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DEVELOPMENT OF FUNCTIONAL COST ANALYSIS IN MACHINE-BUILDING ENTERPRISES

A. A. Boiko (a)*, A. V. Kukartsev (b), S. O. Kurashkin (c), D. V. Rogova (d),
I. V. Markevich (e)
*Corresponding author

(a) Reshetnev Siberian State University of Science and Technology, Krasnoyarsk, Russia, boiko101961@yandex.ru
(b) Siberian Federal University, Krasnoyarsk, Russia; Reshetnev Siberian State University of Science and Technology, Krasnoyarsk, Russia
(c) Reshetnev Siberian State University of Science and Technology, Krasnoyarsk, Russia
(d) Reshetnev Siberian State University of Science and Technology, Krasnoyarsk, Russia
(e) Reshetnev Siberian State University of Science and Technology, Krasnoyarsk, Russia

Abstract

The importance of the engineering industry for the development of the Russian economy is shown. The problems facing mechanical engineering are formulated, one of which is the low efficiency of internal business processes. To solve the problem, it was decided to introduce a process approach to management at machine-building enterprises, as well as a method of functional cost analysis (FCA). The main tasks of the process approach are identified. The history of the development of functional cost analysis (FCA) abroad and in Russia is considered. The main areas of application of the method, its positive aspects are presented. The main tasks that are solved using the method of functional-cost analysis are considered. New directions and concepts of the FCA method are highlighted. Ways to eliminate the disadvantages of the method are considered. The prerequisites for the use of functional-cost analysis at machine-building enterprises are revealed, namely: the aggravation of competition, the introduction of a process approach, an increase in overhead costs, the introduction of information technologies, the dynamism of the external environment, the "imperfection" of performers, individualization of products. the true cost of production, as well as the individualization of consumer products. The relevance of the implementation of this method at machine-building enterprises at the present stage has been proved.

Keywords: Cost accounting, functional cost analysis, mechanical engineering, operational requirements, process approach to management

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1. Introduction

Mechanical engineering and metalworking are the most important sectors of the national economy, determining the state of Russia's production potential, ensuring the functioning of the sectors of the national economy, as well as filling the domestic consumer market. The most important specific indicators of GDP (material consumption, energy consumption, etc.), the environmental safety of industrial production, labor productivity, and the country's defense capability directly depend on the level of development of mechanical engineering (Boyko et al., 2019).

The transition to market conditions of management painfully affected the machine-building complex. The volume of industrial production decreased several times, and the share of mechanical engineering in industrial output decreased to 20%. Compared to developed countries, where the share of engineering products is 35 ... 50% of the general industrial output, in Russia this figure is 1.5 ... 2 times lower (Anisimova & Zagoretska, 2014).

2. Problem Statement

To do this, it is necessary to solve a number of complex problems facing mechanical engineering (Fedonin et al., 2020):

- a high level of debt burden (including payments to the budget and off-budget funds);
- lack of working capital and investment in the development of production;
- unsatisfactory condition of the active part of fixed assets, that is, the fleet of technological equipment, most of which is physically and morally obsolete;
- underdevelopment of domestic markets, low domestic demand and its inconsistency with the available production capacity;
- lag behind developed countries in terms of the level of technological base;
- low level of exports;
- lack of an effective system of training and retraining of skilled workers and management personnel;
- one of the lowest level of labor productivity in industry;
- weak interaction with financial and credit institutions;
- outstripping growth rates of prices for the products of natural monopolies;
- underdevelopment of the infrastructure for innovation;
- low efficiency of internal business processes.

3. Research Questions

In our opinion, of all the above problems, the most important for the domestic engineering industry is the low efficiency of internal business processes. The solution to this problem is largely facilitated by the introduction at machine-building enterprises of a process approach to management and the method of functional cost analysis (FCA) based on it.

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4. Purpose of the Study

Implementation of a process approach to management at machine-building enterprises, as well as the method of functional cost analysis (FCA) (Fedorova et al., 2019).

5. Research Methods

The history of functional value analysis goes back to the 40s. XX century. During the Second World War, the American electrical company General Electric faced the question of how, in connection with the increased need for military equipment, to solve the problem of shortage of scarce non-ferrous metals, primarily supplied from other countries. Engineers at General Electric, led by engineer LD Miles, were forced to look for alternatives to these materials and used more readily available materials for the manufacture of some parts. Subsequently, an analysis of the data on the operation of parts made of new materials showed that they all functioned normally, and in some cases their reliability increased. This prompted research to replace expensive materials with cheaper ones.

