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RESEARCH AND ASSESSMENT OF THE STATE OF TECHNICAL OBJECTS BASED ON COMPUTER MODELING

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ABSTRACT

The development of modern equipment and technologies in recent decades has been carried out with great leaps. At the same time, the problem of ensuring and improving the reliability of technical objects (appliances, household appliances, technological complexes, building structures, etc.) of operation in conditions of constant miniaturization of elements and structures, various loads (temperature, mechanics, chemistry, etc.) is especially relevant. This article describes the software, various methods and models in order to analyze how reliable different technical objects are. Reliability, one of the main indicators of product quality, largely determines the economic profitability of its production. The solution of the problem of increasing reliability is complicated by the fact that it is diverse and reflects the specifics of all stages of the existence of technical objects-from the design stage to the operation stage.

Keywords: *Method, Program, Distribution, Simulation Modeling, Variation Series, Reliability, Failure, Interpolation, Model.*

1. INTRODUCTION

Each technical system goes through various stages of its life cycle: design, pre-production, prototyping and testing, mass production and operation, modernization, decommissioning. At all stages of the life cycle of the modeling system, it is used in various ways, currently it is computer modeling.

Since ancient times, special attention has been paid to modeling in science. Over time, it began to be used in many branches of science, for example, in architecture, chemistry, astronomy, construction, design, engineering planning. There is modeling in the social sciences, physics, biology. Almost all branches of science in the 1900s recognized the use of modeling. Regardless of the scientific direction, the modeling methodology is being developed. Until that time, there was no single term or concept. Over time, modeling began to be used as a universal way of learning science. The "model" is found in all branches of human activity. The "model" can be interpreted in different ways [1].

The relevance of this problem, its insufficient development. In various studies, regardless of scientific activity, a computer is needed. It allows you to study complex systems. The principle of computer modeling allows us to identify the relationship of the experiment with the theory. Computer modeling allows us to understand how different systems operate and develop. It also allows you to test a hypothesis and a theory.

To simulate an event, phenomenon, and even predict an object, computer modeling is used. It is found in almost all scientific fields, in almost all technical fields. You can predict any phenomenon that implies certain parameters in advance.

The purpose of the study is the theoretical justification of the chosen topic "Research and assessment of the state of technical objects based on computer modeling".

2. RESULTS AND DISCUSSION

Computer modeling is a mathematical construction of a model used as a method of cognition. Combining different logical expressions, symbols, equations and formulas is a mathematical model. With the help of a computer

in our time, you can build a model on a given topic in any field of knowledge. Computer modeling allows you to implement software. There are different types of modeling using a computer. There is a relationship between them. The study of models as well as their creation is carried out using a personal computer [2].

Computer modeling is a great way to study complex systems. The study is carried out taking into account the economy in order to identify not only physical nuances, but also material difficulties. The main features of the system under study are confirmed by the relevance of the computer model.

First, the object of knowledge is studied. This is the beginning of the simulation. Information is separated and formalized from the real object in order to identify the problem. The data necessary to implement the tasks is selected at the stage of creating an information model. The inability to make a decision may occur due to the loss of the necessary data. If there is not enough data, it will be difficult to make a competent decision.

So, the data is collected at the second stage. Information about the object is selected. Then the relationship of the data is determined, their formalization is performed, system patterns are revealed. The necessary actions are performed to prepare the information for processing.

Thus, an information model is created. The composition of the information model [3]:

1. a set of constant values. They are needed in order to generally find the characteristics of the modeling object, to understand which components are included in its composition. Constant values are constant statistical parameters;

2. a set of variable values. In order to change the behavior of the model, the value of these variables can be changed. Variable values are control parameters. Sometimes they are called dynamic;

3. algorithms showing the relationship of all values that occur under different states of the modeling object;

4. formulas that are used to show how the state of the modeling object changes.

In the real world, various phenomena, tables, and graphs are created. This is the result of computer simulation. This process is called the information model.

The third stage of computer modeling is the creation of an algorithm.

The fourth stage is the implementation of the model. For this purpose, various suitable program elements are evaluated. After that, the program is tested, some details are edited. Test models are used for testing [4]. Errors are detected by a special program during testing. When a test model is selected, different testing principles are used. During testing, many types of the model are destroyed. The compliance of the model with the original is checked. To do this, different simple examples are used for the test. The reflection of the main properties of the object of study in the model is also checked. You need to keep in mind whether the result is known or not.

