КОНТРОЛЬ ЯКОСТІ, ІНФОРМАЦІЙНІ І ВИМІРЮВАЛЬНІ СИСТЕМИ

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INFORMATION TECHNOLOGY IN DECIDING OF TECHNOLOGICAL PROBLEMS IN INSTRUMENT-MAKING AND MACHINE ENGINEERING

Виконано аналіз використання інформаційних технологій під час розв’язання задач технологічної підготовки виробництва в приладо- та машинобудуванні. Показано, що для розв’язання задач стиснення інформаційних масивів, класифікації, групування та розпізнавання образів доцільно використовувати методи багатовимірного статистичного аналізу. Наведено ефективні методи параметричного та структурного моделювання під час розв’язання технологічних задач та рекомендації з їх використання. Вказано на доцільність використання запропонованих методів за інформаційної підтримки життєвого циклу виробів.

The analysis of the information technologies usage has been done at manufacturing technological preparation tasks solution in instrument – and machine building. It is showed that for the informative massifs compression tasks solution, classification, grouping and recognition of patterns, it is expedient to use the methods of multidimensional statistical analysis. The effective methods of parametric and structural design at solution of technological tasks and recommendation of their use have been made. It was painted on expedience of the offered methods use at informative support of wares life cycle .

Setting of problem. Modern productions of instrument-making and machine engineering require the use of the results of modern scientific and technological developments that are based on scientifically highly intensive (high) technology. High technologies are possible on the basis of ideas CALS – technologies that provide information support to the life cycle of products. So important is the integration of process data using information support life cycle products (ISP), ie CALS – technology that requires a high level of information and mathematical modeling.

The problem of increasing the efficiency of instrument-making and machine engineering production sharply raises the problem of improving outcomes and shortening technological preparation of production through the creation of advanced technological processes of manufacturing equipment. Quality problem solving technological preparation significantly depending on the problem, methods of resolution and the original reporting purposes for their decision. So urgent is the problem of developing scientific approaches to the processing of technological information and informed choice of methods for resolution of various technical problems.

This necessitates the creation of technological methods of processing information through the use of multivariate statistical analysis in order to maximize the incorporation of diverse parameters and indicators relevant technological tasks of design and rationale for the use of modern simulation methods and mathematical modeling methods for parametric and structural optimization.

Organize tasks technological preparation of instrument-making and machine engineering production, rationale for the choice of initial information in solving these problems, the rationale and choice effective methods of formalizing these problems and their solution methods, which were connected to the complex all stages of manufacturing devices and their life cycle an issue relevant and timely.

Analysis of the information technology using. Scientific and technical analysis of national and foreign literature has shown that efficiency of technological preparation of production restricted insufficient use of modern information technologies at all stages of the design.

Analysis of information technologies that are used in solving problems of technological design, found the methods of multivariate statistical analysis to reduce the dimensionality of the factor space, classification, clustering and pattern recognition practically are not applied.

Methods for solving problems of technological preparation of production characterized by the using of limited initial technological information and its one-sidedness and subjectivity of choice, using techniques that are not in all cases allow you to best practices, conditions and means of manufacturing products, efficient processes and that do not always correspond specified requirements.

Objectives technological preparation of production not correct formalized, usually adequate mathematical models that describe process parameters are absent and output parameters of manufacturing processes and assembly of parts of products to a limited level solved the problem of parametric and structural optimization of instrument-making and machine engineering production.

There is no justification for the choice of initial information in the mathematical modeling, the choice of effective methods for simulation and mathematical models parameters and technology processes indicators, which affects the results of automatized designing.

Using the mehtods of parametric and structural modeling is limited to well-known methods are not always effective.

In order to solve various problems of technological preparation of production does not use modern methods of information theory, queuing theory, pattern recognition, design of intelligent IT systems and so on.

Out researched the possibilities of modern simulation methods and mathematical modeling, and there is no scientific justification for the choice of currently used methods for resolution of problems of technological preparation of production.

No recommendations on the use of effective methods of technological information and insufficient use of modern methods of multivariate statistical analysis, parametric and structural modeling and optimization in solving problems of technological preparation of production makes it necessary to develop scientifically basis using the technology in instrument-making and machine engineering of modern information technologies make it possible to increase the effectiveness of instrument manufacture.

