MATHEMATICAL MODELING

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

page 4–12

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 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 call distribution than normal, or exponential.

Keywords: call center, IVR system, simulation model, GPSS World.

References

1. Gol'dshtein, B. C., Freinkman, V. A. (2002). *Call-tsentry i komp'iuternaia telefoniia*. SPb.: BHV, 372.
2. Rosliakov, A. V., Samsonov, M. Yu., Shibaeva, I. V. (2002). *Tsentry obsluzhivaniia vyzovov (Call centre)*. M.: Eko-Trendz, 272.
3. Zarubin, A. A. (2003). Call- i kontakt-tsentry: evoliutsiia tehnologii i matematicheskih modelei. *Vestnik sviazi, 8*, 85–88.
4. Gordon, G. (1961). A General Purpose Systems Simulation Program. *Proceedings of the December 12–14, 1961, eastern joint computer conference: computers — key to total systems control on — AFIPS'61 (Eastern)*. Washington D. C., 87–104. doi:10.1145/1460764.1460768
5. Boev, V. D. (2004). *Modelirovanie sistem. Instrumental'nye sredstva GPSS World*. SPb.: BHV-Peterburg, 368.
6. Borshchiov, A. *Ot sistemnoi dinamiki i traditsionnogo IM — k prakticheskim agentnym modeliam: prichiny, tehnologiia, instrumenty*. Available: http://www.gpss.ru/paper/borshevarc.pdf
7. Gulati, S., Malcolm, S. A. (2001). Call Center Scheduling Technology Evaluation Using Simulation. *In Proceedings of the 2001 Winter Simulation Conference*. New Jersey: Institute of Electrical and Electronics Engineers, Inc, 1438–1442. doi:10.1109/wsc.2001.977467
8. Koole, G. (2004). The Calculus of Call Center: Server Level Definitions and computations. *In: MSON Conference*. Endihoven: Vrije Universiteit Amsterdam.
9. Mandelbaum, A., Sakov, A., Zeltyn, S. (2001). *Empirical Analysis of a Call Center*. Israel: Technion Israel Institute of Technology.
10. Mehrotra, V., Fama, J. (2003). Call Center Simulation modeling: Methods, Challenges, and opportunities. *Proceedings of the 2003 International Conference on Machine Learning and Cybernetics, Vol. 1*, 135–143. doi:10.1109/wsc.2003.1261416
11. Bapat, V., Pruitte, E. B. (1999). Using Simulation in Call Centers. *In: Proceedings of the 1999 Winter Simulation Conference*. New Jersey: Institute of Electrical and Electronics Engineers, Inc., 1395–1399. doi:10.1109/wsc.1998.746007

SYSTEMS AND CONTROL PROCESSES

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

page 13–20

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.

References

1. Kweder, J., Zeune, C. H., Geiger, J., Lowery, A. D., Smith, J. E. (2014). Experimental Evaluation of an Internally Passively Pressurized Circulation Control Propeller. *Journal of Aerodynamics, Vol. 2014*, 1–10. doi:10.1155/2014/834132
2. Schlichting, H. (1969). *Boundary-layer theory*. Moscow: Nauka, 713.
3. Shafer, D., Ghee, T. (2005, June 6). Active and Passive Flow Control over the Flight Deck of Small Naval Vessels. *35th AIAA Fluid Dynamics Conference and Exhibit*. American Institute of Aeronautics and Astronautics. Available: http://doi.org/10.2514/6.2005-5265

