Application of computational techniques in the development of programs and their mathematical modeling

Scientific leader: Onarkulov Maksadjon Karimberdiyevich,	Doctor of Physics and Mathematics (PhD)
Researcher: Yigitaliyev Yoldoshali Umarjon ogli	Doctor of Physics and Mathematics (PhD)

ABSTRACT

No technical achievement has so affected the intellectual human activity, like electronic computers. Increasing in tens and hundreds of millions of times the speed of execution of arithmetic and logical operations, thereby enormously increasing the productivity of intellectual human labor, computers caused fundamental changes in the field of education information boots. At the beginning of the 21st century, computers have become so advanced that there is a real opportunity to use them in scientific research cations, not only as large adding machines, but also to apply with their help you to the study of such branches of mathematics, which were previously practically not available for research. This was realized even when deciding on noncompliance. advanced computers complex mathematical problems of nuclear physics, ballistics, applied celestial mechanics.

Keywords: mathematical model, criterion, optimality, experiment, factor, parameter, regression

At present, the automation of research and design work has become the main direction in the development of scientific and technological progress. The widespread introduction of a computer-aided design system and its application in practice contribute to the creation of more advanced and versatile machines.

Mathematical modeling and computer-aided design (CAD) are quite powerful tools for developing scientifically based solutions that ensure the accuracy of practical solutions and free specialists from long routine work (for example, in the 1960s, it took up to several months to solve such problems).

Mathematical modeling on a PC and CAD allows you to explore the capabilities of the machine being designed, to study the influence of various factors and parameters without resorting to the creation and testing of real machine samples, to evaluate the effectiveness of numerous options and choose the best one from them.

The concept of "parameter" should be given: this is a value that is an essential characteristic of a system, technical device, phenomenon or process. The issue of determining the design parameters of road-building, mining machines and equipment seems to be fundamental for the process of designing modern models of machines, the correct solution of which determines the efficiency of the entire economy in the future.

The parameters, the knowledge of which is necessary to assess the production potential of a technical tool, are called the main ones. As a rule, the main parameters of the technical means include: one of the dimensions of the working body, the mass and power of the power plant.

The main parameter characterizing the size of the working body for an excavator, scraper, loader is the bucket capacity; for a bulldozer, motor grader - blade length. The correspondence of the dimensions of the working body to the mass, power and traction characteristics of the machine uniquely determines its efficiency.

The practice of designing and creating a new technical tool determined the need for a special study aimed at substantiating the design parameters of a technical tool when developing a design specification, when the concept and purpose of a future machine are determined.

The application of mathematical methods and models to the calculation of road-building, mining machines and equipment makes it possible to find patterns in random relationships between machine parameters, interpret these relationships with mathematical expressions, objectively establish relationships between factors that affect the change in the design parameters of road-building machines, average and neutralize the influence of insignificant factors, take into account the experience of designing and producing road construction equipment in the shortest period of time, encode a period of time, encode large amounts of information with a small number of regression equations.

The most interesting and popular in the practice of designing road-building, mining machines and equipment is the method of determining the parameters of machine structures based on their optimization according to one criterion that best suits the design task. The question of substantiating the design parameters of machines in this method is reduced primarily to the choice of a criterion, the quantitative value of which makes it possible to assess the degree of rationality of the desired values of the parameters. Despite significant differences in the final goals of the studies of these works, one can note the commonality of the following methodological provisions:

- the first step in determining the design parameters of machines is to establish the necessary range of parameters;
- the desire to create a mathematical model of the relationship between the design parameters of the machine with an indicator that leads to unit costs, on the basis of which the process of optimizing the parameters is carried out;
- the use of regression equations to determine the cost components depending on the design parameters of the machine;
- the use of the principles of system analysis in the process of forming a technical and economic model for determining indicators of specific reduced costs.

