**MATHMATICAL MODELING**

**DEVELOPMENT OF MODELS OF CALL CENTER WITH THE SYSTEM OF INTERACTIVE VOICE RESPONSE**

The analysis of literature indicates no serious research of call center, which would take into account the impact of interactive voice response (IVR), but at the same time, experience shows that its introduction significantly affects the operational costs of the system owner.

That is why the development of adequate models of functioning call center is quite an urgent task when designing for leading to the improvement of operation and, therefore, reduces the cash costs of their operation.

The work was performed statistical analysis, and the data on the work of the Call-center, a queuing system. IVR system performance was investigated on the developed simulation model in the system GPSS World, experimental studies of developed methods and algorithms are conducted.

Number of calls that were serviced, the percentage of lost calls of operators, histogram average waiting time in the queue at different values of the number of working operators, histogram queue length are obtained. They allow predicting the workload of the Call-center, and calculating based on the number of operators required.

The research results show that changing the length of the IVR only a few seconds significantly affects the quality parameters of call-center such as the percentage of lost or rejected calls, average wait time, average queue length for operators. With increasing served IVR calls that left behind this system, the average call time in the queue and the average queue length to operators significantly reduced, and the simulation model allows tracking statistics module.

Developed and statistical simulation models can be used in the design and operation of call-centers. In the future, it is proposed researching models on the more complex models of distribution than normal, or exponential.

**SYSTEMS AND CONTROL PROCESSES**

**USING SYNTHETIC JET GENERATORS IN THE SYSTEMS OF CONTROL OF SEPARATED FLOWS OF TURBOMACHINES**

The article presents the features of the use of pulse-periodic systems, which are presented in the form of generators of synthetic jets and can be used to eliminate flow separation of blade rows of turbomachines.

It is known that the control system of separated flows characterized by greater efficiency in the modes of operation of stages of turbomachines that are close to resonance. Therefore, ensuring the flexibility of the control system of separated flows and the possibility of its adjustment under certain operating conditions of stages of turbomachines, greatly expand the range of effectiveness of the latter. Such flexibility of the control system of separated flow can be achieved by using a moving element, which is used as a vibration exciter. With moving parts can configure the system to the required frequency range, the moving element can also play the role of a diagnostic element of the system.

It should be noted that the integral separated wake on the stages of axial turbomachines has a requirement for control method for the presence of feedback, which in turn needs a shaping procedure and settings.

Adjusting the natural frequency of the control system of separated flows will provide expansion of its range of effective work, as well as increase the efficiency of stages of turbomachines in general. The study results can be used for the selection of configuration of moving parts of repetitively pulsed systems.

**KEYWORDS:** generators of synthetic jets, pulse-periodic systems, blade rows, separated flows, moving element.

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This article provides an analysis of the contents of binary relations in the form of cause-and-effect relationships. It is shown that this form of relationship is the basis for modeling and cognition of the laws of relations among elements of various systems. At the same time, there is the possibility of using the relationship in the form of dialectical unity of opposites of categories «single — general» for the discovery of new laws for the systems in the form of organized whole. It has been shown that the principle of forming an organized whole from its parts is the principle of the dialectical unity of opposites of qualitative and quantitative characteristics of their states. There are established rules for the formation and implementation of the activity of an organized whole.

It is shown that the fundamental rule of the formation and implementation of the activity of a dialectically organized whole, and also its cognition, is the rule of duality. Cognition of a dialectically organized whole is possible only by simultaneously exploring ways of forming characteristics of the states of its parts, and the mechanism of realization of its integrated activity. The possibility and necessity of introduction to the set theory of dialectical relationship in the form of «single — general» and an appropriate label for this relationship. This will form the set-theoretic mathematical models for dialectically organized wholes.

It is important that the rule for action is cognition dialectically organized whole. Activity of a dialectically organized whole has a dual character: on the one hand the integrated activity is realized in the form of «unit operations», the result of which is a «philosophical zero», characterized by the category of «general» and on the other hand there is realized the physical process of getting a specific result, characterized by the category of «single».

Keywords: system, the whole activity, integrity, category, concept, mechanism, motion, control, compliance, dialectic.

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Abstracts and references

**Development of Principles of Binary Relations in the Theory of Economic Management**

page 24–27

The problem of developing a system of predictive ore crushing control is considered. A method of forming forecasting control of ore crushing, which is based on static nonlinearities inverting input-output of block-oriented model and approximation of trajectories of control systems of orthonormal Laguerre functions, allows to reduce the problem of determining the sequence of actions to control the problem of quadratic programming. By means of simulation it is shown that the proposed system provides higher quality control of transients and calculated load on the control unit as compared to non-linear predictive control.