4. Lupea, I. (2012). Considerations on the Helmholtz resonator simulation and experiment. *Proceedings of the Romanian academy, Series A, Vol. 12, № 3*. The Publishing House Proceedings of the Romanian Academy, 118–124.
5. Shimizu, T., Hori, D., Kitamura, K., Daimon, Y., Oyama, A. (2011, June 27). Slit Resonator Design and Damping Estimation in Linear and Non-linear Ranges. *41st AIAA Fluid Dynamics Conference and Exhibit*. American Institute of Aeronautics and Astronautics. Available: http://dx.doi.org/10.2514/6.2011-3261
6. Kinsler, L. E. (2000). *Fundamentals of Acoustics. Chaps 10*. New York: John Wiley & Sons, 272–301.
7. Bohdanov, M. Yu., Yasynitskyi, E. P., Okhmakevych, V. M., Nikitina, V. M., Kinashchuk, M. I. (2013). Do pytannia zastosuvannia pasyvnykh metodiv upravlinnia pohranychnym sharom dlia zmenshennia vtorynnykh vtrat v lopatkovykh vintsiakh osovoho kompresora. *Materialy XI mizhnarodnoi naukovo-tekhnichnoi konferentsii «AVIA-2013», Vol. 3*, 14.5–14.8.
8. Abzalilov, D. F., Valitov, N. B., Il'inskii, N. B. (2009). Modelirovanie ustroistv aktivnogo upravleniia pogranichnym sloem, predotvrashchaiushchih otryva potoka na krylovyh profiliah. *Materialy XVI Mezhdunarodnoi konferentsii po vychislitel'noi mehanike i sovremennym prikladnym programmnym sistemam (VMSPPS2009), Alushta*, 45–47.
9. Golovanov, A. N. (2006). Vliianie akusticheskih vozmushchenii na svobodno-konvektivnogo techeniia. *Prikladnaia mehanika i tehnicheskaia fizika, Vol. 47, № 5*, 27–33.
10. Zanin, B. Yu., Zverkov, I. D., Kozlov, V. V., Pavlenko, A. M. (2007). O novyh metodah upravleniia dozvukovymi otryvnymi techeniiami. *Vestnik Novosibirskogo gosudarstvennogo universiteta, Vol. 2, №* 1, 10–18.
11. Collins, F. G., Zelenevits, J. (1975, March). Influence of Sound upon Separated Flow over Wings. *AIAA Journal, Vol. 13, № 3*, 408–410. doi:10.2514/3.49717
12. Patterson, C. (2011). *Evaluation of Pulsed & Steady Blowing Flow Control in a Slotted Leading Edge Configuration*. School of Engineering, Tufts University Medford, 53.
13. Shafer, D. M. (2014). Active and passive flow control over the flight deck of small naval vessels. *Scientific World Journal*. Available: http://www.hindawi.com/journals/tswj/
14. Rullán, J. M. (2014).Flow control over a circular arc airfoil. *Thesis submitted to the Faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE In Engineering Mechanics*. Blacksburg, Virginia: Virginia Polytechnic Institute and State University. Available: http://scholar.lib.vt.edu/theses/available/etd-10222004-132351/unrestricted/thesis_Jose_Rullan.pdf
15. Levichev, O. F. (2013). Kategoriia sinteza v nauke, filosofii i obrazovanii. *Elektronnyi nauchnyi zhurnal, 6*. Available: http://grani.agni-age.net/articles12/4914.htm
16. Lebedev, S. A. (2010). Urovni nauchnogo znaniia. *Voprosy filosofii, 2*, 1–8.
17. Kornilov, V. I., Boiko, A. V. (2010). Upravlenie turbulentnym pogranichnym sloem passivnymi i aktivnymi metodami. Uspehi i problemy. *International Conference on the Methods of Aerophysical Research — ICMAR*, 1–9.
18. Hwang, D. (1997, January 6). A proof of concept experiment for reducing skin friction by using a micro-blowing technique. *35th Aerospace Sciences Meeting and Exhibit*. American Institute of Aeronautics and Astronautics. Available: http://doi.org/10.2514/6.1997-546
19. Danilov, D. S., Lipatov, I. I., Tolkachev, G. Yu. (2010). Samoindutsirovannyi otryv laminarnogo pogranichnogo sloia i protsessy viazko-neviazkogo vzaimodeistviia nad poristoi poverhnost'iu. *Pis'ma v ZhTF, Vol. 36, № 19*, 72–75.
20. Valitov, R. A. (2009). Primenenie ustroistv aktivnogo upravleniia pogranichnym sloem s uchetom energeticheskih zatrat dlia predotvrashcheniia otryva potoka. *Trudy matematicheskogo tsentra imeni N. I. Lobachevskogo : Materialy Vos'moi molodezhnoi nauchnoi shkoly-konferentsii «Lobachevskie chteniia-2009», Vol. 39*, 147–148.
21. Sheplak, M., Cattafesta, L., Nishida, T., Horowitz, S. B.; assignee: University of Florida. (2004, August 24). Electromechanical acoustic liner. *Patent U.S. № 6782109*. Filed 3 April 2001. Available: https://www.google.com.ua/patents/US6782109?dq=Electromechanical+acoustic+liner&hl=ru&sa=X&ved=0CBsQ6AEwAGoVChMIr6C5j-3axgIVwnE-Ch2N6Qko
22. Ingard, U. (1999). *Notes On Duct Attenuators (N4)*. NE: Kittery Point. Available: http://www.ingard.com/
23. Liu, F., Horowitz, S., Nishida, T., Cattafesta, L., Sheplak, M. (2007). A multiple degree of freedom electromechanical Helmholtz resonator. *The Journal of the Acoustical Society of America, Vol. 122, № 1*, 291–301. doi:10.1121/1.2735116.
24. Liu, F., Horowitz, S. B., Cattafesta, L., Sheplak, M. (2003). A Tunable Electromechanical Helmholtz Resonator. *9th AIAA/CEAS Aeroacoustics Conference and Exhibit (Hilton Head, South Carolina). AIAA Paper 2003–3145*. Available: http://www.researchgate.net/publication/233532493_A_Tunable_Electromechanical_Helmholtz_Resonator
25. McKee, R. J., Broerman, E. L. (2009). Acoustics in Pumping Systems. *25th International Pump Users Symposium, February 23–26, 2009, Houston, TX*. Available: http://turbolab.tamu.edu/uploads/files/papers/p25/P25-Tut1.pdf
26. Loitsianskii, L. G. (1987). *Mehanika zhidkosti i gaza*. M.: Nauka, 840.
27. Fischer, F. A. (1955). *Fundamentals of Electroacoustics*. New York: Interscience Publishers Inc., 186.
28. Blackstock, D. T. (2000). *Fundamental of Physical Acoustics*. New York: John Wiley & Sons, 560.
29. Prasad, S. A., Gallas, Q., Horowitz, S. B., Homeijer, B. D., Sankar, B. V., Cattafesta, L. N., Sheplak, M. (2006, October). Analytical Electroacoustic Model of a Piezoelectric Composite Circular Plate. *AIAA Journal, Vol. 44, № 10*, 2311–2318. doi:10.2514/1.19855

DEVELOPING OF DEVICES AND METHODS OF TIMEKEEPING FOR TRAINING 4 X 100 m RELAY TEAMS

page 20–23

This work is devoted to the development of the method of timekeeping cross sections at a distance during training 4 x 100 m relay teams. Specificity of training is that the measured time of running athlete with the baton over zone of 20 m. By virtue of the fact that the transmitting and receiving cross section of start and end of zone, resulting in redundancy of temporal information. Existing methods of timing do not allow fixing it. It is developed a method for a single time field and measuring equipment, allowing providing a preliminary analysis of the received signals, providing higher reliability and accuracy of the data. It minimizes the appearance of artifacts that are conceptually solves the problem of reliability and accuracy of information transfer and ultimately the effectiveness of training athletes.

