CONSIDERATIONS UPON THE POSSIBILITIES OF APPLYING THE VALUE ANALYSIS METHOD IN MANUFACTURING ROLLING CONTACT BEARINGS

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Abstract. Applying the studies of value analysis in the framework of manufacturing simple components or sub-assemblies of complex products raises several difficulties, especially due to the necessity of observing the principle of systemically approaching the utilization value. In the particular case of applying the value analysis method in manufacturing bearings, the difficulties are generated by the diversity of the technical products wherein they are to be used and by lack of knowledge upon the functions that they are to fulfil in the assembly they are to be integrated within, during the moment of their design and manufacturing.

The paper herein presents the stages to be gone through in order to achieve the value analysis studies in the case of bearing manufacturing and there is exemplified the manner in which there may be identified the functions of the products undergoing the value analysis study, in the case of bearing manufacturing. There are likewise forwarded the authors' considerations as regards the necessity for including a new condition which is to be fulfilled in the case of bearing manufacturing and utilization: the environmental condition. We deem that only simultaneously observing the requirements of all parties involved: users, manufacturers and environment may ensure for the products in which there are integrated bearings, a utilization value correlated with the environment requirements.

Keywords: value analysis, bearing manufacturing, environmental condition

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1. Introduction

Bearings are constitutive parts of various complex technical products. They consist of two rings – internal and external – in which there are performed the rolling paths, a number of rolling bodies – balls, rolls, needles – which enable the rolling motion and a cage which ensures the uniform distribution of the rolling bodies on the circumference and impedes their contact. In practice, there is used a wide diversity of constructive variants of bearings, which drift from the simple image submitted so far, but which may be included within the wide group of the rolling friction bearings [1].

The bearing manufacture and demand have marked a high rise during the past decades, due to the ever-increasing variety of technical equipment wherein they are used and to their great volume of production. Therefore, bearing manufacturers are preoccupied with producing them under technical-economic conditions that should increasingly satisfy consumers – the producers of technical machines, outfit and equipment and that should ensure for them the highest benefit possible. In order to achieve these desiderata, based on the on-going studies, there have been perfected the manufacturing technologies, there have been conceived state-of-art constructive variants that should comply with current requirements, there have been automated the manufacturing lines etc.

The current preoccupation of bearing manufacturers is oriented towards finding the methods and the means enabling the manufacture and the consumption of these components to generate the lowest negative impacts upon environment [2].

In order to keep on improving the bearing production through manufacturing them on the necessary level for complying with the producers and consumers' requirements and with the environmental requirements, there is called for the follow-up, the extension and the deepening of the studies and of the researches in the field. One of the research-design methods successfully used in solving such problems is the value analysis method (AV) or value engineering (IV) as it is encountered in more recent studies [2, 3, 4]. Both names refer to the same methodology, however during different stages of the analyzed product lifecycle.

Value analysis is the method applied to the

products existing on the market, which are in the maturation phase of their existence, whilst the name of value engineering is attributed to new products, which make the object of research – design, products, which are in the phase before their launch on the market.

Applied in Romania since 1968, the method has fully proved its usefulness [3]. The four basic principles substantiating it – the principle of *functional analysis*, the principle of *function double dimensioning*, the principle of *maximizing the ratio between utilization value* and *cost* and the principle of *systemically approaching the utilization value* – have facilitated achieving analysis stirring up the production activity [3, 5]. The method is applied not only for studying products, but also for different purposes such as: re-designing technological processes, investments, financial-accounting activities, re-designing organisational structures [5].

2. Applying the value analysis method in the case of the rolling contact bearings

In order to apply the methodology of value analysis in the case of manufacturing components or sub-assemblies (category that bearings fit within), there is necessary to clarify their place and role for the product they are integrated within, as well as the contribution to its utilization value.

In compliance with one of the basic principles of IV – the one of systemically approaching the utilization value – the study object of the method is made up, in the first place, by the product [3]. Being applied to the utilization values that directly answer social requirements, there ensues that the method cannot be applied for studying parts of the product – piece, sub-assembly – as they do not constitute by themselves the object of explicit social requirements. There is deemed that solely [3] applied on the level of components or on the one of a sub-assembly, the method does not put forth its entire essence.

