise in order to obtain the finished product, experimental data, a set of defects detected during the production cycle, problems associated with the organization of sequential technological operations.

3. The main provisions

The main questions about the quality of materials used in work with low-tech equipment, which are prevalent everywhere in the domestic enterprises of electronic and machine-building industry, set a topic for research and forecasting the appearance of new defects in experimental batches of products. To reduce such risks, it is necessary to use the toolkit for analyzing the causes of the emergence of new defects and protocols for reducing the likelihood of new occurrences by anticipating current causes using FMEA techniques.

Consequently, consideration of the basic technological structures, as well as analysis of the possibilities, the existing technological line is necessary for understanding not only the throughput of the production under study, but also the identification of losses in processes carrying value.

The main reason for the low productivity is the downtime of the equipment relative to the production cycle. To analyze the causes and identify the difference, actual and planned indicators, such tools as SMED-method (S-Single, M-Minute, E-Exchange, D-Dies), FMEA-method, workplace tools ordering are used. In a broad sense, it is derived from a rather old and proven 5S lean manufacturing tool. The use of the tools presented above provide an opportunity for a profound modernization of existing technological processes based on the data obtained after research on the course of a particular technological process within the system. The essence of the study lies in the constant or periodic monitoring of technological operations within the processes that create value. How the information will be recorded within the framework of the study, the organization determines on its own, for audio, video recording formats, text formats, without a difference. However, there are such specific technological processes, where the choice of carrier is not unimportant for further analysis and development of recommendations for improving the process, therefore the choice of information carrier remains for the organization’s specialists.

For the study of technological operations that create immediate value, it is necessary to form a working group to monitor all actions performed in the process: both by humans and in the environment-man-machine system. These two systems can and should be separated, since the “environment-human-machine” system performs the function of moving or transporting inter-operational stocks when the purpose of the “human-machine” system is to create value with an acceptable level of costs in this system, including the first and the second kind [1, 2].

To do this, it is necessary to form a clear sequence of technological operations and subject to periodic monitoring at different times of the working day. All technological operations should be monitored, not only the process under study, but also the next process and the previous process based on the planned route map. If you use a one-time impact on the process, then such a point effect will not have a serious success. Indeed, experimental use as an illustrative approach to visualization of invested funds and the amount of employee free time from work must be demonstrated and, if successful, replicated and implemented in other divisions, but there is a common problem of not understanding modernization processes and introducing new techniques into organizational production processes. There is a lack of understanding by the staff of the general paradigm of improvement activities carried out. Consequently, the meaning of the application of the SMED technique is that it is quite a private approach to the use of resources, which leaves the optical radius of the heads of
departments, whose responsibility includes the rational location of the tools at the workplace and compliance not only with safety measures, but also Work instructions for performing a process or operation. Therefore, there may be a drift in the characteristics of the process in the direction of increasing indicators that do not bring value, thereby increasing the second kind of mudu (figure 1).

A dead uncontrolled process has great risks of loss occurring in the production cycle. In this process, an extremely low value of the process occurs, but the performance leaves much to be desired [3,4,5]. The boundary process has high rates, but leaves the uncertainty of the further state. Restructuring of the process is necessary when it is established that the process is critical and a complete revision of all operations and adjustment of positions of responsibility is necessary.

Therefore, the purpose of conducting research procedures is to study the rational use of not only free space, but also all the actions performed by the employee and the head [6,7,8]. All the problems that arise at the beginning of the application of the concept of lean manufacturing are reduced to the difficulties of understanding the need to apply and the general perception of the usefulness of research work by staff. The model of perception of changes in the production system can be represented as the following system:

\[
X = \{x_1, x_2, x_3, x_4\} \\
Y = \{Y(x_1), Y(x_2), Y(x_3), Y(x_4)\} \\
Q = \{Q(x_1, x_2), Q(x_1, x_3), Q(x_1, x_4)\} \\
K = \{x_1, W, p, C, D\}
\]

where \(x_1\) - the general representation of all elements; \(Y_i\) - properties of elements; \(Q\) - an established relationship; \(x_1\) - equipment; \(x_2\) - staff; \(x_3\) - technology; \(x_4\) - materials; \(K\) - type of control вид; \(W\) -

![Figure 1. Presentation of the manageability of the process value.](image-url)
batch size; \( p_1 \) - probability of defect-free production; \( C_1 \) - cost of the process; \( D \) - A set of documents ESTD.

The staff rightly believes that the work is not in accordance with the scope of the document, a problem arises: experts will not only resist this change, but also demonstrate phantom successes in mastering one or another tool or register the ultimate use of impact skills and skills when working with equipment. There is a serious error in the use of detailed tools for lean manufacturing, which, of course, directly affects the judgment of the authorities about the effectiveness and efficiency of such activities. The traditional way of thinking of domestic leaders not only of the highest level, but also of the structural units is reduced, if not to an immediate result, then at least to demonstrative success, which is extremely difficult in the process of applying such strategic tools. Therefore, for a preliminary analysis in order to determine the need for measures to introduce elements of lean manufacturing, it is worthwhile to deploy.

For the analysis of possible states \( 0,0_{n+1},0_{n+2},0_{n+3} \) (figure 1), and their components, methodologies for assessing the quality of the process are used, containing various criteria (Table 1).

| №  | Name                              | Formalization                                                                                                                                                                                                 | Characterization of formalization |
|----|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| 1  | Integral model of process quality assessment | \( Q_o = \frac{NT_{max}K}{C + C_1K_uT_o + C_2T_i} \)                                                                                                                                                    | \( N \) - process performance; \( T_{mid} \) - total process time, h; \( K_u \) - changeover time, h; \( C \) - cost of the process, rub. \( C_1 \) - the cost of equipment downtime \( C_2 \) - maintenance cost, rub. \( T_o \) - average reconfiguration time, h; \( T_i \) - equipment maintenance time |
| 2  | Process Evaluation Model          | \( Q_g = \sum_{i=1}^{4} T_i \)                                                                                                                                                                        | \( Q_{g1}^{i} = \frac{Q_{current period}}{Q_{past period}} \) \( T_1 \) - working hours; \( T_2 \) - reconfiguration time; \( T_3 \) - idle timeout; \( T_4 \) - service time; \( T_i \) - working hours; |
| 3  | Multiple Indicator Evaluation Model | \( Q_s = \sum_{i=1}^{\alpha} F(x) \) \( \frac{F(x)}{F(x)^i} \), \( F(x) \rightarrow \max \)                                                                                      | \( F(x) \) - the investigated parameters of the product \( F(x)^i \) - the best features \( Q_{s1}^{i} = \frac{Q_{current period}}{Q_{past period}} \) |

Table 1. Techniques for assessing the quality of the process [5].
Conclusion
The proposed approaches make it possible to manage the technical potential of the technological process for carrying out measures for modifying the existing value characteristics by applying the techniques presented in the table. The practical significance of the proposed approaches consists in analyzing the potential of the process and applying the SMED methodology to reduce the identified losses and rationalize the cycle of the production cycle.

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