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Application of value analysis in processes of cog-wheels production

M.T. Roszak*, D. Szewieczek
Division of Materials Processing Technology, Management and Computer Techniques in Materials Science, Institute of Engineering Materials and Biomaterials, Silesian University of Technology, ul. Konarskiego 18a, 44-100 Gliwice, Poland
* Corresponding author: E-mail address: marek.roszak@polsl.pl

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ABSTRACT

Purpose: The analysis of the processes based on the value analysis allows to evaluate of applied technologies of production. In the paper there is presented the value analysis for chosen processes of cog-wheels production as well as correlation of the functions of the product with the costs of operations creating them. An evaluation of applied technologies of production was done.
Design/methodology/approach: Application of the method of value analysis with reference to productive chains including results of cost analysis.
Findings: The study presents results of performed value analysis for chosen processes in particular with reference to costs of realized processes of cog-wheels. The analysis was done in the productive processes of the same product in two different technologies.
Research limitations/implications: Evaluation of costs of operations of the productive processes.
Practical implications: Presented in the paper approach and application of the method of value analysis essentially influences evaluation and increasing of efficiency of realized productive processes.
Originality/value: Presented method is based on the methodology by L.D. Miles, L.W. Crum.
Keywords: Productivity and performance management; Manufacturing technology management; Supply chain management; Value analysis

1. Introduction

The present market is characterized by fast economic development and growth of social needs. The globalization of economy forced from the enterprises the production of articles at suitable quality and at low cost of production and exploitation, what results from the social needs and expectations.

The production of high quality, but cheap articles, is associated with solution of number of problems in macro- and microeconomy. It is connected with application of suitable productive materials, modern technologies as well as the techniques of organization of production [1,2].

Improvement and modernizing of finished products or productive systems requires consequent solution of problems, often at all rungs of management. To do it, a lot of methods, organizing and rationalizing techniques is used; however there is no universal method, and each of them has its area of application and destination where its effects are possibly the largest. Among many methods one could distinguish value analysis [3-7].

In the beginning period the method of value analysis was used to investigation of products, but after years its range of application was broadened. Nowadays the value analysis is used to rationalizing of the course of technological processes, administrative procedures, organization of auxiliary processes, organizing structures etc. [7-9].

The analysis of value is one of the basic methods of preparation and undertaking the decision of choice of correct solution, it enables to solve complex problems in a transparent and effective way [3,4,6].

During the value analysis of the finished product or the productive process, a lot of attention is paid on the analysis of the

functions of the given product as well as its components, their connections and costs. It results from the fact that the consumer deciding on purchase of the finished article, first of all is buying its useful functions of the given article, which satisfy his definite needs. Such approach is called functional approach [3,4,6,].

During the value analysis after defining the functions, the examined product is replaced by collection of functions, and after it the cost of their obtainment in the analysed product is established. Such approach with determined functions of the product of even the smallest component elements permits on dematerialization of the product, thanks to what it is possible to evaluate it according to its functions with reference to concrete needs which should be satisfied by the given needs [3,4].

The functional approach is understood as inseparable connection of functions and costs; analysing of only one of these elements is not adequate for the established aim, it means realization of functions at the lowest costs. The determination of the costs of the function as well as making it clear that they are too high, often makes a stimulus to search for new solutions [10,11].

The analysing of the product as a system of the functions allows to determine which parts of the material structure is used to do the functions fulfilled by the given product, what enables to determine their costs. It is the main feature distinguishing the value analysis and the functional approach from the other methods of reduction of costs [10,12]. The analysis of functions makes it possible to separate from existing technological, constructional or organizational solutions. It enables to look at the product in a new way what permits to find completely new interesting and original solutions and distinguishes it from the traditional methods [4,12-14].

Arisen from experiences, functional approach is one of the most effective methods of reducing the unit own costs as well as the way of increasing the quality of the finished products.

The effectiveness of functional approach is mainly associated with answers to following questions: [6]

- what functions the finished product fulfils and what functions should be fulfilled from the point of view of the needs of the user,
- if and in what way it is possible to gain a cheaper product at similar or higher quality but at lower costs when we throw aside existing solution,
- how it is possible to assure fulfillment of the functions of the finished article at the lowest unit costs.

All the objects, things, articles, which are products of the man's work, are produced in some determined purpose. To reach this purpose, some definite functions have to be realized.