Keywords: electron-optical systems, optical beam, one temporary space, optical target.

References

1. Galitsa, V. I., Kachanov, P. A., Gorlov, A. S., Karetskii, E. A. (2012). Tehnicheskie sredstva i sistemy ekspress diagnostiki dlia ispol'zovaniia v tehnologiiah upravleniia podgotovkoi sportsmenov. *Visnik NTU* «KhPI», 37, 42–50.
2. Lutfullin, I. Ya., Mavliev, F. A., Hadiullina, R. R. (2012). Osnovnye napravleniia ispol'zovaniia informatsionnyh t*ehnologii v praktike sporta. Uchenye zapiski universiteta im. P. F. Lesgafta, 9(91)*, 88–93.
3. Arhandeeva, L. V. (2010). Informatizatsiia otrasli fizicheskaia kul'tura i sport. *Vektor nauki TGU*, 24–26. ISSN 2221-5662.
4. Voronov, I. A.; S-Peterb. Gos. Un-t fiz.kul'tury im. P. F. Lesgafta. (2005). *Informatsionnye tehnologii v fizicheskoi kul'ture i sporte*. SPb., 79.
5. Fedorov, A. I.; Ural.gos.akad. fiz.kul'tury. (2001). *Metodologicheskie aspekty informatizatsii vysshego fizkul'turnogo obrazovaniia*. Cheliabinsk, 246.

6. Orlova, Yu. A. (2008). Informatsionnye tehnologiipri podgotovke menedzherov v VUZah fizicheskoi kul'tury i sporta. *Uchenye zapiski universiteta im. P. F. Lesgafta, 6(40)*, 88–93.
7. Solov'ev, V. V., Dmitriev, G. G., Hagai, V. S. et al. (2007). Innovatsionnye informatsionnye tehnologii v sisteme marketinga fizicheskoi kul'tury i sporta voennosluzhashchih. *Uchenye zapiski universiteta im. P. F. Lesgafta, 9(31)*, 92–95.
8. Sergeev, A. G., Latyshev, M. V., Teregeria, V. V. (2005). *Metrologiia, standartizatsiia, sertifikatsiia*. M.: Logos, 560.
9. Horlov, A. S., Halytsia, V. I., Bleshchunova, K. M.; In: Tovazhnianskyi, L. L. (2012). Novitni tekhnolohii upravlinnia bihovym trenuvalnym navantazhenniam sportsmeniv. *Tezy dopovidei XX Mizhnarodnoi naukovo-praktychnoi konf. «Informatsiini tekhnolohii: nauka, tekhnika, tekhnolohiia, osvita, zdorov'ya», 15–17 travnia 2012 r.* Kharkiv: NTU «KhPI», 293.
10. Ermakov, S. S., Adashevskii, V. M., Sivolap, O. A. (2010). Theoretical and experimental determination of biomechanics descriptions at run. *Fizicheskoe vospitanie studentov, 4*, 26–29.

DEVELOPMENT OF PRINCIPLES OF BINARY RELATIONS IN THE THEORY OF ECONOMIC MANAGEMENT

page 24–27

This article gives 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 between elements of various systems. At the same time there is shown 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 dialectical by organized whole is only possible 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 the rule action for 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.

References

1. Pospelov, G. S., Irikov, V. A. (1976). *Programmno-tselevoe planirovanie i upravlenie (vvedenie)*. M.: Sov. radio, 404.
2. Fon Bertalanfi, L.; In: Sadovskiy, V. N., Yudina, E. G. (1969). *Obshhaya teoriya sistem — kriticheskij obzor. Issledovaniya po obshhej teorii sistem*. M.: Progress, 520.
3. Gegel', G. V. F. (1997). *Nauka logiki. Pervaia chast' Obiektivnaia logika. Vtoraia chast'. Subiektivnaia logika*. Sankt-Peterburg: Nauka, 800.
4. Ficapal-Cusí, P., Torrent-Sellens, J. (2014). New Human Resource Management Systems in Non-Based-Knowledge Firms: Applications for Decision Making on the Business Performance. *Modern Economy, Vol. 05, № 02*, 139–151. doi:10.4236/me.2014.52016
5. Obeidat, B. Y., Masa'deh, R. (Moh'd, T.), Abdallah, A. B. (2014, February 25). The Relationships among Human Resource Management Practices, Organizational Commitment, and Knowledge Management Processes: A Structural Equation Modeling Approach. *International Journal of Business and Management, Vol. 9, № 3*, 9–26. doi:10.5539/ijbm.v9n3p9
6. Elwyn, G., Taubert, M., Kowalczuk, J. (2007). Sticky knowledge: A possible model for investigating implementation in healthcare contexts. *Implementation Science, Vol. 2, № 1*, 44. doi:10.1186/1748-5908-2-44
7. Juaneda Ayensa, E., González Menorca, L., Marcuelo Servós, C. (2013). El reto de la calidad para el Tercer Sector Social. Análisis de casos de implantación del modelo EFQM. *Cuadernos de Gestión, Vol. 13, № 2*, 111–126. doi:10.5295/cdg.110285ea
8. *ISO 80000-2:2009. Quantities and units — Part 2: Mathematical signs and symbols to be used in the natural sciences and technology*. Available: http://www.iso.org/iso/rss.xml?csnumber=31887&rss=detail
9. Dotsenko, S. (2014). Process and activities of the «unit of activity» — two forms of the organized whole. *Technology Audit And Production Reserves, 5(1(19))*, 9–12. doi:10.15587/2312-8372.2014.28079
10. Dotsenko, S. (2014). On the issue of system methodology crisis and ways to overcome it. *Technology Audit And Production Reserves, 4(1(18))*, 12–17. doi:10.15587/2312-8372.2014.26230

PROCESS CONTROL OF ORE CRUSHING USING BLOCK-ORIENTED PREDICTIVE MODEL

page 28–32

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, allowing reduce the problem of determining the sequence of actions to control the problem of quadratic programming. By means of simulation it is found 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 granulate characteristics of crush 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.

