

PROBLEMS AND CONCEPTS OF ENSURING THE RELIABILITY OF ELECTRO- AND RADIO-ELECTRONIC APPARATUS

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Abstract. Analysis of problems and tendencies which characterize today's state of theory and practice of ensuring quality and reliability of electro- and radioelectronic apparatus is given. The expediency of development and introduction of optimisation of these processes with respect to criteria of quality as well as rational supply and use of resources is substantiated.

Keywords: optimization of technological processes, quality, reliability, defectiveness

1. Introduction

Nowadays stage of development of Ukraine causes the necessity of intensification of processes for supplying this country with electro- and radioelectronic apparatus which considerably contribute to progress of science, technology, medicine, and other spheres of social activity. Strict requirements of marketing have pushed into the foreground the problem of improvement of processes of designing, manufacturing, and operation concerning this kind of engineering on the basis of progressive technologies, modern information facilities, using new materials, introduction of effective systems of checking and operation which can ensure high performance quality indices of articles under rational resources consumption.

This problem calls for carrying out systemic scientific investigations of quality ensuring processes and, in particular, those of reliability of articles in all stages of their life cycle (the term **life cycle** includes elaboration of a concept, designing, manufacturing, testing, and operation of an article).

2. Tendencies and problems of ensuring quality of electro- and radioelectronic apparatus

The investigations testify that certain tendencies which result in main directions of the work concerning improvement of electro- and radioelectronic apparatus have lately arisen in processes of their designing, manufacturing, and operation.

One of them consists in progressing enhance of the requirements to quality of articles caused by the requirements of the world- and home markets; they are more and more characterized not only by price competition but by strict competition of quality levels as well. This tendency causes the expectation that the next

period of development of our home industry will be characterized by the techno-economic strategy aimed at the achievement of higher quality levels, i.e. the creation of practically failure-free (and thus competitive) articles. With this, all the stages of their life cycle must be effective, able to ensure the necessary properties of the articles under minimal or admissible expenditures what becomes especially significant under market relations.

Nowadays, the strategy for ensuring production quality is mainly directed toward the use of technologies of designing, manufacturing, and operation of this kind of apparatus; such technologies are being developed in specialized establishments for research institutions, design offices, and, especially, for enterprises of the branch. The type technology determines the structure of processes, the enumeration of materials, semi-finished items, necessary equipment, modes and regulations of performance of technological, checking, and preventive procedures; amount of manufacturing and methods of checking are also determined there. Therefore, in the plants where such apparatus are produced, the measures concerning the quality are, first of all, aimed at the observance of the requirements of type technologies.

The tendency toward wide use of type technological processes is characterized by the increase in technological and economic indices of enterprises due to unification of technological and checking equipment, tools and auxiliaries, automation of processes, reduction in expenditures and in periods of assimilation, increasing quality. However, the application of typical technologies without proper taking into account specific conditions of designing, manufacturing, and operation often leads to the situation where these resources are used non-rationally, and the level of quality which is achieved under such conditions becomes essentially lower than the potentially possible one.

Numerous investigations have shown that 45...50% of all failures of the apparatus occur through failures of electro- and radioelectronic elements (ERE); about 50% through industrial defects made during the manufacturing, and about 5% through other causes. It should be noted that under the general tendency of increase in the reliability of articles of last generations, the proportion of their failures caused by failures of elements and those caused by industrial defects remains constant. The peculiarity is that about 50% of all

operational failures are parametrical ones; defects of ERE, imperfectness of the apparatus production technology, ineffective checking become the sources of these failures. The quota of parametrical failures increases during operation of articles. The rise in the complexity of apparatus leads, in most cases, to the increase in the number of parametrical failures. Therefore, the existing tendency of raising complexity of articles, transition to systems and complexes does not remove but, on the contrary, enhances the problem of parametrical failures. This causes the necessity of improvement and development of methods of ensuring parametrical reliability of apparatus during their designing and manufacturing.

Nowadays, there are numerous scientific works on different aspects of ensuring failure-free performance of apparatus. Without underestimating their scientific and practical merits, it is nevertheless necessary to note that in them the issue of ensuring reliability is considered, mainly, in the context of problems which are to be solved in stages of development of electronic circuits and apparatus construction. Attention to issues of ensuring precision and stability of apparatus parameters during manufacturing is insufficiently paid, though it is proved that just such stages as training elements, adjusting and technological running-in concerning the apparatus are notable for their high effectiveness in reliability ensuring. The problem of reliability estimation of electro- and radioelectronic apparatus with respect to their defects level has not been solved yet.

The quality and reliability of apparatus considerably depend on the perfectness of methods and means of checking which are used during their designing, manufacturing, and operation. Checking operations make up an essential part of the technological process of designing. In this case, their labour content reaches 40...50% of the general labour content of apparatus designing. And the expenditures for checking them in the process of their manufacturing become commensurable with the expenditures for their manufacturing, and they have a tendency to increase. The complication of the construction and that of manufacturing technology of the apparatus, raising requirements to the quality and reliability have determined changes in the tactics of checking. Attention becomes more and more focused not on the detection of defects in ended products but on checking the quality of execution of individual stages of designing concerning some operations and technological processes in order to remove possible deviations.

The necessity of raising the effectiveness of checking which embraces all stages of designing and manufacturing causes the urgency of methods development for substantiation of indices of checking procedure effectiveness.