In case of value analysis "function" is understood as a purpose (task) determined (specified) by a man, which the analysed object (product, productive process or its part) fulfils (or should fulfill). So the function answers the questions: What does the object execute? What tasks does it fulfill? To what fulfillment is it designed? So the studied object is the carrier (the executor) of the functions fulfilling the determined tasks.

One should notice that majority of the products or their parts can fulfill not only one function, but several or a dozen or so. The classification of functions in the analysis of value can be made in the generic arrangement and superiority. During carrying out of the value analysis the attention is paid not only on the functions, but also on costs of their fulfillment by the finished product and its component elements. Comparing the functions with the costs one could detect incorrect constructional, technological, material or other solutions, having place in the analysed finished article [6-8,11].

All above mentioned shows the fact, that in the value analysis the attention is directed to the costs, but not to the costs of production of the finished article but to the costs of fulfillment of the functions. However, one should notice, that in the aim of establishment of costs of the functions, the knowledge is necessary about particular parts of unit costs of production [15]. Determination of the costs of functions is a difficult and complicated operation. It results from the fact that costs not always could be exactly determined because individual functions not always agree with concrete parts or components.

This operation is easy only when costs of function of the part are determined which realized only one function and in the realization of this function no other components take part. In such a situation cost of the part is the same as cost of the function. But those situations do not happen often [8,11-13].

Determination of the costs of function is very important during the comparative investigations when the product is compared to other products of the competition or different enterprises, because it permits to find "weak points" of the compared article. It is also used in comparing with the products not comprising all the functions, and mainly in the case of products making the same functions. It is also very important to compare costs of functions of the analysed product with the projected solutions [6, 40].

Establishment of costs of function could be made on basis of constructional and technological documentation (operation is the carrier of function) etc. This activity requires arrangement of special system of reference costs. It is a characteristic feature distinguishing analysis of value from different methods of improvement of articles or the productive processes (together with determination of costs of fulfillment of the particular functions and their analysis according to the special rules) [7,12,14].

Another characteristic feature of value analysis which deserves special emphasis is simultaneous analysing (investigation) functions and costs. It is important because of the fact that both functions and costs are the object of opinion of existing and new solutions. Value is the measure of opinion of the finished article, which simultaneously is the relation of these two sizes [7,12,14].

Additionally, simultaneous analysis of function and costs during analysis of value permits to get well to know with the investigated product, thanks to what the possibility of elaboration of new, better, more economical and more original solutions is increased [12,14].

2. Analysis of value for processes of production of cog-wheels

2.1. The processes of production of cog-wheels were analysed.

The dimensions of cog-wheel are presented in figure 1. The entrance material was forged shape or rod.

To the defined requirements for the investigated product belong: hardness of teeth of wheel HRC 55 ÷ 60, resistance to abrasion, high endurance, resistance to the corrosive factors (moisture and gas -

methane). The type and kind of entrance materials used in the studied productive processes are presented in the table 1.

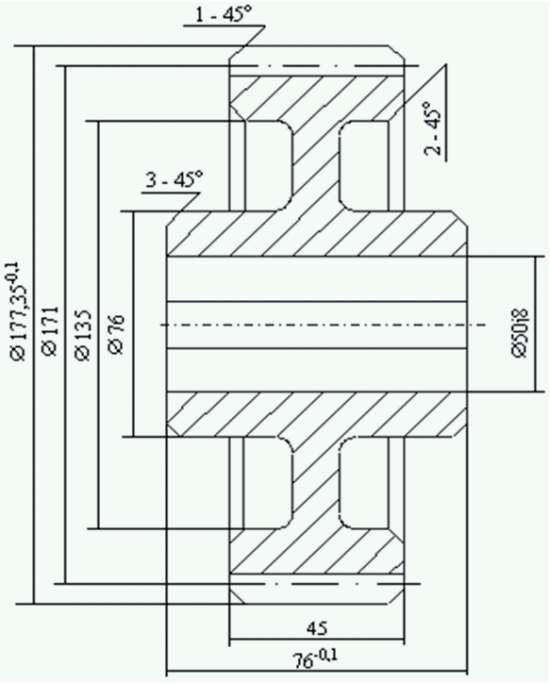

Fig. 1. Characteristic of the investigated product

Table 1.
The entrance materials in the technological process

The entrance material	Cog-wheel 1	Cog-wheel 2
Type	Forged shape	Rod
Kind	18H2N2 (18CrNi8)	40H (41Cr4)

2.2. Determination of function of the examined product

The function of the studied product was described as transfer of rotary moment. This function is realized directly by teeth of cog-wheel. The analysed function describing the class of the product is closely connected with requirements placed to the product, as hardness of teeth and their endurance, resistance to abrasion and resistance to corrosive factors.