For current practise, there has been called for the necessity of finding modalities for efficiently applying the method of value analysis also in the case of studying parts of the products – especially for economic organizations that have as object of activity manufacturing such components. Such situations appear in the case of the factories manufacturing assembling organs, or bearings or different sub-assemblies. However, there has proved of usefulness the use of the method in the case of analyzing complex products, whose study entails too much complication, or when there is only aimed at several sub-assemblies of those products. In these cases, the papers [2, 3, 6] make some recommendations which may contribute to finding the necessary solutions.

Applying the value analysis method for studying a sub-assembly / simple component has to be done by observing the basic principles, especially the principle of the functional approach. Therefore, it is necessary that in the case of the study there should be initially gone through the following stages:

a. accurately identifying the functions of the products that the sub-assemblies or the simple components which make the object of the study are to be integrated within;
b. determining the product function benefiting from the component or the sub-assembly which has to be analyzed;
c. determining the degree of importance of the product function / functions benefiting from the component or the sub-assembly which has to be analyzed;
d. determining the degree of participation of the component or of the sub-assembly in attaining the level of the function.

Under the conditions of correctly going through the stages presented above, the appreciations upon the contribution of the component or of the sub-assembly in the production functions may be affected by a certain degree of subjectivism. There is deemed that [3, 4] there is the possibility for obtaining satisfying results in the practice, if this stage is substantiated through statistic survey among the specialists and the users of the product.

Afterwards, achieving the study entails going through the working methodology of value analysis (stages and phases) specified in STAS 11272/1/2 and through the indications submitted in the papers [3, 4, 5].

Applying the methodology of value analysis in the bearing production raises some particularities upon which there are brought forth as follows useful considerations for practical activities.

The difficulties arising whilst initiating the value analysis studies in the framework of the bearing manufacturing are brought about by the lack of capital data connected to:

- equipment or machines wherein they will be integrated;

- functions exerted by the equipment or the machines wherein they will function;
- level of importance of the functions in whose materialization there will contribute the bearings.

In the absence of these data necessary for applying the consecrated methodology of value analysis, there is recommended considering the requirements imposed while choosing the type of bearing.

To the purpose of adequately choosing the type of bearing so that might fit into a sub-assembly, there is recommended to take into consideration the following requirements [4]:

- precision to be ensured within the sub-assembly it has to function within;
- size, type and direction of the strain – radial, axial or combined forces – that it takes over and then sends forward during functioning;
- cut-off rotative speeds for which it ensures the smooth functioning during the working condition of the equipment or of the machine they are to function within;
- he temperatures for which they ensure the normal functioning;
- the level of noise brought about during the different working conditions of the sub-assembly in which they are to function;
- rigidity that the bearing might provide;
- unction manner and lubricating material.

Based on these requirements, there may be settled the quality characteristics (aptitudes) that the bearings should possess, which, in the design phase change into specific and particular functions of the product. We deemed [8] that in the case of the rollers (rolling contact bearings – in particular) the functions they are to carry through may be grouped as follows:

a. general functions of the bearings;
b. specific functions of the rollers (rolling contact bearings);
c. particular functions (for the case of an analysis value study achieved upon a certain type of bearings, for instance: conic roller radial – axial bearings), brought along by the specific set-up and running conditions imposed by the application wherein the respective bearing will be integrated.

Figure 1 illustrates the classification submitted for the functions of a conic roller radial – axial bearing, classification necessary for identifying and defining the functions of the product undergoing the value analysis study. Provided with these functions, bearings are to contribute to carrying through the functions of the product wherein they are to be assembled.

According to the consecrated methodology [9] after identifying and characterizing the functions, there is determined the level of importance for each of them and there is worked out their distribution into hierarchy.

3. New condition for applying the method

In the perspective of the durable development of the bearing industry, their production is to be achieved under conditions in which both technical-economic requirements of manufacturers and users (technical machine, outfit and equipment manufacturing companies) and the environmental conditions should be complied with. The cases mark up an ever-increasing rise when the machine manufacturers also set out, among priority objectives to improve the environment performance yielded by the company whom the products it carried through. Consequently, they set the requirement for each component part of their products, manufactured under their management or acquired from another company, to also abide by the environmental requirements. Under these conditions, the bearings also fit in. When machine or equipment manufacturers may acquire for themselves component parts or sub-assemblies under the same technical and pecuniary conditions, they would obviously rather have the variants that likewise comply under the aspect of the environmental conditions. Only in this manner there is possible for the products of the company to ensure the utilization value, achieved without registering significant impacts upon the environment [6, 7].

