AP23490796. Development of digital models of the production process based on multi-criteria analysis of BigData management within the framework of technological preparation of production of machine-building enterprises. sc.sp. – Zhetesova G.S.

Relevance

Currently, industrial enterprises operate in the market economy, one of the main features of which is competition. Thus, in modern economic conditions, increasing the efficiency of the production process by optimizing its process parameters is one of the priority tasks of an industrial enterprise.

Optimization of the process is based on a detailed model of the product manufacturing process, which describes changing its state in the form of a set of parameters. Based on the digital model, the target indicators are optimized by varying the values of the control parameters within the specified ranges of values.

From the point of view of the control process, the technological process of mechanical treatment is a structurally complex control object and is a clear sequence of intermediate states of the product in the process of changing the structure and properties of the original workpiece. The result of managing this process is a set of optimal values of the process parameters that contribute to the achievement of intermediate states of the product that meet the specified requirements.

In this case, the problem is reduced to the formation of the best - optimal control strategy within a multi-level hierarchical system. The general target state of the control object is characterized by a balanced system of target indicators that determine the overall efficiency of the system.

Thus, optimization of the parameters of the technological process of mechanical treatment is one of the key tasks within the stage of technological preparation of production, the solution of which contributes to increasing the efficiency of an industrial enterprise and maintaining its competitiveness.

Implementation of this project is aimed at implementing the main aspects of improving the efficiency of BigData management of mechanical engineering enterprises based on the development of a digital model of the production process (digital twin), which allows determining already at the stage of technological preparation of production the optimal values of the technological parameters of the product manufacturing process aimed at reducing labor intensity and cost, as well as improving its quality by modeling various scenarios for product manufacturing.

The relevance of the research topic lies in the digitalization of production processes of mechanical engineering enterprises, based on the development of a structurally complex hierarchical model of the product manufacturing process, which allows optimizing the technological parameters of the production process depending on the chosen optimization strategy, taking into account resource constraints.
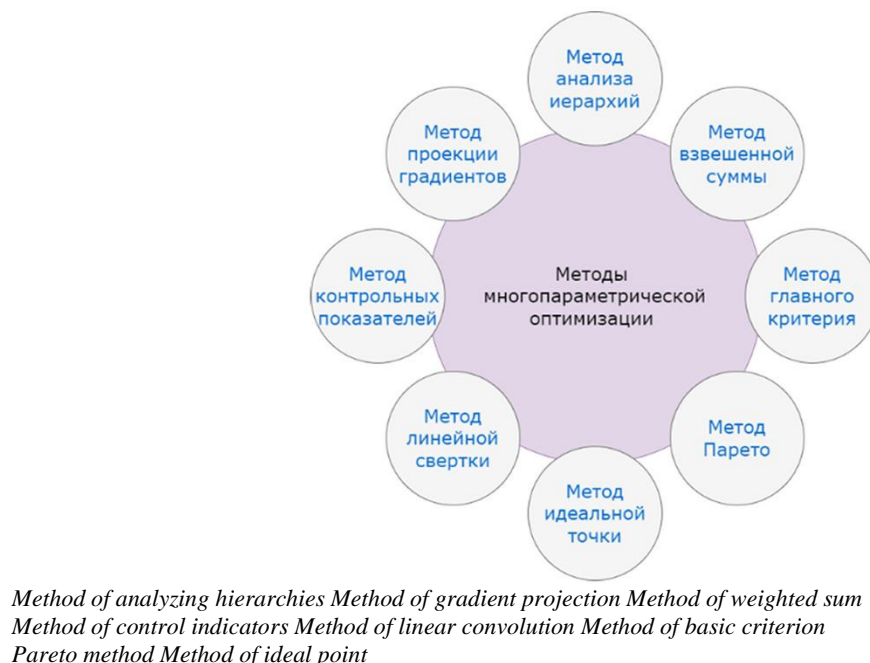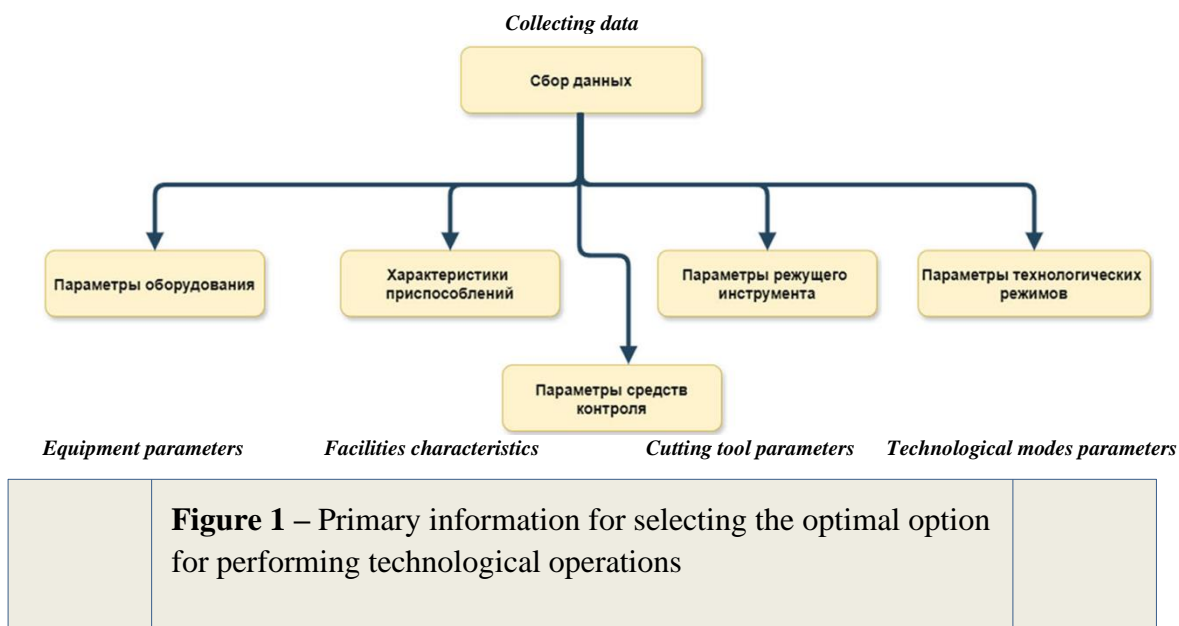
Project objective