References

1. Allgöwer, F. (2004). Nonlinear Model Predictive Control: From Theory to Application. *Journal of the Chinese Institute of Chemical Engineers, Vol. 35, № 3*, 299–315.
2. Veremey, E. Y. (2014). *Upravlenye s prohnozyruyushchymy modelyamy*. SPb.: SPbGU, 212.
3. Kabanov, S. A. (1997). *Upravlenye systemamy na prohnozyruyushchykh modelyakh*. SPb.: SPbGU, 200.
4. Patikirikorala, T., Wang, L., Colman, A., Han, J. (2012). Hammerstein-Weiner Nonlinear Model Based Predictive Control For QoS Management in Complex Software Systems. *Control Engineering Practice, Vol. 20, № 1*, 49–61. doi:10.1016/j.conengprac.2011.09.003
5. Bazara, M. (1982). *Nelyneynoe prohrammyrovanye. Teoryya y alhorytmy*. M.: Mir, 593.
6. Hadef, J. E., Olaru, S., Rodriguez-Ayerbe, P., Colin, G., Chamaillard, Y., Talon, V. (2013). Nonlinear Model Predictive Control Of The Air Path Of A Turbocharged Gasoline Engine Using Laguerre Functions. *In Proceedings of System Theory, Control*

and Computing (ICSTCC), 2013 17th International Conference. Sinaia, 193–200. doi:10.1109/icstcc.2013.6688959
7. Hadef, J. E., Olaru, S., Rodriguez-Ayerbe, P., Colin, G., Chamaillard, Y., Talon, V. (2013). Explicit-Ready Nonlinear Model Predictive Control of the Air Path of a Turbocharged Spark-Ignited Engine. *In Proceedings of 7th IFAC Symposium on Advances in Automotive Control*. Tokyo, Japan, 189–194. doi:10.1109/cca.2013.6662746
8. Lee, J. H., Chikkula, Y., Yu, Z., Kantor, J. C. (1995). Improving Computational Efficiency of Model Predictive Control Algorithm Using Wavelet Transformation. *International Journal of Control, Vol. 61 № 4,* 859–883. doi:10.1080/00207179508921935
9. Wang, L. (2009). *Model Predictive Control System Design and Implementation Using MATLAB*. London: Springer-Verilag, 375. doi:10.1109/acc.2009.5159781
10. Porkuyan, O. V. (2007). Ydentyfykatsyya obektov upravlenyya na osnove modeley Hammershteyna otnosytelno k protsessam mahnytnoy separatsyy. *Visnyk Kryvorizkoho tekhnichnoho universytetu, 19*, 223–228.
11. Korniyenko, V. I. (2010). *Avtomatyzovani systemy optymalnoho keruvannya protsesamy krupnoho droblennya ta samozdribnyuvannya rud*. Dnipropetrovsk, 40.
12. Mykhailenko, O. Yu. (2013). Udoskonalennia matematychnoi modeli konusnoi drobarky z urakhuvanniam rozdilennia kamery droblennia na zony. *Visnyk Kryvorizkoho natsionalnoho universytetu, 35*, 163–170.
13. Mykhailenko, O. (2014). Cone Crusher Model Identification using Block-Oriented Systems with Orthonormal Basis Functions. *International Journal of Control Theory and Computer Modelling (IJCTCM), Vol. 4, № 3*, 1–8. doi:10.5121/ijctcm.2014.4301

DEVELOPMENT OF A MODEL FOR INTERNATIONAL CARGO DELIVERY PROCESS

page 33–36

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 analisys.

References

1. *Road Transport — A change of gear*. (2012). Luxembourg: Publications Office of the European Union, 16.
2. Tubis, A., Szozda, N. (2010). The improvement of the supply process for the variable demand goods. *Logistics and Transport, 1(10)*, 49–56.
3. Raczyk, R. (2010). The organization of materials handling in a distribution plant. *Transport Problems, 5(2)*, 65–70.
4. Vidyarthi, N., Çelebi, E., Elhedhli, S., Jewkes, E. (2007). Integrated Production-Inventory-Distribution system design with risk pooling: Model formulation and heuristic solution. *Transportation Science, 41(3)*, 392–408. doi:10.1287/trsc.1060.0173
5. Koźlak, J., Creput, J.-C., Hilaire, V., Koukam, A. (2006). Multi-agent approach to dynamic pick-up and delivery problem with uncertain knowledge about future transport demands. *Fundamenta Informaticae, 71(1)*, 27–36.
6. Bock, S. (2010). Real-time control of freight forwarder transportation networks by integrating multimodal transport chains. *European Journal of Operational Research, 200(3)*, 733–746. doi:10.1016/j.ejor.2009.01.046
7. Naumov, V. (2012). *Freight forwarding in logistics systems*. Kharkiv: KhNADU, 220.
8. Naumov, V. (2012). Definition of the optimal strategies of transportation market participators. *Transport Problems, 7(1)*, 43–52.
9. Naumov, V. (2014). An approach to modelling of demand on freight forwarding services. *Trip Modelling and Demand Forecasting, 1(103)*, 267–277.
10. Bergami, R. (2012). Incoterms 2010: The newest revision of delivery terms. *Acta Universitatis Bohemiae Meridionales, 15(2)*, 33–40.

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

page 36–40

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.