There is consequently called for updating and completing STAS 11272 – 2/79 with provisions related to the environment and for elaborating a new application methodology, wherein environmental requirements should be included. At the same time there is necessary for the producers to be preoccupied with manufacturing bearings that might be eco-labelled according to the provisions of the ISO standards. This way, the utilization value of the products wherein the bearings will be integrated, may be ensured without their contribution to significant impacts upon the environment.

The current methodology for applying the value analysis to products, stipulated in STAS 11272 – 2/79 [9], in the 6 stages and 21 phases does not tackle environmental issues. Working out and drawing up value analysis studies under these circumstances leads therefore to solutions that only partly satisfy the users.

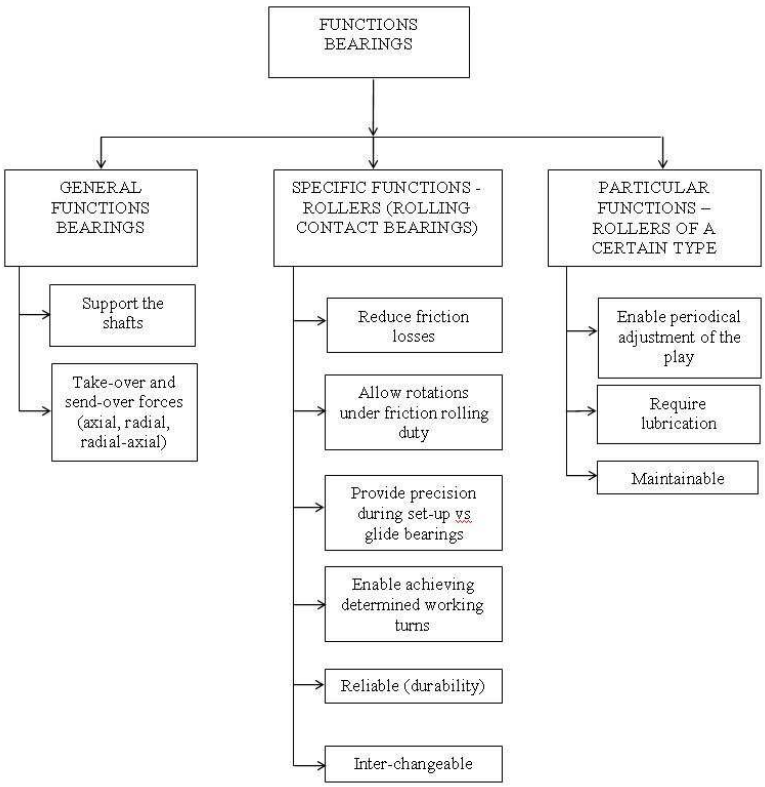

Figure 1. Classification of the functions „radial-axial bearing with conic rolls"

The authors advance the completion of the existing methodology with a new stage, entitled „Verifying the compatibility of the product with the environment" wherein five phases should be included (figure 2). This stage is to be undergone after the product has been designed or reconceived, to its greatest part, when all necessary information enabling verification are acquired.

The five phases of the new stage are to determine the limits of the impact that the product may exercise upon environment along its useful lifecycle, and during post-utilization. We thereby may, since the project stage, become acquainted and avoid the possible major negative impacts upon environment.

Phase 1 Verifying the useful lifecycle – within the filled in methodology – is of importance in determining, ever since the project phase, the exploitation period of exploitation. The longer the product will be used, the more the need for manufacturing a new product is eliminated. There will be thereby no longer necessary for the environment to yield up other quantities of primary resources for manufacturing new products. At the same there are eliminated the pollution possibilities caused by manufacturing new products.

Phase 2 Analyzing and evaluating the lifecycle – will determine when and to what extent, along the product lifecycle, and likewise during post-exploitation, there are generated major negative impacts upon environment. This phase is to end either in accepting the submitted project describing the product, or in submitting the proposal to find other solutions for carrying through the functions whose obtaining led to the impact-generating variant. The materialization of the new solutions will of course must not bring along other impacts or transfer their manifestation from one stage to another of the useful lifecycle.

Phase 3 Analyzing the up-dating capacity. Under the conditions of knowledge development and of the rise in the implementation speed in the humans' creations, the product obsolescence is carried out in an increasingly shorter while. So that the products need not be put thereby out of use, before the exhaustion of their available physical capacities, they also need to dispose of the capacity of undergoing updating.