In the complex of tasks which in total determine this problem, the following ones are distinguished

- development of theory and technique for estimating the apparatus quality through testing the apparatus in the course of designing;
- scientific substantiation of the selection of such indices which are the most informative (from the continuum of indices of quality of articles) and making them normative ones.
- optimal trustworthiness ensuring results of checking.
- thorough structural and parametric optimization of the system of checking at all stages of the life cycle of the apparatus.

Nowadays, in such amount this problem of checking effectiveness in scientific, theoretical and applied aspects is not solved to sufficient extent; therefore, in practice, this problem is often solved either with perfectly unwarrantable assumptions and arguments, that inclines practitioners to rely on intuition, or with relay on heuristic methods. Neither the former approach nor the latter one ensures the choice of an optimal version.

3. State-of-the-art problems of system analysis and modeling of processes of ensuring apparatus quality

The complexity of systems to which processes of ensuring quality of electro- and radioelectronic apparatus during their life cycle belong causes the necessity of their systematic study. These systems are characterized by peculiar properties which are not equivalent to the sum of the properties of their constituent subsystems. Formally, all properties of the systems can be divided into two groups. The first of them is distinguished by mutually independent influence of different factors upon indices of quality of articles. Such additive influence of these factors is determined by corresponding summation of the partial influences. The second group is characterized by combined influence of factors upon quality indices. This determines one of the most important systemic properties of complex multi-step processes – its emergentness. This property of a system causes the necessity to study this phenomenon as something organic whole which is characterized by interactions of components.

Presently, these phenomena, which are characteristic of modern technological systems for manufacturing electro- and radioelectronic apparatus, are studied insufficiently both in qualitative and quantitative aspects. The known mathematical models do not reflect the objective essence of emergentness. Therefore, they do not ensure their sufficient adequacy to real multi-step processes of quality formation.

Nowadays, we can, without exaggeration, assert that this direction has gained appropriate development neither in theoretical nor in practical aspects. Though, as

the investigations have shown, a promise to create adequate mathematical defectiveness formation models of real multi-step processes of apparatus designing and manufacturing is evident.

4. Scientific and technological potential and problem of resourcing

Optimal resourcing during designing, manufacturing, and operation of electro – and radioelectronic apparatus is one of the main conditions of ensuring its quality, reliability, and effectiveness. Among many engaged resources (material, energy, metrological, technological and others) the decisive significance for creation of the necessary techno-economic potential of an enterprise is considered to be personnel and, in particular, intellectual resource. The creation of intellectual resource is a complex problem to solve which both industrial and educational establishments of different levels should be engaged. Therefore, without integration of education, science, and manufacture it is impossible to succeed in this way. Processes of the integration should be, first of all, directed to the creation and functioning of a dynamic system of providing the branch and concrete enterprises with personnel taking into account their nomenclature specialization, amounts of production, and other factors. As evidence of such considerable improvement of the quality of training engineers and the reduction of their adaptation periods in new conditions practically to zero may serve the examples of functioning such systems at Lviv Polytechnic.

The problem of creation of intellectual resource calls for conducting scientific research engaging specialists not only in engineering specialties. Such research teams must create an effective methodology for formation of creative aptitudes of future workers of research, designing, industrial establishments and organizations, they must also take an immediate part in this process.

Modern home and foreign production of complex electro- and radioelectronic apparatus is characterized by the tendency to reduction of resource expenditures and, at the same time, by raise of quality and reliability of articles. This accounts for the change of approach to formation of all kinds of resources, the raise of their effectiveness and optional use.

5. Conclusions

The analysis of tendencies and peculiarities of designing, manufacturing, and operation processes of electro- and radioelectronic apparatus testifies the necessity of revision of approaches to solving the problem of quality and reliability insurance for this kind of machinery. Under modern conditions, traditional methods guarantee no more of the rise in techno-economic production indices. The strategy of complex optimization of the processes of creating such apparatus based on the

use of mathematical models taking into account the existing tendencies and possibilities at all stages of the life cycle of apparatus must become the main one.

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ПРОБЛЕМИ І ЗАСАДИ ЗАБЕЗПЕЧЕННЯ НАДІЙНОСТІ ЕЛЕКТРО- І РАДІОЕЛЕКТРОННОЇ АПАРАТУРИ

Юрій Бобало

У статті подано аналіз проблем і тенденцій, які характеризують сьогодення стану теорії та практики забезпечення якості й надійності електро- і радіоелектронної апаратури. Обґрунтовано доцільність розвитку і введення оптимізації цих процесів стосовно критеріїв як якісного, так і раціонального постачання й використання відповідних ресурсів.



Yuriy Bobalo – DSc., professor, graduated from Radio Engineering Faculty of Lviv Polytechnic Institute in 1973. In 1984 after completing his post-graduate studies at S.

Ordzhonikidze Moscow Aircraft Institute he received a PhD degree in the field of radioengineering and television systems. His further scientific research was focused on ensuring quality and reliability of radio electronic devices using complex optimization of their design, production and operation. In 2000 he started working as an associate professor and in 2004 as a professor at the Department of Theoretical Radio Engineering and Measuring of Lviv Polytechnic National University and became a distinguished lecturer in the discipline “Control and diagnostics of radio electronic devices”.

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In 2010 he successfully defended his Doctor of science thesis in the sphere of the processes automation at National Technical University “Kharkiv Polytechnic Institute”. He is an author of more than 150 scientific publications; among them there are three monographs, seven text-books and numerous papers in proceedings of international conferences and symposiums. Under his supervision four candidate of science dissertations have been defended.

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