References

1. Zhiltsov, V., Kostenko, V. (2009). Collection device using biometric sensors tenzorezistornyh. *Technology and designing in the electronic equipment, 6(84)*, 15–18.
2. Zhiltsov, V., Kostenko, V. (2009). Multi-channel tensometric acquisition device parameters on the basis of semiconductor strain sensors. *Electrical machinery and electrical equipment, 72*, 29–34.

3. Kostenko, V., Popereka, K., Nikolenko, A., Yadrova, M., Tymaniuk, K. (2014). Information-measuring system of control of the normalized parameters of industrial factors. *Eastern-European Journal Of Enterprise Technologies, 3(9(69))*, 51–56. doi:10.15587/1729-4061.2014.25419
4. Klich, Y. A., Kontreras, M. V., Yadrova, M. V. (2006). A mathematical model of the control system piezomanipulator. *Proceedings of Odessa National Polytechnic University, 2(26)*, 146–150.
5. Klich, Y. A., Kontreras, M. V., Yadrova, M. V. (2007). The evolution of the mathematical model of adjustable piezomanipulator. *Proceedings of Odessa National Polytechnic University, 1(27)*, 191–195.
6. Frieden, G. (2006). *Modern sensors*. Moskow: Technosfera, 592.
7. Dzhagupov, R. G., Yerofeyev, A. A. (1994). *Pieso device for computing, control and monitoring systems*. S.-Petersburg: Politechnika, 608.
8. Kostenko, V., Jarovtcev, S. (2007). Photosensitive regulable synapse on the basis on the combined transistor. *Photoelectronics, 16*, 106–108.
9. Kostenko, V., Jarovtcev, S.; assignee: Odessa National Polytechnic University. (25.05.2009). Optoelectronic integral sensor. *Patent Ukraine 86870* МПК *G 01N 21/62 H01L 31/00*. Appl. 10.09.2007. Bul. № 10. Available: http://uapatents.com/3-86870-optoelektronnijj-integralnijj-datchik.html
10. Nikolenko, A. A., Jadrova, M. V. (2006). The control device of piezodrive. *Proceedings of Odessa National Polytechnic University, 1(25)*, 161–164.

FORMING AND ANALYSIS OF REQUIREMENTS TO INFORMATION-ANALYTICAL SYSTEM OF MANAGEMENT BY SAFETY OF LABOUR IN ENTERPRISE

page 41–45

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.

References

1. *GOST ISO/MEK 15288–2005. System engineering. Processes of life cycle of the systems*. (2006). Introduced 01.01.2007. M.: Standartinform, 57.
2. *ISO/IEC/IEEE 42010 Website*. Available: http://www.iso-architecture.org/ieee-1471/index.html
3. Levykin, V. M., Evlanov, M. V., Kernosov, M. A. (2014). *Patterny proektirovaniia trebovanii k informatsionnym sistemam: modelirovanie i primenenie*. H.: OOO *«Kompaniia Smit», 320*.
4. *Avtomatizirovannaia informatsionnaia sistema «Zdravtrud»*. Nauchno-proizvodstvennoe predpriiatie «Etna — Informatsionnye tehnologii». Available: http://www.etna-it.ru
5. *Avtomatizirovannaia sistema «Trud-Ekspert» v.4.0 for Windows*. Klinskii institut uslovii i ohrany truda. Available: http://www.kiout.ru
6. Serdiuk, N. N. (2013). Functional task of assessing the influence of harmful production factors on people. *Eastern-European Journal Of Enterprise Technologies, 4(4(64))*, 22–26. Available: http://journals.uran.ua/eejet/article/view/16334/13845
7. Ievlanov, M. V., Teviashev, A. D. (2012). Kontseptsiia predstavleniia trebovanii k informatsionnoi sisteme. *Materialy Mezhdunar. nauch.-tehn. konf. «Informatsionnye sistemy i tehnologii», Morskoe-Har'kov, 22–29 sentiabria 2012 g*. H.: NTMT, 34.
8. *DSTU OHSAS 18001:2010. Systema upravlinnia hihiienoiu ta bezpekoiu pratsi*. Available: http://www.dnaop.com/html/34112/doc
9. Serdiuk, N. N. (2006). Modeli tipa Gammershteina dlia opisaniia nelineinogo vozdeistviia gruppy faktorov na organizm cheloveka. *Radioelektronika i informatika, 1*, 111–113.
10. Ievlanov, M. V., Serdiuk, N. N. (2015). Modeli i metod opredeleniia sostoianiia organizma sotrudnika predpriiatiia. *Visnik Natsionalnogo tehnichnogo universitetu «KhPI», 21(1130)*, 163–169.
11. Levikin, V. M., Ievlanov, M. V., Kernosov, M. A., Kernosova, M. E. (2014). Osobennosti otobrazheniia ontologii predmetnoi oblasti v opisaniia elementov informatsionnoi sistemy. *Visnik Kremenchutskogo natsionalnogo universitetu im. M. Ostrogradskogo, 5(88)*, 83–91.

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

page 46–50

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.