The fifth stage of computer modeling is an experiment. The model is performed using a computer using different methods. The results are recorded. A computational experiment is performed using statistical analysis. It allows you to predict how the object will continue to behave, how it needs to be improved taking into account different work.

In various technologies and techniques, computer modeling has shown itself to be the best of all. V. Volterra proposed modeling of the system on the principle of victim-predator. His example became a mathematical classic. This type of modeling is used by the humanities of the twentieth century [5].

Currently, computerization is rapidly penetrating the activities of research and design organizations, bringing design work to a fundamentally new level, where the speed and quality of design are significantly accelerated, and complex technical problems are solved with great justification. This is largely facilitated by the use of highly efficient specialized programs that are implemented both in the form of stand-alone software products and in the form of plug-ins and applications for well-known application software packages. As part of the creation of CAD, the creation of specialized software products and special technical means for automating the work of the project is carried out.

Physical systems are best studied using computer modeling. Computer-generated models are easy to learn and explore. It is often difficult to really make a statement; it is impossible to predict the result. Computational experiments can be done using simulation. The properties of the object of study can be identified through the formality and logic of the model. The models also allow us to understand how the initial conditions

change, how the system responds to certain factors.

The phenomena are specific, so you need to separate the model from them. This allows you to create a quantitative and qualitative model. When a quantitative model is produced, various experiments are performed using a computer. The results of the study are interpreted in different ways, and also compared with how the object of research behaves. At the end, the model is refined [6].

Stages of computer modeling:

- The task is being set;
- The object to be modeled is being searched for;
- The concept is being worked out;
- The elements included in the system are identified, as well as how these elements will interact with each other;
- Go to the mathematical model;
- The steps for writing the program are being worked out;
- An experiment is being conducted on a computer;
- The results are analyzed.

There are different types of models:

- simulation models. In practice, they show the functional algorithm of the system that is being studied. A lot of ordinary simple operations are used for this.
- analytical models. They transmit a real object. He uses differential equations, algebraic equations to embody a new method of calculation. They allow to increase the accuracy of the resulting solution.

Modeling works according to the following principles [7]:

1. The principle of data sufficiency. You can't create a model without the necessary information, but if you have the full data, you don't need to work on the model. The model is created only at a certain level of information.

2. The principle of profitability. It is necessary to achieve the research goal within the set time.

3. The principle of diversity of patterns. The research system is divided into different elements. Each element is one model. To fully investigate the system, you need to create several models, and one model should be more developed than the other.

4. The principle of consistency. The research system includes many subsystems. The relationship between them is traced. To simulate a particular subsystem, the usual methods of mathematics are used. It is worth noting that the elements of the system properties do not form the system as a whole [8].

5. The principle of parameterization. There are different parameters that are used to describe the system, for example, a formula, a matrix or a vector.

Differential equations are often solved in order to model technical objects. The lattice method is often involved. This method means the Euler finite difference method – a finite set of nodes is used instead of some arguments. A multidimensional grid is created from a set of nodes. The set of nodes shows the discrete function of the argument. This function helps you calculate integrals and derivatives. In this case, the infinitesimal increments of the function $f = f(x, y, z, t)$ and the increments of its arguments are replaced by small but finite differences [9].

One of the types of modeling is shown above. There are similarities with computer modeling, but in the latter case, technologies are involved.

Software is an important component of computer modeling.

At the same time, you can use universal software. For example, you can use a graph or plain text, or you can use specialized methods [10].

Mathematical modeling is often created on a computer. A lot of operations with numbers are performed, and the problem is analyzed by the person himself.

Computer modeling differs in that different types of model creation are combined. If one process cannot be described using a formula, then the simulation method or the graph method are used. It is often more expensive to create a natural model than to create a computer model.

Modeling with the help of graphs began to be performed more often with the advent of computers. Special programs have been created for creating graphs, drawings and technical diagrams.

A simulation model is created on a computer in the case of increased complexity. In this case, the events in time are processed first, and then the data is processed.

The construction of a model using computer technologies includes several necessary stages [11]. At the first stage, a theoretical idea of the object under study is formed, its conceptual model is created. At the second stage, the conceptual model is translated into the formal

language of mathematics and numerical methods, the language of describing algorithms: mathematical and algorithmic models of the object are created. If you translate the model into a programming language, you will get a computer model that allows you to work with digital information. After all, using data on the parameters of the system under study, it is possible to obtain a complete computer model that allows you to study the properties of objects with varying degrees of reliability, predict the consequences of decisions made and, in other words, conduct a model calculation experiment. Currently, the problem of creating automated modeling systems that allow you to quickly create models, conduct model experiments, process and analyze their results is urgent. In this regard, we will consider the separation of roles when developing a model.

