

## *Physics*

### **INFLUENCE OF MECHANICAL STRESS DURING THE DEPOSITION ON THE COMPOSITION AND STRUCTURE OF THICK ELECTROGALVANICMECHANICAL COVERED WITH IRON**

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Technology electrogalvanicmechanical cement are promising direction size of the recovery in the repair of worn oversized shafts. When using these techniques it will be possible to recover up to 60 - 70% of large parts without destruction.

For coating with optimal performance, you must have clear and as full as possible representation of their composition and structure, which are definable link between deposition conditions and properties of the coatings.

This article first describes the effect of mechanical action instrument in the process of deposition on the composition and structure of the resulting thick coating of iron, which gives the possibility to choose the optimal mode of application electrogalvanicmechanical (EGM) coatings and forecasting work parts with coatings EGM.

As objects of study chosen thick-layer coating on steel samples 30 obtained by electrogalvanic (EG) and EGM cement, when co-precipitation and mechanical activation of the deposited layer.

The results showed that the coating contains high build EGM far below the value of the quantity of harmful impurities (hydrogen - 0.0043%, sulfur - 0.0021%). Use of a smoothing tool and reduces the content of harmful impurity oxides (including hydrogen), which allows to obtain homogenous dense coatings of iron increased thickness (1.5 - 1.8 mm). EGM internal structure of the coating is composed of ultrafine grain size ~ 10-6-10-7 mm, oriented in different directions. This is less than the size of the grains in electrogalvanic EG coatings (~ 10-5-10-6mm), and much smaller than the metallurgical iron grains (~ 10-3mm). It was found that the use of mechanical action eliminates layering and coating makes the structure more uniform, dense, fine mesh density and reduces fracture, which is greater in the EG coating without mechanical action

Key words: electrogalvanicmechanical cement, high build coating, mechanical properties, structure

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### **MECHANICAL PROPERTIES OF SWCNT MODIFIED EPOXY RESINS FOR FIBER REINFORCED COMPOSITES**

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Development of the aerospace industry, which has already used polymer composite materials, as well as the possible expansion of the areas of their application, generates increased requirements to their mechanical properties. Today one of the most promising directions for improving the mechanical properties of materials is the use of various nano-sized structures. Great potential to improve the properties have different structures of carbon nanotubes, in particular, single-walled, double-walled and multi-walled nanotubes. The properties of carbon nanotubes provided improved properties of materials are both a cause of a number of technological problems in difficulties of their distribution in the various systems.

The properties of epoxy resins for the aerospace application modified with oxidized single-walled carbon nanotubes (SWCNT) were investigated. Also the effective ways to reduce the nanotubes dispersion and agglomeration in the volume of material were searched. As main methods for improving nanotubes dispersion considered chemical modification the carbon nanotubes with the carboxyl groups and use of various mechanical methods for their introduction and curing of samples. Epoxy components of the resin and masterbatch with SWCNT were placed into the reactor with an anchor stirrer. Stirring was carried out at high temperature in vacuum. Then hardeners were added and the procedure repeated again. Prepared mixture was placed in a metal mold and cured. Masterbatch with SWCNT was added to epoxy resins to get a concentration of nanotubes in the mixture of 0.2 wt.%. After mixing, nanotubes were effectively dispersed in resin. However, during the subsequent one-hour exposure agglomeration of nanotubes was observed. Curing at high temperatures (120-180°C) promoted to further agglomeration and structurization of nanotubes. Vibration and Aerosil addition didn't manage to eliminate agglomeration. SEM micrographs of the samples showed an appearance of regions of a relatively even distribution SWCNTs in the volume of the matrix, areas without SWCNTs and clusters of SWCNTs with diameter about 10 microns. Clusters of highly entangled nanotubes could readily be identified in these micrographs that can be typical for flexible SWCNT with the largest aspect ratio. The difference in microstructure of samples depending on method of preparation for system T67-SWCNT was not noted.