References

1. Ladanyuk, A., Reshetyuk, V., Kyshenko, V., Smityuh, Y. (2014). *Innovative technologies in the management of complex objects biotech agriculture*. Kyiv: Center of educational literature, 280.
2. Savchuk, O., Ladanyuk, A., Gritsenko, N. (2009). Cognitive approach to modeling and managing semistructured organizational and technological systems (situations). *Eastern-European Journal Of Enterprise Technologies, 2(3(38))*, 14–18. Available: http://journals.uran.ua/eejet/article/view/5888
3. Axelrod, R. (1976). *Structure of decision: The Cognitive Maps of Political Elites*. Princeton, NJ: Princeton University Press, 404. doi:10.1515/9781400871957
4. Kosko, B. (1993). *Fuzzy Thinking: The New Science of Fuzzy Logic*. Hyperion: Disney Books, 336.
5. Silov, V. (1995). *Strategic decision-making in a fuzzy environment*. Moscow: INPRO-RES, 228.
6. Kulinich, A. (2003). Methodology of cognitive modeling of complex ill-defined situations. *Selected works of the Second International conference on governance*. Moscow: ICS RAS, 219–226.
7. Tolstova, Ju. N. (2006). *Osnovy mnogomernogo shkalirovanija*. M.: KDU, 160.
8. Kozlov, L. (2001). *Cognitive modeling the early stages of the project: training manual*. Ed. 3. Barnaul: Altai State Technical University Publishing House, 247.

9. Savchuk, O., Ladanyuk, A., Gerasimenko, T. (2015). Fuzzy cognitive modeling in complex systems of technological milk processing. *New University of Engineering, 1–2(35–36)*, 13–19.
10. Vovk, S., Ginis, L. (2013). Modeling transitions between the reference situation in complex systems under conditions of uncertainty. *Proceedings of SFU. Technical science, 2(139)*, 116–122.
11. Kulba, V., Kononov, D., Kosyachenko, S., Zaikin, O. (2002). Scenario Methodology for Investigation of Socioeconomic. *Production System Design, Supply Chain Management and Logistics. Proceedings of the 9th International Multi-Conference Advanced Computer Systems 2002*. Poland, 134–138.
12. Batagelj, V., Mrvar, A. (2010). *Pajek. Program for Analysis and Visualization of Large Networks Reference Manual. List of commands with short explanation. Version 1.26*. Ljubljana. Available: http://www.fcmappers.net/joomla/

QUALITY ASSURANCE OF ALLIUM URSINUM PLANT PRESERVATION

page 51–55

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 has a maximum, and this gives grounds to use plant height as a control index of process quality. Also it was studied the life cycle of plants and found the relationship between plant height and period of development. The control algorithm of the preservation quality of the plants is developed. The dependence can be used for quality monitoring process.

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

References

1. Shatokhina, Y. (2015). Components intensify management systems. *Intern. Scientific-Practic. Conf. «Quality management in education and industry: experience, problems and prospects», 28–30 May 2015*. Lviv: National University «Lviv Polytechnic», 59.
2. *ISO 14001:2004 Environmental management systems — Requirements with guidance for use*. Available: https://www.iso.org/obp/ui/#iso:std:iso:14001:ed-2:v1:en
3. *ISO 14004:2004 Environmental management systems — General guidelines on principles, systems and support techniques*. Available: https://www.iso.org/obp/ui/#iso:std:iso:14004:ed-2:v1:en
4. *ISO/CD 26000:2009 Guidance on Social Responsibility*. Available: https://www.iso.org/obp/ui/#iso:std:iso:26000:ed-1:v1:en
5. *ISO 9001:2008 Quality management systems — Requirements*. Available: https://www.iso.org/obp/ui/#iso:std:iso:9001:ed-4:v2:en
6. *Guidelines for Drinking-Water Quality. Recommendations, Vol. 1, Ed. 4*. (2011). Geneva, Switzerland: WHO, 564.
7. Pro metrolohiiu ta metrolohichnu diialnist. (2004). Zakon Ukrainy № 1765–IV vid 15 chervnia 2004 r. *Vidomosti Verkhovnoi Rady, № 37, art. 449*.
8. Gryshchenko, F., Lisnichenko, T. (2014). Determination of statistical methods in the development, implementation and operation of a quality management system. *Standardization, certification, quality, 5*, 23–32.
9. Zelik, A. (2009). Statistical methods in process of improving the quality of health services. *Standardization, certification, quality, 6*, 54–58.
10. Petsuh, I. (2015). Medical laboratories towards the provision of quality care. *Intern. Scientific-Practic. Conf. «Quality management in education and industry: experience, problems and prospects», 28–30 May 2015*. Lviv: National University «Lviv Polytechnic», 253–254.
11. Ivanova (Shatokhina), Y., Menaylov, A., Gavrilenko, A., Kirichenko, T. (2011). Recommendations for improvement of normative documents of OJSC «Oblteplocomunenergo» with control cards Shuharta. *Bulletin of the Chernihiv State Technological University. Compilation, 3(51)*, 231–239.
12. Petrishin, I., Petryshyn, N., Dzhochko, P., Bezhachnyuk, Ya. (2010). Organization and procedures of selective statistical control of domestic gas meters operated. *Standardization, certification, quality, 1*, 38–41.
13. Goncharova, E. N. (2012). Hygienic aspects of the use of pesticides. *Collection of scientific works VODGEO*. Kharkov: EPE «Contrast», 482–488.
14. *DSTU BV. 2.1-19: 2009 Soils. Methods of laboratory determination of particle size (grain) and mikroagregative composition*. Available: http://profidom.com.ua/v-2/v-2-1/1464-dstu-b-v-2-1-192009-metodi-laboratornogo-viznachenna-granulometrichnogo-zernovogo-ta-mikroagregatnogo-skladu
15. Ahnazarova, S. L. Kafarov, V. V. (1978). *Optimization experiment in chemistry and chemical technology*. M.: High school, 22–25.

DEVELOPMENT OF METROLOGICAL SOFTWARE FOR CONTROL OF CASTING PROCESS OF COPPER ANODES

page 55–60

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.