Using the proposed system will improve the efficiency of ore dressing in mining enterprises through the formation and stabilization of the required granulometric characteristics of crushed ore, which will reduce energy consumption in the next stages of processing, and as a result, reduce the cost of the final product.

Keywords: fragmentation process, control of forecasting models, quality control, computational load, simulation.

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DEVELOPMENT OF A MODEL FOR INTERNATIONAL CARGO DELIVERY PROCESS

In the conditions of growing level of competition and transportation volumes, the task of the assessment of demand parameters impact on carriers expenses becomes particular important when choosing the optimal technological schemes. At the same time the random nature of the transportation process and the limitations imposed by existing laws and acts regulating international road transport should be taken into account in the mathematical model. Existing methods of rationalization of cargo delivery process have some disadvantages due to which their use in the conditions of transport enterprises at the contemporary market is inefficient. The majority of existing methods and models for rationalization of the delivery schemes do not consider the probabilistic characteristics of transport process parameters, and that reduces the efficiency of managerial and organizational decisions. The proposed mathematical models allow us to take into account the random nature of the process of international cargo delivery, if the appropriate statistical data on time parameters and speed of the vehicle are available. Proposed approach allows defining the impact of stochastic demand parameters on operating costs of the transport firm and, as a result, – choosing the appropriate rational schemes of transport servicing.

Keywords: international cargo delivery, mathematical model, Markov’s chains, regression analysis.

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RESEARCH AND DEVELOPMENT THE MEASURER OF THE LOW FREQUENCY VIBRATIONS FOR THE CONTROL SYSTEM OF NORMALIZED PARAMETERS OF PRODUCTION FACTORS

It is developed and researched the measurer low-frequency vibrations (frequencies less than 1 Hz) based on bimorph with optoelectronic control for the control system of normalized parameters of the production factors.

Development and research are conducted to add the automated information-measuring system by the channel of parameter control of the low-frequency vibrations (up to 1 Hz), for automation of measurement and control process, improve accuracy and performance monitoring of normalized parameters, as well as to provide automatic compensation of the nonlinearity of the piezoelectric bimorph piezoelectric element in the process of monitoring and calibration. The computer simulation of the matching device and bimorph piezoelectric element is conducted to investigate the processes, optimization of parameters and evaluation of frequency characteristics of the device.

This study has allowed determining the timing of the control algorithm implemented by a microcontroller, the frequency change of control action and a maximum frequency of external influence on the piezoelectric transducer, i.e. the maximum frequency of measured vibrations. To automate the process of measuring and improving the accuracy and productivity of normalized control parameters it is necessary use a microcontroller with integrated module of width-pulse modulation included in the circuit of the position adjusting of bimorph piezoelectric element. BPE matching with a microcontroller can be achieved with a pulsed matching device.

The results of studies are useful for the development of devices to expand the functionality of the control system of production factors and can be used in sanitary-hygiene inspection of workplaces.

Keywords: low-frequency vibrations, bimorph piezoelectric element, photodetector, measurement, control, nonlinearity, compensation, modeling.

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The article examines the features of formation and analysis of functional requirements for the information and analytical system of safety management in the enterprise. We consider testing the previously developed technology accelerated the design of information systems.

This subject of research due to the need to reduce the time required to perform the work on the formation and analysis of system requirements. The proposed organization of work allows formalizing and partially automated.

The possibility of using the technology accelerated the design of information systems for the implementation of the formation and analysis of system requirements. This technology makes it possible to unify the work on the creation and processing of functional requirements.

These results confirm the universality of the methods used with functional requirements. It shows a description of the method of allocating requirements of a mathematical model of a functional problem. Results of development of data schemes and of information and analytical system can be re-used to create similar systems for other companies.

Keywords: formation of functional requirements, hierarchy of the frames, synthesis of architecture, safety management.

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DEVELOPMENT OF COGNITIVE MODEL FOR ANALYSIS OF TECHNOLOGICAL COMPLEX OF THE DAIRY FACTORY

The expediency of cognitive modeling approaches to research and improve the management of complex systems. Identified dairy processing facility as a complex semistructured organizing technology system. For the study of systems of this class of methods to effectively use cognitive approach based on expert assessments, qualitative methods of analysis and fuzzy inference rules.