The mechanical properties of epoxy resins with SWCNT were similar for neat and modified samples. The ultimate tensile strength and tensile modulus were 60-80 MPa and 2.5-3.2 GPa respectively. The flexural strength and flexural modulus were 140-150 MPa and 2.7- 3.8 GPa respectively. The more influence of SWCNT on modulus was noted. The significant improvement of fracture toughness up to 90% was observed that can be useful for materials under high shock loads. The energy per unit area of crack surface up to  $G_{Ic}$  was up to 0.47 kJ/m<sup>2</sup> and the critical-stress-intensity factor  $K_{Ic}$  was up to 0.87 MPa/m<sup>2</sup>

Key words: single-walled carbon nanotubes, epoxy resins, mechanical properties, fracture toughness, agglomeration

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## **ELECTRICAL, DIELECTRICAL, AND MAGNETIC PROPERTIES OF NANOSTRUCTURED BARIUM TITANATE**

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Electrical conductivity, linear and nonlinear dielectric properties of nanostructured barium titanate with average sizes of granules near 120 nm were studied within temperature range 20 – 200 °C. Observed dispersion of dielectric permittivity ( $\epsilon$ ) and dielectric nonlinearity of the material under study within the ferroelectric phase are caused by the domain mechanism mainly. It was found that anomalous hysteresis of  $\epsilon$  observed at cycle temperature variation in the vicinity of Curie temperature ( $T_C$ ) is due to interaction of interphasic boundaries with lattice defects. Studies of d.c. electrical conductivity revealed that charge transport is realized mainly through the granule volume. Considerable contribution to a.c. conductivity gives displacement currents which are caused by both the domain wall motion and the Maxwell–Wagner polarization. The last one supposedly due to a migration of charge carries in granule interfaces. Dependences of magnetization on magnetic field strength were studied for both the nanostructured and the bulk ferroelectric BaTiO<sub>3</sub>. It was found that nanostructured barium titanate demonstrates ferromagnetic and diamagnetic properties simultaneously. The annealing of nanostructured BaTiO<sub>3</sub> in H<sub>2</sub> atmosphere under experimental conditions leads to a significant increase of the spontaneous magnetization and decrease of the diamagnetic response. Analysis of experimental results shows that defects in grains surfaces of the nanostructured BaTiO<sub>3</sub> (probably oxygen vacancies) are mainly responsible for electron states, which produce ferromagnetic and diamagnetic responses

Key words: ferroelectric, ferromagnetic, nanostructured material, electrical properties, dielectric properties, magnetic properties

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## *Informatics, computer engineering and control*

### COMPUTER NETWORK MODELING WITH THE USE OF CASE-TOOLS

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The modeling and optimization of the network are important tasks of network management system. Modeling involves the formation of acceptable variants of network components composition. The components of the network are the computers and communications equipment. Optimization is load, performance and equipment cost analysis. Existing specialized network performance simulation program do not form alternatives to the network construction. These programs do not implement the optimization of network structure using technical and economic indicators. The modeling and optimization of the network it is advisable to carry out on the basis of a specialized decision-support system.

This article provides a structure of specialized decision support system on the composition of network components. The system includes standard specialized CASE tool for generating variants of network equipment, expert evaluating options subsystem and choosing the best option subsystem for composition of LAN equipment. Software CASE tool forms the composition of equipment. Experts evaluate the composition of the following characteristics: average server and workstations load, the average time delay on switching equipment, the average data rate, etc. Subsystem choosing the best option for network organization using cost indicators.

Forming the set of alternative options for networking is implemented within the framework of optimization models. The first version of the model allows you to select a limited set of alternatives. The second option creates an alternative model based on expert opinion. Experts designate the weighting coefficients of importance for the operational characteristics. Selects an options with high total coefficients of importance. Selection of the optimal variant is based on cost indicators.

Key words: equipment composition, modeling, optimal selection, performance evaluation

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### **VISUALIZATION OF ENGINEERING PROBLEMS IN THE DEVELOPMENT OF ELECTRONIC PRODUCTS ON UNIX-LIKE OPERATING SYSTEMS**

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This article discusses several software systems to solve engineering problems in the framework of the design of electronic devices. Based on open source code and output file formats, the systems in question, developed a program that allows the construction of an electronic device to perform model based on raw data output formats of the system in a format accessible to other engineering programs. It allows you to create on its basis, new tools and new methods for solving engineering problems, for display designed electronic products, as well as for stages of its design. The algorithms of the program and shows the final results of its work. A variant of a possible replacement of software tools in the free software counterparts with a view to finalizing them for specific engineering problems

Key words: Computer systems, software, modeling, visualization

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## **MODEL OF FUNCTIONAL FAILURES OF THE FLIGHT AND NAVIGATION COMPLEX OF THE HELICOPTER**