A	Stage I	Phase 1 – Determining the Theme
N	Preparing	Phase 2 – Organizing the work team
A	measures	Phase 3 – Methodological instruction
L		Phase 4 – Determining the working plan
Y		Phase 5 – Approving the working plan
S	Stage II	Phase 1 – Culling information
I	Analysing social	Phase 2 – Determining the function list and the limits of the technical dimensions
S	necessity	Phase 3 – Determining the importance level of the functions
	Stage III	Phase 1 – Function technical dimensioning
	Analysis & assessment	Phase 2 – Function economic dimensioning
	of existing situation	Phase 3 – Function systemic analysis
V		Phase 4 – Determining the research directions
A		Phase 1 – Elaborating the proposals for carrying out
L	Stage IV	The new product or update undergoing product
U	Re-designing	Phase 2 – Selecting the proposals
E	the Product	Phase 3 – Proposal development and concretizing on the level of solutions
		Phase 4 – Assessing the solutions
	Stage V *Verifying the compatibility of the product with the environmental requirements*	*Phase 1 – Verifying the useful lifecycle* *Phase 2 – Assessing and analyzing the lifecycle* *Phase 3 – Analyzing up-dating capacity* *Phase 4 – Assessing maintainability and reparability* *Phase 5 – Assessing recycling capacity*
	Stage VI	Approving optimal solution
	Stage VII	Phase 1 – Determining the realization plan
	Achievement & con-	Phase 2 – Making up the approved solution
	trol of application	Phase 3 – Assessing the results after application

Figure 2. Filled-in scheme of the methodology for applying value analysis to products

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Implementing this aptitude within the project ever since the project phase offers the possibility of achieving a longer utilization period.

Phase 4 Assessing maintenability and reparability. Maintaining the normal state in which the products carry out their functions to the designed parameters is closely connected to the two characteristics previously mentioned. These two aptitudes must be implemented in the project ever since its design phase. Being maintainable and

easily reparable, the products will allow their use within normal running functions along their entire useful lifecycle. There are created this way the premises for reducing the consumption of materials and energy afferent to manufacturing other new products of the same type.

Phase 5 Assessing recycling capacity. As it is known [2, 6, 7, 10] the materials proceeding from the natural environment – not the ones of synthesis – maintain their potential of being used after the transformations they have gone through so as to be used in executing the consuming products. This way, the constituting materials of the function carriers of the products should, to their greatest part, are recyclable. There have to be considered both the materials in the constituency structure of the products and the materials used for the consumption of the products. There is likewise aimed at recycling the by-products yielded during the wares manufacture and exploitation. The verification of the recycling character has to extend upon the manner it is carried through. There will be eliminated, ever since the design phase, those recycling variants which are to be executed through consuming quantities of other resources, higher those obtained previously, and through bringing about pollution forms and levels.

Approaching the aspects specific for each of the five phases within the methodology of value analysis application may be done in line with the recommendations of the standards from the series ISO 14000 [10].

Going through the methodology of value analysis application, within the proposed variant, submitted in the paper, there may be achieved the prevention of pollution ever since the source. The product project will have to contain all information referring to the functions (partial utilization values) it achieves under conditions of minimal negative impact upon environment, and likewise the costs entailed by its manufacture and consumption.

4. Conclusions

In order to observe the principle of the systemic approach in the case of value engineering studies upon parts or sub-assemblies which are to be included in different complex technical products, there is called for the identification of the functions that these parts contribute to.

Identifying the contribution part of the bearing to the functions of the products wherein they are integrated renders necessary considering the requirements that are indispensable in designing sub-assemblies for rolling contact bearings.

Besides complying with the users and producers' requirements, according to the methodology of value analysis, there is necessary for the environmental requirements to be considered in the case of the studies that are to be carried through.

Eco-labelling bearings is a manner enabling users to operate this choice taking into consideration the environmental requirements, and the producers guarantee for the compliance with the community standards and regulations referring to these requirements.

Following the series of recommendations and considerations presented herein, there is possible to apply the value analysis studies within bearing manufacturing. New solutions may be found thereby for improving their manufacturing, both under the technical and economic aspect, and as regards environmental requirements. This way, through the analyses carried though, the bearing industry is oriented towards a major desideratum of contemporariness: durable economic development.

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