On the basis of expert assessments, developed a fuzzy cognitive map of the complex functioning of the dairy and conducted its structural analysis. The studies prepared by the generalized static characteristics of the structure of the fuzzy cognitive map, such as consonances, dissonance and the influence of one factor on another. The findings are an initial step for the creation of an automated control system of technological complex dairy plant, and will be used to create resource management scenarios.

Keywords: fuzzy cognitive map, cognitive analysis, static modeling, diversified milk production.

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It is conducted research aimed at ensuring the preservation process of Allium ursinum plant which is listed in the Red Book of Ukraine on the example of Mezyn National Park. It is established samples of fifty units in measuring the height of plants Allium ursinum. Relative error of the arithmetic mean value is equal to four per cent. It was built histogram of selective distribution, which corresponds to a classic type of distribution and equal to four per cent. It was built histogram of selective distribution, which corresponds to a classic type of distribution and equal to four per cent. It was built histogram of selective distribution, which corresponds to a classic type of distribution and equal to four per cent.

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**Keywords:** process quality, plant preservation, mathematical model of the growth dynamics, control algorithm.

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**QUALITY ASSURANCE OF ALLIUM URSINUM PLANT PRESERVATION**

page 51–55

Cast copper anodes — an intermediate product of the process of electrolytic copper production. The state of the surface depends on the competitiveness of the product, and, therefore, this state should be constantly monitored by direct measurement of each casting. The methods of such measurements were proposed. These methods consist in obtaining maps of the object, and computer classification in the group, the boundaries of which are determined by spectral analysis of metal.

The work is devoted to the creation of metrological support of process control of casting copper anodes, which provides accurate, fast, reliable and high quality measurement of electrolytic anode surface at an intermediate stage of the manufacturing process of pure electrolytic copper.

To achieve this, the method was developed for intelligent image recognition of each pixel of a digital image of the surface of the copper anode by comparing its RGB-decomposition with box of the current smelting quality, as well as the method of determining the RGB-coordinates of the box quality for metal by melting current by obtaining prior treatment and spectrogram of the metal.

Production tests of the proposed methods with positive technical and economic effect are realized.

**Keywords:** cast copper anode, methods for measuring quality, display processing, box quality, spectral analysis.

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The established relationship of categories of causes factors of injury / or accident in the enterprise: working conditions, work organization, natural (surrounding) factors of labor, psycho-emotional status of the staff and each employee, as well as the functional state of employee’s organism.

This classification in conjunction with the factors of production and productive working environment allows for a logical conclusion about the need to project labor protection to its approach that is proactive management.

The research results can be used by engineers in the field of occupational safety industrial safety, as well as decision support systems of engineering enterprises.

Keywords: safety, safety project, working conditions, proactive management.

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MODEL OF OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT OF ENGINEERING ENTERPRISE

page 60–65

Society needs industrial technologies, it cannot exist without benefits of civilization like a utopian myth of a society without dangers and threats. Thus, the problem of occupational injuries will always exist, but it still requires a permit a better understanding of its causes, and, consequently, better methods of prevention.

The model of project-based occupational safety and health management allows managing the processes of occupational safety of engineering enterprise, by evaluating the working environment of the enterprise and its level of labor protection for future projects of labor protection, which reduces the likelihood of accidents and / or accidents, as well as minimizing the effects of their occurrence.

Thus, the justification for the applicability of the design-oriented approach to occupational safety and health management of engineering enterprise suggests a proactive occupational safety and health management.
DEVELOPMENT OF THE GENERALIZED CONFIGURATION MANAGEMENT PROCESS EFFECTIVENESS ASSESSING MODEL IN PROJECT MANAGEMENT

Area of project management (PM) has a problem of support coordination of the project, which is that during the entire life cycle (LC) of the project, it included those and only those elements that contribute to the creation of its products. This state of the project is called agreed. The presented problem is solved within the framework of the overall CC process, part of which is CC process of the project. The complexity of effective implementation of the latter is due to the lack of research aimed at the CC processes of intangible objects, such as LC processes, team, risks, procurement, communications, etc. The conceptual unity of the CC processes of the product and the project allowed us to develop a conceptual model of a generalized CC process and formally describe it. In this study was an attempt to develop a model for evaluating the effectiveness of the generalized CC process. As a result, we have developed methods of determining the cost of the universal realization of the CC process and the damage caused by the error of the controlled object. Furthermore, it describes the relative performance efficiency of the process. It was found that, from a mathematical point of view, CC process can be represented as a system of mass service. It was also given a substantiation of the method of simulation to calculate these performance indicators. The results can be used to develop CC mathematical model to a particular object, and further optimization of this process for efficient implementation.

Keywords: configuration, configuration management, object, project, process, optimization.

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