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One of key requirements to architecture of modern complexes of the airborne equipment constructed on principles of integrated modular avionics, is fail-safety. Security of the given property for board informational-steering systems such is reached by various modes, including optimum control of structural dynamics. The assaying and security of fail-safety of a flight-navigation complex of the helicopter considered in operation as multipurpose informational-steering system, it is possible within the limits of an explicated scientific direction in which the unnominal conditions of system called by failures, are considered as admissible, and for them the adequate (functionally steady) control directed on parrying of consequences of failures and maintenance of execution of functions of system is shaped. At the expense of this control redistribution of program and hardware resources of system for execution of a set of the set functions, even in the conditions of failures is ensured. However, existing approaches assume "blind" substitution of the module regarding the refused element answering in the given module for this or that function, other module according to the plan of reconfiguration of system. Authors in a paper offer a sample piece of functional failures at an estimation of stability of a flight-navigation complex of the helicopter taking into account dependent functional failures. Necessity of the account of logical links between multipurpose modules in real physical structure is displayed

Key words: flight and navigation complex, functional stability, functional failure

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## **ALGORITHMIZATION THE PROBLEM OF PLACEMENT SOLUTION ON THE BASIS OF BRANCH AND BOUND METHOD MODIFICATION**

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The article describes generalized mathematical model of the placement problem in conditions of complex-structured technical systems under development. The advantage of the model is an ability of its application for the systems with already formed structure.

Offers an algorithm of the placement problem model's implementation, which is based on modification of branch and bound method. The algorithm includes a procedure of Gomory method, which is used to form the solution graph and table of records for each iteration of calculation cycle. The structural scheme of the algorithm is also considered, including detailed description of each internal procedure. The designed algorithm is intended to solve discrete programming problems by iterative application of Gomory's method. The solution results, which are obtained in each iteration of calculation cycle, will form the table of records, if they satisfy an integrality condition. In other case, they will form the solution graph with adding of new integrality restrictions. The mechanism of alfa-beta pruning is included to the modified branch and bound algorithm to avoid calculation in excess and accelerate the calculation. Presented an example of the practical implementation of the algorithm for the static placement problem with 3x3 dimension.

The developed placement model and the algorithm of its particular implementation could be applied in conditions for solving the development problems of different kinds of complex-structured technical systems, which include informational, industrial and energy systems

Key words: mathematical modeling, discrete programming, optimization

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## **PREDICTION OF THE DYNAMICS OF POTENTIALLY DANGEROUS PROCESSES ON THE BASIS OF NEURAL NETWORK MODELING**

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The article deals with the analysis and modeling of the dynamics of potentially dangerous processes in industrial objects, as a complex nonlinear system based on neural networks. The analysis of the relationship of threat factors leading to critical changes in the dynamics of potentially dangerous processes with different nature of appearance. In the conditions of constantly increasing industrial production the problem of forecasting the dynamics of potentially dangerous processes is the most relevant to improve safety and reduce risks to humans and the environment. Forecasting in tensile-hazardous processes will not only increase the current level of security at industrial facilities, but also offer the opportunity for an integrated approach to security in the development phase of the project documents.

In the context of multicriteria tasks, as well as the presence of pronounced non-linear properties of the studied objects to solve the problem of predicting the dynamics of potentially hazardous process it is proposed to use the apparatus the neural network modeling. Used not classical neural network, a neuron-fuzzy module that combines the benefits of both neural networks and fuzzy logic. At the level of the model proposed modernization of the architecture of the module and the signal preprocessing to improve the quality of the forecast. As a result, the proposed procedures improve the quality of the functioning of the model has shown its effectiveness in predicting the dynamics of potentially dangerous processes

Key words: potentially dangerous process, neural network, fuzzy system



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## THE APPLICATION OF THE SYSTEM OF EMERGENCY PROTECTION AND CONTROL FOR ENSURE QUALITY CONTROL OF ENGINES 14D23 AND RD0124

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The task of support of maintenance of values of pressure in the working camera when carrying out fire tests and ratios of components of fuel is to the important task by deliveries of engines to operation. And article implementation process of a pressure maintenance in the combustion chamber and ratios of components of fuel of engines 14D23 and RD0124A with enhanced accuracy by means of system of abnormal protection and control is described. It is for this purpose offered to realize finishing of system of abnormal protection and control of Operation it is offered to carry taking into account implementation of the primary task – support of protection of the engine and bench in case of fire tests. Finishing of system of abnormal protection and control was carried out with the requirement of minimization of risk of failure of the given cyclogram and formation of spurious command. In case of implementation of the mode with back coupling, especially in case of requirements of numerous change of the modes, careful debugging of interaction of a kernel of system of protection and management system is necessary. Such debugging is possible only when checking with use of the test model of the engine considering influence on parameters of the engine of angles of the drive of the regulator and the choke. The skeleton diagram of debugging of interaction of management system and the program of monitoring and control of system of abnormal protection is provided in article. For improvement of quality of testing within preparation for fire tests with maintenance the system of abnormal protection and control of indices realized simulation of a response of the engine to change of angles of drives of the choke and the regulator. The main results of this operation are marked