Then the idea arose to extend this approach to the product as a whole. L. D. Miles began to consider the adopted product design only as one of the possible options for the implementation of certain functions and built his method so that, abstracting from the existing design and focusing on the functions of the analyzed product, it was possible to find fundamentally new options that provide the company with minimal expenses. As a result, the costs of their manufacture were reduced (on average by 25%), and the savings amounted to $ 10 million (Fedorova et al., 2020).

Miles called his proposed method of reducing production costs value analysis (VA) and defined it as "applied philosophy." According to Miles, “cost analysis is an organized creative approach, the goal of which is to effectively identify non-productive costs that provide neither quality, nor utility, nor durability, nor appearance, nor other customer requirements”.

Initially, the method proposed by L. D. Miles did not receive due recognition, since many considered it "an elementary truth", "the alphabet of construction." Only practical examples, which confirmed the real effectiveness of the new method, attracted the attention of a wide range of specialists, primarily suppliers, competitors and customers of General Electric. Finally, government organizations have become interested in the cost analysis method. The first was the Office of Shipbuilding, which was part of the US Department of Defense.

The successful experience of using FCA by the Directorate of Shipbuilding attracted the attention of other departments of the Pentagon to this method. And soon, in order to reduce the cost of production of military equipment, US Secretary of Defense R. McNamara proposed to include in all contracts passing through his ministry, clauses obliging enterprises to apply functional-cost analysis. Following the enterprises working for the Ministry of Defense, this method was introduced by some sub-contractors. Consumer goods companies followed suit. As a result, by the beginning of the 60s, the FCA began to be widely used in the system of so-called government orders (Konyuhov et al., 2021).

The application of the new method, not protected by the status of a military secret, could not for long be limited to the framework of only American industry. In the 60s, it began to be used in other countries, primarily in Western Europe.

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In England, the first company to start implementing the FCA was Associated Electrical Industrial Ltd. with 100 thousand workers. A little later, with the help of consultants from the United States, the functional-cost analysis is extended to French firms - first the automotive, electrical, instrument-making industries, and then to the household appliance industries. Since 1959 such West German companies as Opel and BMW began to implement the FCA. And by 1968, according to a survey of the heads of 2,000 West German firms, 51% of them used functional-cost analysis (Kukartsev et al., 2018). In 1968, the Association of German Engineers of the Federal Republic of Germany prepared special instructions (No. 2801 and 2802) containing generalized recommendations for conducting the FCA of products, and in 1973, on their basis, the industrial standard DIN No. 69910 “Functional-cost analysis. Concepts and Methodology ". As an object of the FCA, the standard considered not only industrial products, but also processes, systems, activities, etc. Since 1975, the same standard has been in effect in Austria. In the capital of Austria, Vienna, the international journal of the FCA "Forum" is published.

Of the socialist countries, functional-cost analysis was the first (not counting the USSR) to be applied in the GDR, Poland, and Czechoslovakia. In the GDR at the end of the 50s the FCA coordination center was created, and in 1973 a special standard was issued. In Czechoslovakia, experimental work on FCA began in the 50s. in tractor construction. Among the first companies to successfully use functional cost analysis were Adast (Adamov) and ZKL (Brno). In the NDP, the functional-cost analysis was first applied in 1966 in the car-building industry. In the Hungarian People's Republic, the beginning of work on the FCA dates back to 1969, in the SRR - in the 1970s (in 1979, the state standard was published there), in the NRB - in 1978.

In Japan, the FCA method began to be applied later, especially actively after the 1973 oil crisis. In 1965, the Society of Japanese Specialized Engineers for FCA was founded, which actively promoted this method, holding annual conferences with the participation of representatives of the largest industrial companies and government organizations. And already in the 70s, functional-cost analysis was used in Japan 10 times more often than in Germany. In the production of new products, Japanese firms used FCA in 80 ... 90% of cases, and in the improvement and modernization of products - in 50 ... 85% of cases (Mineeva et al., 2020).

Every year, businesses and government organizations save millions of dollars by leveraging value analysis and improve customer satisfaction. In the United States, laws have even been passed that oblige the use of functional and cost analysis when fulfilling government orders: Law No. 99-662 of 1986 "On water exploration and wastewater treatment", if the funding for the work is carried out from the federal budget and exceeds $ 10 million, and Law N ° 104-106 of 1996 approving the appropriation for national security.