References

1. In: Solncev, Ju. P. (2003). *Metally i splavy*. SPb.: NPO «Professional», 420.
2. Cygankova, O. V., Egorov, S. G. (2014). K voprosu kachestva mednyh anodov ognevogo rafinirovanija. *Metalurgija, 1(31)*, 104–108.
3. Konovalov, A. N. (2011). *Issledovanie osobennostei plavki i raskisleniia medi s tsel'iu poluchenііa lityh elektrodov iz hromovyh bronz*. Moskva, 109.
4. Egorov, S. G. (2009). Alternativnye metody rafinirovanija medi. *Metalurgija, 20*, 70–77.
5. Savenkov, Ju. D., Dubodelov, V. I., Shpakovskij, V. A., Kozhanov, V. A., Shtepan, E. V. (2008). *Rafinirovannaja med' Ukrainy*. Dnepropetrovsk: ART-PRESS, 176.
6. Cygankova, O. V., Chervonyj, I. F., Egorov, S. G. (2012). K voprosu o precizionnom ognevom rafinirovanii medi iz vtorichnogo syr'ja. *Metalurgija, 3 (28)*, 79–83.
7. *Ligatury (master splavy) na osnove medi*. (2011). Available: http://lityo.com.ua/materialy/shihta/98-kompanii/ooo-sas-inzhenernaja-kompanija/360-ligatury-master-splavy-na-osnove-mediju. Last accessed 02.11.2011.
8. *Copper: Preliminary Data for July 2013*. (2013). Available: http://www.icsg.org/index.php/press-releases/finish/114-month-

ly-press-release/1626-2013-10-22-monthly-press-release. Last accessed 20.11.2013.
9. *Copper: Market Forecast 2013–2014*. (2013). Available: http://www.icsg.org/index.php/press-releases/finish/113-forecast-press-release/1605-2013-10-icsg-forecast-press-release. Last accessed 20.11.2013.
10. *Osobennosti plavki mednyh splavov*. (2011). Available: http://nagrada.pp.ua/liteika/103-plavcu. Last accessed 27.07.2015.
11. *The World Copper Factbook 2013*. (2013). Available: http://www.icsg.org/index.php/press-releases/finish/170-publications-press-releases/1188-2013-world-copper-factbook. Last accessed 20.11.2013.
12. *GOST 767-91. Mezhgosudarstvennyj standart. Anody mednye*. (1992). M.: Izdatel'stvo standartov, 16.
13. *GOST 31382-2009. Mezhgosudarstvennyj standart. Med. Metody analiza*. (2010). M.: Standartinform, 28.
14. *Metody spektral'nogo analiza. Jemissionnyj i absorbcionnyj metody*. (2014). Available: http://studme.org/1685030328693/bzhd/metody_spektralnogo _analiza_emissionnyy_absorbtsionnyy_metody. Last accessed 03.10.2014.
15. *GOST 9717.1-82 — GOST 9717.3-82. Med. Metody spektral'nogo analiza*. (1982). M.: Izdatel'stvo standartov, 7.
16. Prokopovich, I. V., Shihireva, Ju. V., Duhanina, M. A., Shmaraev, A. V. (2013). Informacionnyj metod izmerenija teplovyh parametrov po infrokrasnym potokam ot poverhnosti detail. *Materiali mizhnarodnoi naukovo-praktichnoi konferencii «Informacijni tehnologii ta informacijna bezpeka v nauci, tehnici ta navchanni «Infoteh-2013»», Sevastopol*, 53–54.
17. Saveleva, O. S., Stanovskyi, O. L., Purich, D. O. (2009). Pidvishhennja nadijnosti sistem distancijnogo diagnos-tuvannja. *Naukovi visti «Galic'ka akademija», 15(1)*, 58–63.
18. Stanovskyi, A., Saveleva, O., Prokopovich I., Toropenko, A., Duhanina, M. (2014). Development of heat-mass exchange optimization methods using fractal convolutions of computer tomograms. *Eastern-European Journal Of Enterprise Technologies, 5(5(71))*, 4–9. doi:10.15587/1729-4061.2014.27978
19. In: Iofis, E. A. (1981). *Sintez cveta Fotokinotehnika*. M.: Sovetskaja jenciklopedija, 342.
20. *Svet i cvet*. (2014). Available: http://www.myshared.ru/slide/179154/. Last accessed 25.12.2014.
21. *Chto takoe infrakrasnoe izluchenie*. (2012). Available: http://www.uborgsauna.ru/theory/whatir.htm. Last accessed 20.02.2012.
22. Bramson, M. A. (1964). *Infrakrasnoe izluchenie nagretyh tel*. M.: Nauka, 225.
23. *Spektralnaja laboratorija*. (2014). Available: http://www.ruscastings.ru/work/168/172/192/1254. Last accessed 13.12.2014.
24. In: Klimishin, I. A., Korsun, A. O. (2003). *Spektrograf. Astronomichnij enciklopedichnij slovnik*. Lviv: LNU-GAO NANU, 449.

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.

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' 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.