Key words: system of emergency protection and control, software, algorithm, liquid rocket engines

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## **INTEGRATION CAM-ELEMENTS IN STRUCTURE OF CONTROL BY THE FLEXIBLE MANUFACTURING SYSTEM**

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In article it are consider problems of complex automation of machine-building production and problems of creation of the integrate control system by the flexible manufacturing systems. To overcome the functional and information gap between CAD/CAE/CAM and control systems for flexible automated production, to improve the flexibility and performance of the company is proposed that the integration of isolated systems through a single information space. The PDM system is provides production planning and management, functioning of the single information environment based on electronic archive, organizes exchange of information between divisions on designing and management of productions and production divisions. On production there is a probability of refusal of technological unit or a stop on preventive repair. Dynamic redistribution of loading between the equipment is necessary not to stop production. It is proposed to use instrumental characteristics of ant algorithm to optimize the operational control of production plans

Key words: flexible manufacturing system, integrate control systems, uniform information field, ant algorithm

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### ***Energetics***

## **THE SIMULATION ON DINAMICAL CHARACTERISTICS OF ADAPTIVE ELECTROMECHANICAL SYSTEM WITH BRUSHLESS DIRECT CURRENT MOTOR**

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The paper deals with the peculiarities of simulation methodology of current characteristics in adaptive electromechanical system with brushless direct current motor, corresponding mathematic dependences are given. The investigation results of brushless direct motor angle between rotor and stator pole insurance on motor functional current are given. With using of mathematical model dependences the brushless direct current motor current characteristics without angle between rotor and stator and with 10° angle dependences are investigated. The summary results on dynamical characteristics and energetic of brushless direct current motor electromechanical system with using in mathematical model of parameters influence of the angle between rotor and stator pole of motor are given. Corresponding mathematic dependences and influence characteristics are suggested. The synthesis methodology of indirect adaptive control of brushless direct current motor electromechanical system is suggested, the corresponding transfer functions for system process investigation are given. The structural scheme of control forming with ideal regulator is suggested, the transfer functions for system with regulator direct or feedback location are also considered. The article results practical use will take energy saving control in brushless direct current motor electromechanical system with its dynamical characteristics improvement.

Key words: electromechanical system, brushless direct current motor, adaptive control

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## ***Radio engineering and communication***

### **USING STOCHASTIC CALCULATIONS FOR IMPLEMENTATION NON-BINARY LDPC DECODER FPGA**

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This article presents a model of efficient hardware architecture for the decoder, built on non-binary block codes, low density parity check based on stochastic calculations. The developed architecture is focused on Xilinx Virtex devices and synthesis reports are summarized in the table. Once-worked architecture includes in its membership three main blocks: non-binary stream turns into a generator of stochastic numbers (converter of non-binary in stochastic representation), decoding algorithmically modules, namely a block control nodes and block check nodes, and the inverse transformation of the stochastic stream to the corresponding non-binary number. Designed as blocks integrated upper module. The top module is synthesized, it is focused on Xilinx Vertex and its metrics are summarized in the table, and produced power analysis. Conclusions about possible further optimization of the modified non-binary architecture using stochastic computing, and this optimization can also be used for higher-order Galois field with the analysis of the different parameters. Powered by modeling in a power dependency graphs used different logic elements in the architecture and the temperature dependence of the crystal of power

Key words: non-binary LDPC codes stochastic calculation, the architecture of the decoder, checking and variable nodes

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The article considers the design of low-power 10-bit 100kS/s successive approximation analog-to-digital converter (ADC) with power consumption of 0,145 mW at 1.8V supply voltage. Device is formed by 180 nm BiCMOS technology by Cadence ADE software. Using of the BiCMOS technology in the synthesized digital part, as well as the using of the binary weighted capacitor array DAC significantly reduce the power consumption of these parts of the circuit. Since power consumption of DAC consumes less 100 pW. Thus a comparator becomes the most consuming part of the circuit. Consequently, the problem of reducing the power consumption of the comparator is primal. The proposed concept of power dynamic latched comparator allows to achieve half of typical scheme power consumption. Relatively low sampling rate of described successive approximation ADC allows to make negligible the disadvantage of the proposed solution, which is time required for stable work of comparator after every time clock. The proposed scheme can be applied in mobile systems requiring low power consumption

Key words: low power, ADC SAR, switched capacitor DAC, Power Dynamic Latched Comparator, Cadence