The essence does not change, but these roles are distributed in an unusual way. Usually, a model is created on a computer, starting with the fact that the object is structured, analyzed and characterized. The formulation of all modeling actions is carried out by a specialist of a certain specialty in the appropriate professional language: a conceptual model of an object, process or phenomenon is created. Then you need the work of a mathematician who performs a mathematical formulation of the problem, creates a description (model) of the object by means of the language of mathematics. Here the specialist clarifies the model, as well as formalizes it. The object is created mathematically [12]. After that, a computational model is created. Then the specialist works on programs. They will help to solve the task. The programmer builds a program and shows the results to the mathematician.

The general assessment of the model according to preliminary calculations should be carried out by an industry specialist who should use a computer model in his practice. At the beginning of the 20th century, domain knowledge models were created to solve this problem, on the basis of which a model of a specific object was created. Several software systems have been developed as part of this approach: MAVR, DESCART, etc.

The MAVR modeling system is designed to automate the construction of a model and the software that implements it, based on the description of an object in a formalized language. This system is designed to automate the design of power plants and energy systems. It previously created a knowledge model for a specific subject area. Using a special language, the specialist created a description of the modeling object. Thus, the SmartMAVR package allows the end user to create models based on object descriptions without developing and programming a mathematical model [13].

To make a model on a computer, it is necessary not to take into account the specificity of the phenomena. It is necessary to distract from the separation of the quantitative and qualitative model. It is necessary to conduct an experiment, decipher its result and compare it with how the object of research behaves. Then you need to make a series of clarifications. Such an action plan is inexpensive, affordable, fast and detailed. The system's characteristics are complete [14].

Computer modeling is necessary in order to create a set of programs or a single program. This program contains a sequence of actions, the interaction of system elements, as well as conducting experiments in the external environment. The essence and purpose of this program is to understand how an object behaves, what is its nature and structure, how it is optimized, what are the further actions of the object.

Requirements for a computer model [15]:

1. Reliability and accuracy of the model characteristics. The model must be complete.

2. The model should show different circumstances of actions, structural changes, and system parameters. The model must be flexible.

3. The specific time for which the model is created. The model should be implemented and developed for a long time.

4. The structure of the model, which varies depending on the changes in its parts. We need a relationship between the database and the model itself with the help of programs. Information support is required. It is necessary that the machine allows you to perform convenient actions for the user at any time.

Computer modeling is performed in stages [16]:

1) the problem is described and installed. The elements of the research system are selected, as well as how the components of the system interact with each other are analyzed;

2) a mathematical model is being created. It means a set of equations that show what the essence of the object of research is;

3) the algorithm of actions is being worked out. When implementing this algorithm, the problem should be solved;

4) the program is being written;

5) certain calculations are made on the computer. After that, the results of the program are obtained;

6) the results of the study are described. The results of the work are summarized, the results are compared with the initial data.

After that, the next level follows. The sequence is repeated.

Computer modeling is divided into several types [17]:

1. Physical simulation: A computer is played as a simulator. It is believed that this is a machine that receives signals from the outside, can count itself, and also transmits signals for control. For example, a computer can be a machine that is used for a pilot to control an aircraft. In this case, the computer is a training model of the aircraft. The so-called manipulator. It is used for honing actions on the tilt of the aircraft, viewing the readings of the device. The manipulator is an imitation of a real airplane.

2. Numerical modeling: used in computational mathematics in order to solve algebraic-level equations. Experiments are also being built in which there are external factors, an initial condition, and variability of system parameters. Dynamic modeling allows you to simulate, for example, how a wave propagates, how a pendulum oscillates, how an animal population occurs, etc.

3. Simulation modeling: a program is being developed in order to simulate the state of some difficult situation in the economy or technical sphere. It is characterized by high accuracy. In this case, the temporary logic is only formal. A logical sequence of actions is described, and also describes how certain components are connected to each other. Simulation modeling allows you to conduct a statistical experiment. It is used in the social system, biological system, economic system. It is often used to create a computer game or a training course [18].

4. Statistical modeling: allows you to characterize stochastic systems. At first, a lot of tests are carried out, after that the results are statistically analyzed. This method is used in the study of information networks, systems that involve many processes, mass service of people, dynamic systems in which there are many factors. They are involved where the tasks are probabilistic. They allow you to extrapolate data, correlate data, interpolate data, regression data, calculate the distribution. Statistical models imply that differential equations and algebraic equations are solved numerically. If this is not possible, then the object of research is replaced by a deterministic automaton.