Defined requirements allow us to select the material and influence on formation of technological process, so that it could shape the product according to the foundations.

The kind of applied technological process determined the possibility of obtainment of suitable values defined in such requirements as for instance hardness of teeth. Chosen requirements can be connected to the functions which are realized by the given product, and in this way they influence its figure. Each product should fulfill the requirements and realize its functions. Depending on the accepted technological process we can form costs of obtained functions of the product.

2.3. Profile of analysed productive processes

The analysed processes significantly differed with the technological operations. The differences in applied technologies concerned the profiles of entrance material as well as the applied formative of the figure and property of article operations. On example, in the operation of thermal processing: in the process realized from forged shape carbureting was used, successively , the volumetric twofold tempering and absolving and in the process realized from rod - volumetric tempering and absolving as well as in turn the inductive tempering of teeth. Both productive processes were conducted in the same factory.

2.4. Results of analysis

The costs and times of individual operations, also adding the value as well as operation creating the function of article, were defined. Table 2 presents chosen results of analysis.

Tabela 2.
The composition of chosen costs of operations of processes for production of cog-wheels (10 pieces): cog-wheel 1 - produced from forged shape, cog-wheel 2 - produced from rod.

Costs [zl]	Cog-wheel 1	Cog-wheel 2
Costs of operations creating the function	2236.0	2229.0
Costs of operations creating value of the product	3517.0	4447.2
All the costs of operations of the productive process (Cost of operations adding value + costs of operations not adding value)	3564.3	4507.6
Price:	5063.0	6393.0

Derived from presented in table 2 costs of operations of processes, the total cost of production of cog-wheel 2 (rod) is larger about 20.9% than the total costs of production of cog-wheel 1 (forged shape), what results first of all from higher costs of technological operations which in direct way do not create the function of cog-wheel as cutting the rod as well as rough and finishing rolling. These operations belong to the group of operations creating value of the finished article, which in both processes of the production are on the same level and make up the main part of total costs – 98.68% and 98,66%. On this basis it is possible to say, that both processes are effective because the operation of not adding values are at the level of near 1.5%, so very low. Because of accepted in the work realization of productive processes in one enterprise, also profitability of both processes is comparable, so the profit with mark-ups is about 29,5% of costs of production.

The essential difference results from comparison of costs of operations creating function of the product with costs of operations creating value, which constitute respectively 63.58% of the value for cog-wheel 1 (produced from forged shape) and 50.14% of the value for cog-wheel 2 (produced from rod).

All above mentioned shows that the costs of operation associated with realized function of the studied product are more

profitably for process realized from forged shape because accepted technology of production described by costs permits to declare that near 64% of costs of production participate in formation of the function of the product which is purchased by a customer.

3. Conclusions

The value analysis is a investigative tool thanks to which the analysed product or process could be recognized in detailed way. The entrance materials for analysed processes were: steel 18CrNi8 for cog-wheel 1 produced from forged shape, and steel 41Cr4 for cog-wheel 2 produced from rod. Thanks to proper chemical composition and properties got in process of thermal processing, both above mentioned materials fulfill requirement described in the studied article: hardness of teeth of cog-wheel 55÷60 HRC, high endurance or resistance to the corrosive factors.

The studied cog-wheels were produced in two different technological processes. In case of operation of thermal processing their number in both processes is equal, but they are not the same. In technological process of cog-wheel 1 there are carbureting, volumetric tempering and absolving, however in technological process of cog-wheel 2 there are preliminary volumetric tempering as well as absolving and inductive tempering. The differences in kind of operation of thermal processing result from different entrance materials to processes and their characteristic.

All the presented data permit to recognise that the applied technology of production is essential costs making factor and decides about possibilities of formation of profitability of realized processes. Use of forged shape in realization of presented productive process allows to get more profitable cost results, it means that the process is cheaper, but also much more higher is cost part of operations forming function of the product.

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