One of the effective ways to implement these provisions is the mathematical modeling of technical objects on a PC. Mathematical modeling is the process of obtaining useful information about an object based on the use of a mathematical model and operating it with mathematical methods. A mathematical model, like any other model (for example, a physical one), is an idealization of a real object based on its formalization, i.e. highlighting its most significant features and means reflecting its parameters and structure. A feature of the mathematical model is that it is a set of elements of a mathematical form, called variables, indicating the relationships in the relationship between them, expressed by mathematical dependencies that adequately reflect the properties of the object.

The development of a mathematical model is an important stage in the mathematical modeling of road construction, mining machines and equipment.

Construction, road and mining machines, as a design object, have a similar structure and consist of many components: parts, assembly units, aggregates, etc. Such a division of machines into constituent elements allows for separate design with subsequent integration into a system.

The quantities characterizing the properties of the system, elements of the system and the environment are called, respectively, output, internal and external parameters.

For example, for an earth-moving machine, the output parameters are the speed of movement and the working force developed by the working body, the parameters of the working body are the bucket capacity or the length of the blade, and so on. Internal parameters are the mass of the working bodies, the transmission efficiency, the type of drive of the working bodies, the force on the hydraulic cylinder for controlling the working body; external parameters - soil characteristics, conditions for its intake and shipment.

The triad of the theory of knowledge (from contemplation to abstract thinking and later to practice) in the methodology of science turns into three sections of scientific activity: induction, deduction and verification (verification).

Using a mathematical model to calculate the state of an object when variables change is a complete analogy of a physical experiment.

A natural experiment is carried out for the most part to solve a specific task that proposes the optimization of some property, a sign of the state of an object by quantitatively characterizing them (achieving the best state).

All quantities that determine the state of the object under study are called factors in the theory of experiment. Changing the factors changes the result of their influence, and therefore affects the optimized value. Each of the factors is characterized by the scope, i.e. set of values that it can take in the experiment, either due to its physical nature, or because of the limitations imposed by the research problem. Depending on the nature of the object, the scope may be continuous or discrete. Factors are divided into quantitative and qualitative, the latter can be transferred to the category of discrete quantitative. Therefore, in applied research, they never start researching a model according to a written algorithm. This is always preceded by a period of program debugging by carrying out test calculations, which allow, by comparing the known results of experiments (for example, one-factor ones) and the corresponding calculations, to correct errors and typos when creating an algorithm and writing a program by a machine.

In preliminary calculations, the mathematical model itself is also evaluated: it turns out how adequate it is to the class of phenomena described. Let us emphasize that they can be carried out according to fairly reliable measurements in the area of existence, where the difficulties of natural experiment, which was discussed above, do not yet fully arise.

Comparison of such data helps the compilers to refine the mathematical model, to create confidence in the correctness of the predictions of the behavior of the object, which will be obtained for more complex conditions.

Only after lengthy fine-tuning work on the model and the machine algorithm is the experiment itself carried out - with the help of mathematical modeling, the behavior of the object under study is predicted in conditions where experiments have not yet been carried out or where they are completely impossible.

The solution of the original problem, the formulation of which ends with the compilation of a mathematical model in an algorithmic form, is sought in a space whose dimension is determined by the number of input variables (significant factors). In the event that this is a physical problem - in the space-time region at each point.

Whatever the area of existence of variables (factors), a computational experiment, like a full-scale one, does not allow one to determine the output variables (optimization parameter) at all its points, since their number is not limited (in set theory, their number is called a continuum). We have to limit ourselves to the calculation of the mathematical model at a finite number of points in the region.

The set of points of the existence domain in the space in which the output variables of the model are determined is called the grid (experiments), and the points themselves are called nodes.

In each study of mathematical models, one more practical problem is solved: how should a continuous domain of definition of variables be replaced by a discrete set of points (grid)? At first glance, it seems that increased mesh density will give a more representative solution. However, along with this, the costs of computer time grow, the reduction of which (and hence the cost of this part of the computational experiment) is possible only by reducing the number of nodes in the grid.

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