Setting of problem research To achieve this goal we must decide such basic scientific and applied tasks:

1. Based on the analysis of information technologies in instrument-making and machine engineering justify scientific ways to improve technological preparation of production through efficient use of technological information, the creation and using of new methods and models for solving technological problems.

2. To develop methodologies to reduce the dimension of the factor space in solving technological problems and create appropriate algorithms and programs to implement the practical testing of these techniques in determining the physical and mechanical properties of structural and tool materials.

3. To show the feasibility and efficiency of pattern recognition methods in problems of technological preparation of production. To develop algorithms and applications of discriminant and cluster analysis of technological information. To perform practical testing techniques for pattern recognition in automatized designing of technology for bodies parts of devices in the instrument-making.

4. To do analyze of methods for obtaining mathematical models of technological parameters, to determine their efficiency. To prove the feasibility and effectiveness of using modern heuristic techniques and neural network modeling in parametric modeling, to develop methods of modeling, algorithms and establish appropriate programs to perform practical testing of these techniques in solving technological problems.

5. To do analyze of methods for parametric optimization prove the effectiveness of the methods of nonlinear and stochastic programming to solve optimization problems in technological preparation of

production. To prove the feasibility and to develop algorithms and software for solving problems of multidimensional optimization and fulfill their practical testing.

6. To do analyze methods for structural modeling and optimization used in solving problems of technological preparation of production. To prove the feasibility and effectiveness of methods of many-valued logic and sequence determinants and methods of Petri nets for modeling and optimization of loading equipment technological production systems. To develop algorithms and programs those implement the solutions to these problems and fulfill their practical testing.

7. To do justifying the necessary for the development of methods and algorithms for solving the problems of modeling design equipment and processes of assembly, perform testing of these techniques to create an automated system design technology mechanical assembly operations in instrument-making production.

8. To develop generalizations based practical solutions and give practical advice on the use of the proposed methods and mathematical simulation and optimization in solving various problems of technological preparation of instrument-making and machine engineering production.

Solution of the problem. Analysis for the use of modern information technology in solving economic and mathematical problems revealed the following.

Compression of technology data array, that implemented the methods of factor, component analysis and multivariate scaling method can significantly improve information content of the researching results to simplify solving the set tasks technological preparation of production by reducing feature space reduction of time and solve various technological problems, and improve the quality of the solutions.

These methods of multivariate statistical analysis (component, factor and scaling) are formalized and presented in the form of appropriate algorithms, which resulted in the following conclusions: a method of multivariate statistical analysis of specific mathematical rigor and completeness of techniques, the methods should be used if large volumes of information about object of research and design, which is typical for problems of technology of instrument-making and machine engineering [1-3].

Classification, clustering and pattern recognition techniques are implemented cluster (hierarchical and fast) and discriminant analysis can successfully solve these technological problems [2, 3].

1. To determine which of a plurality of parameters characterizing the structural material, the most significant impact on their technological properties.

2. To do objective classification of the construction materials for the set of process parameters (physical and mechanical properties, chemical composition, etc.).

3. For given parameters of the investigated construction material to determine the group (cluster) to which it belongs, and a selected group of analog-find material. This material can be used for replacement of the material, analogous for multiple sets of properties.

4. For given parameters of a new structural material to define the conditions and methods of processing based on the establishment of similar material conditions-analogue.

5. By describing the set of design and technological features of the new part of the knowledge base to identify businesses similar to detail, process of manufacture will be the basis for a new single technological process.

When considering the mathematical modeling of technological parameters revealed that the construction of a mathematical model of a complex object is possible through the use of its decomposition into components interrelated elements and a mathematical model of these components. This can significantly simplify obtaining adequate mathematical model of the object, and in some cases it is the only possible option solution of the problem.

Analysis and comparative evaluation of used methods of mathematical modeling used in solving technological problems, has shown that numerical interpolation methods yield qualitative mathematical dependence of the output parameter of one variable, with the best approximation to a real function given spline functions. Therefore, numerical interpolation methods are useful in identifying and solving problems as internal procedures of complex multivariate methods of mathematical modeling.

Methods of functions approximation by the method of least squares is an effective means of obtaining simple mathematical relationships output parameter from one or more input variables for preassigned (or known) type model, ie the solution of problems of identification. The method of least squares should be used as an auxiliary (internal) procedure for solving multidimensional problems of mathematical modeling.