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### A DUAL CHANNEL COMBINATIONAL SELF-TIMED CIRCUIT WITH RECOVERY

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One of the promising directions of development of modern digital circuit design - self-timed circuits (STC). STC does not require a clock can operate at ultra-low power supply voltages, which ensures energy efficiency, in addition, they self-checking regarding a sufficiently broad class of failures. They are characterized by a two-phase functioning. During first phase, called spacer, is transmitted on the same signal lines variables in operating phases are inverse signals. With such discipline, corresponding to the so-called indicators and hysteresis trigger (C-elements Muller) is provided the displayed output of all elements of the STC. In order to implement a passive fault-tolerant dual-channel STC analyzes the combination STC and provides a method of data recovery. Since the operating phase, the information is transferred in paraphase code, additional inverters introduced. For quenching (phase spacer) used transistors permission. Describes developed a reducing redundant information based on the transistor structure, parrying a single failure in the working phase or phase cancellation. Conclusions on the possibility of implementing a fault-tolerant STC on the basis of the proposed approach

Key words: self-timed circuits, recovery

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## IMPLEMENTATION A LDPC DECODER OF LOW COMPLEXITY USING AN ALGORITHM MIN-SUM

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This article is a resource-efficient decoder architecture based on low density codes. The algorithm used for the LDPC decoding algorithm is the min-sum. Decoder reduces complexity by limiting the internal connection posts on the outer circumference of 2 bits, and simplifies node checks. The simulation algorithm and the results show that the performance is better than the other algorithms. This algorithm can be introduced in a partially parallel architecture hardware to obtain significant savings in the hardware resources when implemented in a FPGA. The algorithms were simulated using MATLAB and compares BER performance of different algorithms. The modified algorithm min-sum (MMS) provides better performance, and can provide a significant reduction in the hardware resources in implementation. various types of hardware architectures have been studied. The total decoding time can be reduced by a more rapid convergence of the decoding algorithm and simple calculations. The fully parallel architecture requires a large amount of hardware resources, compared with a partially parallel architecture hardware. MMS algorithm when implemented in a partially parallel architecture hardware requires much less hardware for implementation

Key words: iterative decoding, the LDPC decoder, min-sum algorithm, hardware architecture, FPGA implementation

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## **PLANAR SHF AND EHF LEAKY WAVE ANTENNAS WITH LOW SIDE-LOBE LEVEL OF THE RADIATION PATTERN**

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The results of synthesis and computer simulation of a high gain linearly polarized planar leaky wave antenna arrays for broadside radiation, optimized for low (less than  $-20$  dB) side-lobe level of the radiation pattern in the frequency bands of 24–24,2 GHz and 60,2–61 GHz. Antennas contain planar dielectric waveguide, one-dimensional periodic strip grating and the excitation device for the dielectric waveguide (strip comb line or slotted power divider). To reduce the side-lobe level of the radiation patterns in E- and H-planes, special aperture distributions are used in the antennas, in particular, by varying the leakage coefficients in orthogonal directions by changing the design parameters of the structures (for example, the width of the metal strips, as well as the length of lateral stubs of the comb line). As a result, the side lobe are reduced to the levels of  $-(20 \dots 28)$  dB. The best result was obtained in the antenna with a slotted waveguide power divider. It is noted that further side radiation level reduction can be achieved by phasing of radiation of grating elements by varying periods of gratings.

Key words: antenna array, leaky waves, aperture distribution, radiation pattern, side-lobe level

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## *Mechanical engineering and science of machines*

### **DEVELOPMENT OF PRINCIPLES OF SIMULATION MODEL BASED ON THE EVENT OF TECHNOLOGICAL PROCESSES**

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Article suggests the principle of creating simulation models based on the events of technological processes. Primarily we considered simulation method as applied to the study of production process engineering industries. We consider two basic ways to create simulation models using the universal programming languages and using simulation software. A study of the development of simulation models of technological processes in software systems simulation, which showed that existing software have not been adapted for use in the Russian machine-building industries. Based on the findings formulated the basic principles of the creation of simulation models to ensure adaptation to the Russian machine-building enterprises. The first principle of creating simulation models based on accurate simulation of production units, taking into account the scale. Such an approach would solve the layout and planning of the enterprise objectives. The second principle involves creating a list of model based on the technological processes used in the production process. On the basis of the principle of the proposed list of events designed forming algorithm based on process. The effect of the algorithm on the basic elements of a simulation model created on university-greasy programming language. The article also provides a generalized structure of the interaction of objects in the simulation model created by the proposed principles

Key words: simulation, events, processes

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