The foundations of functional-cost analysis in our country were laid in the late 1940s by Yu. M. Sobolev, a design engineer at the Perm Telephone Plant. Proceeding from the position that there are savings reserves in each production, he analyzed a number of units of the same type of products produced by different enterprises, and, having found in them a lot of flaws (unjustified complication of the form, overestimation of accuracy and purity of processing, expensive coatings, etc.), came to the idea of using a systematic technical and economic analysis and element-by-element development of the design of each detail.

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He considered each structural element that characterizes a part (material, size, tolerances, threads, holes, surface roughness parameters, in a word, everything that in one way or another characterizes the part and is included in the technical requirements of the drawing) as an independent part of the structure and, depending on the functional purpose, included it in one of two groups: main or auxiliary. The elements of the main group are characterized by the fact that the quality and work of the part depend on them. Therefore, they must meet the operational requirements for the part. Elements of the auxiliary group serve for the complete structural design of the part and do not change its functional purpose.

The element-by-element economic analysis of the design showed that the costs, especially for the auxiliary group of elements, are usually overestimated and they can be reduced without compromising the quality of the product. It was as a result of the dismemberment of the part into elements that the unnecessary costs became noticeable. An individual approach to each element, the identification of unnecessary costs for the implementation of each element formed the basis of the Sobolev method (Ogloblin et al., 2019).

The main difference between the Sobolev method and the Miles method was that the first was aimed at finding more economical methods of manufacturing a product mainly within the framework of the existing design solution, while Miles and his followers based their method on the function, considering the original design of the product only as one of the possible options for performing certain functions. They suggested looking for new options and, with the obligatory preservation of quality, reliability and other operational requirements and characteristics, choose the most economical option from among them.

The method of functional cost analysis in the USSR began to be introduced at the end of the 60s. But only in 1975, from the book by H. Ebert and C. Thomas "Cost Analysis Based on Use Value (New Methods of Rationalization)", published in the GDR and later translated and published in the USSR, Soviet economists learned that the foundations of this highly effective method had been developed precisely in our country.

One of the first in the USSR to pay attention to the Miles method was EA Gramp, an employee of the Foreign Economics and Information Department of the Informelectro Institute, head of the laboratory for the study of foreign management experience. While working on his dissertation, he became interested in a methodology that allows American corporations to make significant profits, maintain the competitiveness of their products, and find fundamentally new solutions for the design of products, without reducing their quality and at the same time reducing the cost of providing it.

In 1974-1975, E. A. Gramp was directly involved in the work on the FCA of lighting products in the framework of a joint project of the Institute "Informelectro" and the Moscow PA "Electroluch". Then the FCA method began to be applied at the Electroapparat VNII, the Cheboksary Electrical Apparatus Plant, the Vorovsky Sverdlovsk Machine-Building Plant, the Uralmash Production Association, etc. The new method made it possible to reduce non-productive costs in production (Sofrankova, 2017).

In 1976, the board of the Ministry of the Electrotechnical Industry decided to introduce the FCA as a systematic method of reducing production costs. In 1977, the first in the USSR three-tier FCA management system was created in the Ministry of Electrotechnical Industry: the ministry had a coordination council for the FCA headed by the deputy minister, in research institutes - committees, laboratories, groups, bureaus for FCA, similar divisions began to operate on enterprises.

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The Resolution of the Central Committee of the CPSU "On the work of the Ministry of the Electrotechnical Industry to save material and labor resources in the light of the requirements of the XXVI Congress of the CPSU," adopted in 1982, noted the positive experience of using functional and cost analysis in the electrical industry; The State Planning Committee, the State Committee for Science and Technology, the State Committee for Labor and the Central Statistical Office of the USSR were instructed to generalize this experience and distribute it at the enterprises of the country's national economy.

In the same year, the USSR State Committee for Science and Technology approved the "Basic Principles of the Methodology for Conducting a Functional Cost Analysis of Products" prepared by a team of leading specialists of the country. Cross-sectoral regulations for the FCA were developed, a plan of all-Union measures to expand the use of the FCA in the national economy was approved. Among them are the transformation of several associations and enterprises into indicative according to the FCA, the inclusion of works on the FCA in targeted scientific and technical programs, scientific support for the development of the method, studying the possibilities of taking into account the requirements of the FCA when approving prices, projects, estimates, determining the amount of financing and lending to an object, developing standards, training of engineering and economic personnel who know the FCA method, publication of literature, further promotion of the method, scientific and technical cooperation with foreign countries, etc. (Sosedko & Yanishevskaya, 2017).