Developing a digital model of the production process based on algorithms and mathematical models based on multi-criteria analysis of BigData management to determine the optimal technological parameters of the production process, taking into account the selected optimization strategy within the stage of technological preparation of production.

Expected and achieved results

1. The criteria for optimizing production processes at machine-building enterprises were determined.

2. The levels of optimization of the control object were decomposed, structural elements for each level of management were determined.

3. Target indicators, control parameters and boundary conditions for implementation were determined for each structural element of the hierarchical model of the production process.

4. An array of data on various structures of sections/shops of mechanical treatment was obtained and their parameters were determined based on Big Data management.

5. A database of parameterized main and auxiliary technological transitions for mechanical treatment was formed.

Collecting data

Equipment parameters *Facilities characteristics* *Cutting tool parameters* *Technological modes parameters*

Figure 1 – Primary information for selecting the optimal option for performing technological operations

Method of analyzing hierarchies Method of gradient projection Method of weighted sum
Method of control indicators Method of linear convolution Method of basic criterion
Pareto method Method of ideal point

Figure 2 – Methods of multiparameter optimization

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List of publications

1. Zhetessova G.S., Zharkevich O.M., Khrustaleva I.N., Kozhanov M.G., Shakhatova A.T. Analysis of multiparameter optimization methods for mechanical treatment of parts // University Proceedings, No. 3 (96), 2024, 73 – 79.

2. Zhetessova G.S., Zharkevich O.M., Shakhatova A.T., Khrustaleva I.N., Shkodyrev V.P. Additive Optimization Method for Choosing CNC Machines for Technological Preparation of Machine-Building Production //Material and Mechanical Engineering Technology, №3, 2024, 32 – 37.

Information for potential consumers

The development of a digital model of a structurally complex production process (digital twin) will improve the efficiency of technological preparation of production through multi-criteria analysis of various scenarios for the implementation of the technological process and the selection of the optimal option, which helps reduce labor intensity and the cost of manufacturing the product, as well as improve its quality.

Scope

Technological processes of mechanical engineering production, as well as any technological processes of industrial production.

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