5. Information modeling: certain signals and signs are created that show the importance of the object of research. For example, an animated model is created, a text model is created, a visual model is created, etc. for example, a graph or diagram is created on a computer, an earth surface is schematically depicted, etc.

6. Knowledge modeling: artificial intelligence is involved. It is based on a part of the real world. So, a model of logical knowledge or a semantic network is created that shows the rules of the game of checkers in a program on a computer. Thus, it is possible to build artificial intelligence systems, prove a theorem, create a robot, create a virtual reality effect in a computer game.

Now let's analyze how computer modeling is practically used. Let's take an oil rig for example. Here it is necessary to simultaneously monitor the work of personnel, the operation of equipment, and the gas of the air environment. To analyze the concentration, it is necessary to make measurements at different points and areas. The course of the process is predicted sequentially. Where there is most gas, gas analysis systems are installed.

FlowVision is a computer simulation program. It allows us to calculate the gas dynamics [19]. With its help, you can understand how the liquid and gas flow will be produced regardless of the conditions. It counts the required number of gas analyzers. The system detects the stagnation points of the gas set.

The standard k-ε model was used in the experimental model for determining stagnation zones. The standard k-ε model has proven to be very stable, relatively economical to computing resources and has acceptable accuracy for a wide range of tasks. To describe the turbulent quantities, it uses a system of two nonlinear equations – for the kinetic energy of turbulence k and the rate of dissipation of the turbulence energy ε.

$$\partial\rho k/\partial t + \nabla(\rho V^{\rightarrow} k) = \nabla\,[(\mu + \mu/\sigma k)\,\nabla k] + \mu t G - \rho\varepsilon$$

$$\partial\rho\varepsilon\,/\,\partial t + \nabla\,(\rho V^{\rightarrow}\varepsilon) = \nabla\,[(\mu + \mu_t/\sigma\varepsilon)\,\nabla_\varepsilon] + C1\;\varepsilon/k\mu_t G - C_2\rho\varepsilon^2\,/k\mu t = C_\mu\rho k^2\,/\,\varepsilon,$$

где: $G = D_{ij}\partial V_i\,/\,\partial x_i$

$$Dij\partial V_i\,/\,\partial x_i = Sij - 2/3\;(\nabla V^{\rightarrow} + \rho k/\mu t)\;\delta_{ij}$$

$$Sij = \partial V_i/\partial x_j + \partial V_j/\partial x_i$$

The remaining values are empirical constants, which by default have the following values: $\sigma k = 1;\ \sigma\varepsilon = 1{,}3;\ C\mu = 0{,}09;\ C1 = 1{,}44;\ C2 = 1{,}92$

These values give a good result for a wide current range, but can be changed by the user if necessary [20]. Thanks to the use of CFD modeling, it was possible to significantly reduce the design time and reduce the number of errors previously detected only during installation, which made it possible to reduce changes in the project to almost zero. Ultimately, thanks to an integrated approach to the analysis of the project and the ability to make changes before the start of construction, the level of safety for the subsequent operation of the technical object increases.

3. CONCLUSIONS

Modeling is the creation of a model. There are several groups that include methods for creating models. The first large group is the reproduction of any science in the object. Such a group is physical. When such models are studied, experiments are carried out.

The second group is actions with information models. In turn, such models are formulas, diagrams, drawings that describe the object of research. Mathematical model creation is often used as a kind of information modeling. In this case, mathematical languages and methods are used.

In modern conditions, problems are solved in practice using mathematical models, because they are characterized by increased complexity. They cannot be solved without the use of a computer. With the help of a computer, a certain goal is set, a solution method is selected. Such an algorithm of actions is done for each task. The task statement is the identification of questions and the search for answers to them. The initial data is selected to search for answers.

Modeling is performed according to certain laws. Assumptions are made to find answers. During this work, patterns are revealed. They are shown as relations in mathematics.

Simulation modeling is a complex variety. It is used to analyze complex systems, to make forecasts for the future with the help of management strategies.

So, modeling in the broad sense is nothing but art. It is a mistake to consider modeling as a science. A computer is considered as a universal experimental configuration when creating computer models. Each system parameter is controlled through a computer experiment. In turn, it is safe and inexpensive to conduct it. The computer allows you to conduct experiments of any complexity.

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