However, the sharp deterioration of the economic situation in Russia since the beginning of the 90s of the last century could not but affect the state of work on the FCA. Research in this area has been curtailed everywhere at enterprises, training of specialists in functional-cost analysis at advanced training institutes and training centers has practically ceased, the amount of published literature has sharply decreased, and the wealth of experience accumulated over 50 years of applying the method has been undeservedly forgotten. Due to the collapse of the enterprises, some specialists in functional and cost analysis were not in demand, and therefore went abroad or were forced to retrain.

Currently, functional and cost analysis in Russia is entering a qualitatively new stage - the stage of revival. Seminars are held, publications appear, books and collections of scientific papers are published, intelligent computer technologies for search and decision-making are being developed.

6. Findings

The main prerequisites for the use of FCA at modern Russian machine-building enterprises are the aggravation of competition, the introduction of a process approach, an increase in overhead costs, the introduction of information technologies, the dynamism of the external environment, the "imperfection" of performers, individualization of products. Let's consider these prerequisites.

1. Aggravation of the competition. In connection with the transition to market conditions of management, the development of industry in Russia in recent years has been characterized by an intensification of competition. Moreover, the impending globalization deprives Russian producers of the opportunity to hide from foreign competitors beyond national borders.

In this situation, a prerequisite for the long-term survival of an enterprise is its achievement of competitiveness. Manufacturers have practically no other choice but to transform into competitive world-class companies by optimizing their business processes. Competitiveness can be achieved either by

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improving quality or by reducing cost. The solution of these problems is facilitated by the introduction of the FCA method at enterprises, which allows to identify the strengths and weaknesses of a business organization in terms of creating use value. A future model of production organization is being developed on the basis of the FCA data. As a result, the cost of business processes is reduced, the duration of their execution is reduced, which immediately affects the competitiveness of the enterprise. Thus, functional value analysis contributes to the creation of a competitive advantage that every enterprise should have (Strizhakova, 2016).

2. Implementation of a process approach. Recently, in connection with the introduction at Russian enterprises of new quality management standards of the ISO 9000 series, based on the process approach, the need for functional cost analysis has become especially tangible. The process approach, which was formed by the mid-80s of the last century, is the development of the functional approach, but at the same time it acts as a kind of alternative to it.

With a functional approach to management, a number of functions are assigned to each structural unit of an enterprise (employee, department), its area of responsibility is described, and criteria for successful activity are formulated. At the same time, as a rule, horizontal ties between the structural units of the enterprise are weak, and vertical ties along the line "boss - subordinate" are strong. The subordinate is responsible only for the functions assigned to him and, possibly, for the activities of his unit as a whole. He is not interested in the functions and results of the work of parallel structural units. As a result, isolated islands of automation and management often appear in an enterprise, where a highly specialized task (for example, accounting) takes precedence over a general corporate one (supplying goods and services to the market). Most often, this results in the creation of impenetrable inner walls between the units.

To eliminate the shortcomings of the functional approach, many Russian manufacturers are moving to regular interconnected management based on the process approach. With this approach to management, each structural unit ensures the implementation of specific business processes in which it participates. Responsibilities, area of responsibility, criteria for successful activity for each structural unit make sense only in the context of specific business processes. With this approach, horizontal ties between structural units are much stronger, and vertical ties along the line "boss - subordinate" are somewhat weaker. An employee is responsible not only for his functions, but also for those business processes in which he is involved. The functions and the result of the activity of parallel structural units, which participate in the same business processes as he, become important to him. There is mutual responsibility for the result of the business process between all its participants (Vorozhbit et al., 2020).

One of the tasks of the process approach is to assess the effectiveness of business processes. In its most general form, efficiency is the ratio of the result to the costs that ensured its receipt. Traditional costing methods are product-driven and therefore not suitable for the process approach. In this case, you need to use a method that focuses on business processes. Functional value analysis is just such a method. Thus, the implementation of the process approach at enterprises is carried out using the FCA.

3. Growth of overhead costs. At present, the product strategy of most Russian enterprises is developed on the basis of information borrowed from financial statements, accumulated by the traditional cost accounting system. This system accurately measures the basic materials consumed by the products and

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the labor of the main production workers due to the simple causal relationship between them. The only thing left to measure is the overhead. This is where difficulties arise.

