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VALUE ANALYSIS OF THE PROCESSES OF THE MACHINING OF MACHINE COMPONENTS

The most important problem of the modern engineering industry consists in ensuring the competitiveness of its products. One of the ways to settle this problem is to optimize the machining processes so as to enhance their efficiency.

At present, various methods of process design are elaborated and well known. The papers [1–4] show that they are suitable enough for existing production relations. However, these methods cannot always ensure the required process efficiency now, at the time of increased product competitiveness requirements. So, at the present stage of production development, when product quality and competitiveness requirements are rapidly changing [5], new approaches to the methods of the design and optimization of existing processes should be elaborated.

The manufacturing engineering paradigm has changed. Now the content of the process is determined not only by the level of technological progress but also producer's and customer's requirements [6]. Among such requirements, the following ones can be mentioned: compliance with the international quality level, capability of manufacturing products in the shortest time, gaining maximum profit, taking customer's interests into consideration, etc. [7]. In general, the task is complex when the content of working operations and the process as a whole is formed on the basis of a number of requirements (criteria) of different nature.

The new approach to production control opens new opportunities for creating competitive processes for engineering companies (where, in ISO 9000:2000 terms: "The process is a group of interrelated or interacting activities transforming "inputs" into "outputs" [3, 8]. The transition from functional control to process control requires the application of such tools that focus on the direct development of production and technological processes. The value analysis (VA) should be used as such a tool [9].

The present article aims at the elaboration and substantiation of the main principles of the construction of value analysis methods for engineering companies having small and medium batch production.

The value analysis, as a process optimization tool, allows to calculate costs associated with the implementation of the processes of the machine working of machine components, assess their efficiency, find out their strong and weak sides with respect to the generation of use value. In this way, the application of the VA method by process engineers creates conditions for constant process development and improvement, promotes the formation of competitive advantages which every company should have.

The process is a sequence of working operations required for the implementation of works of a certain type; it is a part of the production process, which contains actions aimed at the change and (or) determination of the conditions of the subject of labor. Workpieces and products belong to subjects of labor. Thus, from the VA point of view, the process is a stable, purposeful set of horizontally and vertically interrelated functions, repetitive in a definite sequence, which, in accordance with the preset sequence and within the prescribed period of time, transforms resources into finished products being valuable to the customer.

The main features of process VA which make it different from product VA are as follows:

– in process VA, assessment focuses on processes implemented in production for manufacturing products, in product VA – on functions performed by these products for the customer;

– in process VA, a larger number of functions are assessed than in product VA;

– the work content in process VA is higher than that in product VA;
– the information database for process VA differs from that for product VA;
– in product VA, the product cost is made up of the costs of its functions, and the function cost equals the sum of the costs of its structural elements ensuring its fulfillment; in process VA, the process cost is made up of the costs of its component functions, and the function cost equals the sum of costs of its mechanisms and controls, the product cost at the process output is made up of the process cost and the cost of the resources at the input;
– the fundamental principle of product VA is the process approach, that of product VA – the functional approach.

All this makes it necessary, first of all, to define more exactly the notions and principles of organizations' process value analysis. The value analysis of the processes of the machining of machine components is a tool for studying processes to determine and compare their significance, cost and effectiveness in the manufacture of products meeting customer's requirements

The main differences of the proposed determination consist in the following:
– during process VA, the efficiency of manufacturing methods, customer's satisfaction are examined, which meets the requirements specified in international quality management standards;
– one of the stages of process VA is the assessment of process significance, it allows to detect disproportions between the importance of processes and their implementation costs.

The process value analysis should be based on a number of principles. Traditionally, the following principles of value analysis are mentioned: systematic character of VA, comprehensive approach, system approach, functional approach, correspondence between function significance and their implementation costs, conformity of the real parameter (resource) with the required one, activation of creative thinking, collective labor, interdisciplinary approach, application of the latest scientific, technical and economic knowledge, prediction of the development of the object studied. The above mentioned principles form the base of product value analysis, therefore, they are mostly not applicable for process VA. Undoubtedly, the principles of value analysis should meet the quality management principles contained in the standards of ISO 9000 series (Table 1).