References

1. *Travmatyzm na vyrobnytstvi u 2014 rotsi. Statystychnyi biuleten Derzhkomstatu Ukrainy*. (2014). K.: Derzhkomstat Ukrainy, 195.
2. Korolev, G. F. (1976). *Proizvodstvennyj travmatizm i metody vyjavlenija ego prichin*. M.: NIIMASh, 41.
3. Belov, P. G. (1999). *Modelirovanie opasnyh processov v tehnosfere*. K.: KMUGA, 124.
4. Ho, T. (1985). Analiz sistem (bezopasnost'): metody i analiz. *Jenciklopedija po bezopasnosti i gigiene truda, Vol. 1*, 117–121.
5. Monto, M. (1986). Neschastnye sluchai, analiz. *Jenciklopedija po bezopasnosti i gigiene truda, Vol. 2*, 1348–1352.
6. Shennon, G., Devis, D. (2001). MIAM: Mersisajdskaja informacionnaja model' neschastnogo sluchaja. *Jenciklopedija po ohrane i bezopasnosti truda, Vol. 2*, 179.
7. *Guidelines on occupational safety and health management systems, ILO-OSH 2001*. (2003). Geneva: The International Labour Office. Available: http://www.ilo.org/wcmsp5/groups/public/@ed_protect/@protrav/@safework/documents/normativeinstrument/wcms_125017.pdf
8. *OHSAS 18001:2007. Occupational Health and Safety Assessment Series. Specification*. Available: https://managementmania.com/en/ohsas-18001-occupational-health-and-safety-assessment-specification
9. *International Labour Organization. ILO DWT and Country for Eastern Europe and Central Asia*. Available: http://www.ilo.org/public/english/region/eurpro/moscow/index.htm
10. *SA 8001:2001. Social Accountability Management System*. Available: http://www.tuv-sud.cn/cn-en/activity/auditing-system-certification/sa8000
11. *ISO 14001:1996. Environmental management systems. Specification with guidance for use*. Available: https://www.deq.state.ok.us/factsheets/customer/ISO_14001.pdf. doi:10.3403/00889097
12. Moskaliuk, A. Yu., Teslenko, P. A. (2011). Proektyzatsyia protsessov okhranы truda. *Upravlinnia proektamy: Stan ta perspektyvy: Materialy 7-yi Mizhnarodnoi naukovo-praktychnoi konferentsii*. Mykolaiv: NUK, 208–210.
13. Moskaliuk, A. Yu., Teslenko, P. A. (2013). Mesto proektnoho upravlenyia v predmetnoi oblasty okhranы truda. *Tezy dopovidei II Mizhnarodnoi nauk.-prakt. konf. studentiv, aspirantiv ta molodykh vchenykh «Stan ta perspektyvy rozvytku sotsialno-ekonomichnykh system v epokhu ekonomiky znan»*. Luhansk: Skhidnoukrainskyi natsionalnyi universytet im. V. Dalia, 44–49.
14. *OHSAS 18011:1999 Systema menedzhmentu haluzi promyslovoi bezpeky ta okhorony pratsi. Vymohy*.
15. *DSTU ISO 9001-2001 Systemy upravlinnia yakistiu. Vymohy*. (2001). Effective from 01.10.2001. K.: Derzhstandart Ukrainy, 23.
16. *DSTU EN 1050:2003 Bezpechnist mashyn. Pryntsypy otsiniuvannia*. (2004). K.: Derzhkomstat Ukrainy, 18.
17. *A Guide to the Project Management Body of Knowledge*. (2013). An American National Standard ANSI/PMI 00-001. Ed. 5. PMBOK, 615.
18. Moskaliuk, A. (2012). Informational support for labour protection projects as complex organizational&technical systems. *Technology Audit And Production Reserves, 4(1(6))*, 39–40. Available: http://journals.uran.ua/tarp/article/view/4784

DEVELOPMENT OF THE GENERALIZED CONFIGURATION MANAGEMENT PROCESS EFFECTIVENESS ASSESSING MODEL IN PROJECT MANAGEMENT

page 65–72

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. On the basis of this formal description, 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 the 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.

References

1. Morozov, V., Rudnitskyy, S. (2013). Conceptual model of the configuration management process in projects. *Eastern-European Journal Of Enterprise Technologies, 1(10(61))*, 187–193. Available: http://journals.uran.ua/eejet/article/view/6766
2. Rudnitskyy, S. (2015). Object configuration management process. *Eastern-European Journal Of Enterprise Technologies, 2(3(74))*, 15–25. doi:10.15587/1729-4061.2015.39788
3. Rudnitskyy, S. (2015). Development of the generalized configuration management process mathematical model in project management. *Eastern-European Journal Of Enterprise Technologies, 4(2(76))*. Available: http://dx.doi.org/10.15587/1729-4061.2015.47292
4. Ratushnyi, R. T. (2005). *Metody ta modeli upravlinnia konfihuratsiieiu proektu vdoskonalennia systemy pozhezhohasinnia v silskomu administratyvnomu raioni (na prykladi Lvivskoi oblasti)*. Lviv, 19.
5. Mykhaliuk, M. A. (2008). *Obgruntuvannia metodiv i modelei identyfikatsii ta kontroliu konfihuratsii proektiv system tsentralizovanoi zahotivli moloka*. Lviv, 20.
6. Tatomyr, A. V. (2009). *Uzghodzhennia konfihuratsii proektiv servisnykh ta obsluhovuvanykh system (stosovno elektrozabezpechennia silskohospodarskykh pidpryiemstv za vykorystannia enerhii vitru)*. Lviv, 20.
7. Sydorchuk, L. L. (2008). *Identyfikatsiia konfihuratsii parku kombainiv u proektakh system tsentralizovanoho zbyrannia rannikh zernovykh kultur*. Lviv, 18.
8. Reilly, M. A. (1995). *Spent Nuclear Fuel Project Configuration Management Plan*. United States, 12. doi:10.2172/97000
9. Naliutin, N. Yu. (2008). *Metody i programmnye sredstva upravleniia konfiguratsiiami proektov razrabotki vstroennyh sistem*. Moskva, 226.
10. Vann, J. M. (1996). *TWRS Configuration management program plan*. United States, 54. doi:10.2172/662064
11. Rudnitskyy, S. (2015). Development of object model of the generalized configuration management process in project management. *Technology Audit And Production Reserves, 2(3(22))*, 38–44. doi:10.15587/2312-8372.2015.41498
12. Venttsel', E. S. (1972). *Issledovanie operatsii*. M.: Sovetskoe radio, 552.