When attributing overhead costs to a particular type of product, the traditional cost accounting system uses, as a rule, the operating time of the main production workers or equipment as the basis for their distribution, and thereby distorts the true cost of production. As practice shows, the products with the lowest production volume and the greatest complexity are usually the most cost-intensive. They are underestimated when using the traditional cost accounting system. In contrast, the least costly products are those with the highest volume of production and the least complexity. When using the traditional cost accounting system, they are the ones that are overvalued.

The traditional cost accounting system was created several decades ago, when the range of products manufactured by enterprises was limited and the dominant costs were the cost of basic materials and labor of basic production workers. Overhead costs were relatively small, so cost distortions due to inadequate allocation of overhead costs were negligible (Yakovlev, 2020).

Today enterprises automate their business processes and produce a very wide range of products. The consequence of this is a significant increase in the share of overhead costs in the overall cost structure. Accordingly, the distortions of the cost price calculated on the basis of the traditional approach to cost accounting increase, as a result of which the managers of the enterprise may make the wrong decision regarding the range of products, for example, curtail the production of a product that makes a profit, or continue the production of a really unprofitable product.

Eliminate the above disadvantages of the traditional cost accounting system allows the FCA method, since the functional cost analysis focuses first on the business processes of the enterprise and only then on the unit of production. This logic is explained as follows. The same product can be produced with different efforts and, accordingly, costs. This means that costs are generated not by the very fact of production, but by one or another organization of human activities, the actions of employees, integrating into business processes. Ultimately, the cost of a unit of production consists of the cost of materials required for its manufacture and the business processes associated with its production. Thus, functional cost analysis helps to determine the true cost of production.

4. Introduction of information technology. Functional cost analysis of business processes is a rather laborious procedure. So, modeling and analysis of one business process, consisting of 10 ... 20 functions, requires 1 ... 1.5 working days of a highly qualified analyst. Today, Russian manufacturers can use software products such as BPwin, EasyABCPlus, etc. as instrumental support for FCA business processes.

Thus, in connection with the introduction of information technologies, the possibilities of using functional and cost analysis at Russian enterprises are significantly expanding (Yoshikawa et al., 1994).

5. The dynamism of the external environment. The constantly changing external environment in which Russian enterprises are forced to operate requires their accelerated adaptation to new conditions. To maintain their market position, manufacturers must continually improve their business processes. This means that it is necessary to eliminate functions that have become unnecessary in the new conditions of the enterprise; add functions that meet the new requirements of the external environment; determine the required degree of performance of these functions and the required resource coverage. The solution of these problems is largely facilitated by the introduction of the method of functional cost analysis at enterprises.

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6. "Imperfection" of performers. Any enterprise, especially a large machine-building enterprise, even if at the time of its foundation it was built according to a completely optimal scheme, eventually loses its original optimality, acquires functional inconsistency, illogicality, and opacity. Business processes get confused, there is a departure from the original priorities of activity, etc. The reasons for this are the "imperfection" of the performers, the subjectivity of their perception, addiction to certain negative phenomena, the difficulty of applying theoretical principles to specific human relations, staff turnover. All this leads to a gradual deformation of the basic principles and guidelines, a departure from optimality, an increase in spontaneous development and, ultimately, to a mutation of the management system and the enterprise as a whole. To return to optimality, it is necessary to carry out a complete reorganization of the enterprise, including the reengineering of business processes. Reengineering involves rethinking and redesigning the business processes of companies in order to significantly improve such indicators of their activities as cost, quality and speed. Functional and cost analysis can provide significant assistance in reengineering.

7. Individualization of products. An equally important prerequisite for the introduction of FCA at enterprises is the evolutionary transformation of sales markets, expressed in the individualization of consumer products. Individualization not only manifests itself in fundamentally new properties of products, but also, as a rule, affects the external forms, constituting the basis or essence of the object, endowing it with such specific features demanded by the consumer as color, equipment, service, quality, cost, etc. to keep their customers who want to get something that meets their financial capabilities, technical and aesthetic requirements, manufacturers must constantly improve their business processes. The solution of this problem is also largely facilitated by the introduction of the method of functional cost analysis at enterprises (Zhang et al., 2020).

7. Conclusion

Thus, the need to use functional cost analysis in modern machine-building enterprises is becoming more and more obvious. Since this method solves a large number of problems and helps to optimize the business processes of companies in order to significantly improve such indicators of their activities as cost, quality and speed (Konyuhov et al., 2021).

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