Often for multidimensional mathematical models of process parameters used statistical methods. Experimental design and processing of the results of regression analysis provides a fairly simple linear mathematical model of the object, and in some cases – non-linear model. But it requires considerable experimental research and, consequently, high costs of and time. At the same time is not always possible to set the required values in the experiment points the factor space (limit values of the input variables). Direct use of regression analysis for mathematical models requires conducting experiments in a strictly prescribed plan, and you can use the results of the passive experiment. But it is difficult to process the results of experiments can be obtained only in the form of polynomial models that do not adequately describe the study process. Therefore, to obtain adequate mathematical models necessary to apply artificial techniques that are based on the experience of the designer.

To do significantly reducing of number of experiments and, therefore, the time and the means of their implementation can be achieved by the using of methods of similarity theory and dimensional analysis.

The methodology of fractal analysis provides a quantitative evaluation of the surface integral of parts processed by cutting, by taking into account indicators that comprehensively characterize the structure and properties of the material, the detail and the parameters of its surface. In addition, the using of fractional dimension surface detail allows greater accuracy in determining optimal modes of processing of surfaces with high levels of quality and its take into account this dimension when determining scientifically based tolerances for processing.

Proposed for mathematical modeling in solving technological problems to apply the methods of heuristic self-organization models, which allow a single model of optimal complexity by sorting a large number of models for a given criterion based on a small number of a priori information. The advantage of these methods, in contrast to the methods of regression analysis is the use of external criteria for selecting a mathematical model that can objectively assess the quality of study design parameter. Methods of self-organization should be used for mathematical models, if the object is not managed, the initial data obtained as a result of passive experiment or statistical processing, the experiment is manageable, but the combination of the values of the arguments cannot be reached or causes alarm (critical) situation and the planning of the experiment requires lengthy and expensive research.

A new, efficient method for obtaining mathematical models is fuzzy group method of accounting arguments (GMAA), which has all the advantages of classical GMAA and at the same time deprived of its lack – it allows you to determine the value predicted outputs is not a separate point, and some confidence interval. In addition, the method has no effects of linear algebraic equations for determining the coefficients of the mathematical model. Proposed algorithms and applications of fuzzy GMAA to predict and simulate the process parameters with greater accuracy than the classical method in a small number of initial information.

Promising tools for modeling and forecasting technological parameters as well as the tasks of classification, pattern recognition and decrease the dimension of the factor space is the use of artificial neural networks [4].

Concomitant use of methods of artificial neural networks and heuristic self-organization models (classic and fuzzy GMAA) allows you to organize computer experiment, which allows to significantly reduce material, energy and time consumption during the experimental studies.

Analysis of parametric optimization problems to be solved when technological preparation of production, showed that most of them are multi-dimensional non-linear problems of mathematical programming. The method of solution depends on the formulation of the optimization problem, the dimension of problem, type of objective function and relationships that define the region of feasible solutions.

Depending on the problem, the type of objective function, the type and number of constraints and optimizing variables to solve optimization problems are encouraged to use methods of convex programming, moving admission and sent to a random search of the self. In addition, there are effective stochastic programming method that takes into account the problems of parametric optimization random parameters and variables in the mathematical model (in the objective function and constraints functions). The method of multicriteria optimization, which allows you to use multiple criteria simultaneously when

solving minimax problems. The method takes into account the significance of each partial optimization criterion, which is based on peer review. [5]

For optimization work of manufacturing systems modeling and optimization of these systems are done. Found that promising for solving parameter optimization of production systems are methods of mathematical and simulation, based on the use of structural and logical approach to mathematical systems modeling and simulation methods Petri nets [6, 7]. These methods are implemented in the optimization process of loading equipment.

On the basis of information communication devices carried formalization of design and technology for their assembly. It is possible to develop a method of automated design technology assembly, and functional block diagram of the automated system design technology mechanical assembly and electrical work. The recommendations on the use of an automated system in conjunction with CAD – solid system design Solid Works, realizing thus the possibility of virtual product assembly while receiving technical documentation [7].

Conclusions. The investigations allow realizing modern information technology in technological preparation of production, to improve information quality and design work.

The results of researching are the basis for the creation of automated technological preparation of production, design of advanced process technology, science-based regulation of technological processes of manufacture of parts and assembly of products, the organization of the production process systems, as well as the basis for the widespread use of CALS – technologies in instrument-making and machine engineering production.

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