Table 1

The principles of value analysis should meet the quality management principles contained in the standards of ISO 9000 series

Main principles of quality management as per ISO 9000	Main principles of VA
1. Customer orientation. Organizations depend on their customers, so they should know and understand their needs which are present now which may appear in future, satisfy their requirements and make efforts to exceed their expectations.	1. Customer orientation. VA methodology deals with the perfection of the product use value, the main index showing its compliance with customer's needs and expectations.
2. Leaders' role. The leaders seek unity of the organization's objectives and development trends. They should form such an environment that allows them to be fully involved in the reaching of the organization's objectives.	2. Leaders' role. The top managerial personnel is in charge of the general management of the organization and VA implementation.

Continuation of Table 1

3. Employee involvement. Employees of all levels constitute the base of each organization. By involving them in full, the organization can use their capabilities in the most profitable way.	3. Employee involvement. In the company, multilevel training in VA is organized, the method is popularized.
4. Approaching it as a process. The desired result is reached in the most efficient way when the appropriate activities and resources required for them are managed as a process.	4. Approaching it as a process. The value analysis is regarded as a continuous process of the improvement of products, processes, organization structures.
5. System approach to management. The identification of interrelated processes, their comprehension, directing and managing them as an integrated system results in the effectiveness and efficiency of the organization's activities in reaching its objectives.	5. System approach to management. The value analysis represents a system of mutually coordinated actions and methodical means aimed at the continuous improvement of both products and the company itself.
6. Constant improvement. The organization's invariable objective lies in the continuous improvement of all its activities.	6. Constant improvement. The organization and implementation of VA in the company are permanent activities and are built using the technological normative documentation adopted in the company.
7. Fact-based decision making. Efficient decisions are based on data and information analysis.	7. Fact-based decision making The value analysis is based on modern analysis, search, and decision-making methods and means.
8. Mutually profitable relations with suppliers The organization and its suppliers depend on each other. If their relations promote mutual benefit of both parties, their capability of creating values increases.	8. System and comprehensive approach to study. During the study, the value analysis uses system and comprehensive approach.

The formulated principles of the process value analysis are common for all companies. However, the organizational forms of process VA implementation may differ considerably depending on the industry sector, production type, character of products, features of production economics and organization.

For example, when making the process value analysis in engineering companies having small and medium batch production, one should take its main features into account, specifically:

1. High significance of VA application at the process design stage. As the production system has an objective tendency to stable output, any improvements in already existing processes, in case of batch production, are quite difficult to make. The application of VA at the process design stage will eliminate to a certain extent the necessity of their subsequent rationalization and reconstruction and ensure stable output of quality products.

2. Importance and complexity of the analysis of customer's satisfaction with the finished product. During VA, one should draw attention to the analysis of customer's satisfaction including the analysis of operational costs and factors determining such costs (reliability, durability, repairability, etc.).

3. Importance of group VA application. Batch production processes are characterized by a high level of typification. In these conditions, the subprocess value analysis is ineffective, so one should use the group VA when the analysis object is a group of processes, not a single one. The group VA is a labor-intensive scientific and technical procedure, however its cost is repaid due to its high efficiency and better validity of complex decisions.

4. Importance of the thorough elaboration of the calculation and analytical VA apparatus. In the value analysis of processes designed foe batch production, it is quite difficult to find "superfluous" functions. In this case the process efficiency increase reserves are latent in character, so one needs a sophisticated analysis tool to reveal them, which provides for an organic synthesis of design and research works with economic analytical ones.

Based on the definition, features and principles of process value analysis, general requirements were formulated which the methods of process VA should comply with.

– as the process VA provides for the assessment of processes applied by a company for production, the subject of the study should be a system of interrelated processes;

– by definition, the stages of the method of process VA should include process analysis only and not include the stages of use value management because they are realized in the methods of functional-value management;

– according to the definition and the system approach, the process VA should provide for the assessment of process effectiveness, significance and cost;

– as the process cost is made up of the costs of its component functions, the function cost equals the sum of the costs of its mechanisms and controls and the product cost at the output incorporates the process cost and the cost of the resources at the input, the method process VA should include a similar approach to cost formation.

SUMMARY

As the information databases for process and product VA differ, taking the principle of fact-based decision making into account, a conclusion on the necessity of the improvement of the information database for process VA implementation in engineering companies with batch production has been made.

Based on the principles of process VA and considering its peculiarities, when conducting it in engineering companies with batch production, methods of process value analysis for the said companies has been elaborated which would allow to calculate more precisely the cost of each working operation being a part of the manufacturing process, find functions with a low efficiency of use value assurance. These functions should be regarded as objects which should be improved first and foremost.

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