Research Inventy: International Journal Of Engineering And Science
Vol.3, Issue 12 (December 2013), PP 20-29
Issn(e): 2278-4721, Issn(p):2319-6483, Www.Researchinventy.Com

Computer game modeling organizational structures of enterprises and industrial associations

[1]Ostroukh Andrey Vladimirovich, [2]Barinov Kirill Aleksandrovich, [3]Surkova Nataliya Evgenievna

[1]*full member EAEN (Hannover, Germany), Dr. of Tech. Science, Professor Dep. «Automated control systems», Moscow Automobile & Road construction State Technical University,*
[2]*Ph. D., Ass. Professor Dep. «Automated control systems»,Moscow Automobile & Road construction State Technical University,*
[3]*Ph. D., Ass. Professor Dep. «Automated control systems»,Moscow Automobile & Road construction State Technical University,*

ABSTRACT - *The paper proposes a formalized representation of technological processes and queuing network modelling (QNM) to assess the temporal characteristics that allow implementing the mechanisms of modeling and parameterization of the local environments of the individual processes; in addition, we have developed a Petri net for the compatibility of logical conditions to the technological processes implementation using an event approach.The following was used in the development of formal models for the components: general systems theory methods, the classical set theory apparatus, theory of stochastic processes, queuing systems theory and experiment planning, graph theory, methods of mathematical programming, simulation, etc.*
The practical value of the work lies is the development of methods for modeling the technological processes included in the simulation system of organizational management structures and others. The developed methods and algorithms have been tested and implemented for practical use in a number of companies.

KEYWORDS - *collaborative learning, business game, corporate learning system, distance learning, formal models and method, Petri nets, queuing networks*

I. INTRODUCTION

Organizational and technological level of the modern industrial enterprises is largely determined by the creation and application of effective mechanisms for the formation and implementation of strategic development plans and the effectiveness of the operational management of all production, logistics, organizational and economical processes that aim to achieve high production profitability, development and improvement of production. In this regard, building the organizational structure of the enterprise management is a complex multi-layered problem. Principles and methods of the organizational structure development are directly dependent on many factors. The most significant of these are the specifics of particular production, sets of technological processes used, production volumes, capacity utilization, tactical, technical and quality parameters of products, standardization and certification issues, qualification level of technical, administrative and management personnel, management system applied, organizational and legal form, regulatory and legal framework of the enterprise, organization of internal and external documents circulation.

Building the organizational structure in an industrial environment is a paramount task in relation to other tasks of the industrial process control. Formulation and solution of this task at a high scientific and technical level is a prerequisite for the effective organization of production, high competitiveness of products, growth of financial and economic indicators, continuous dynamic development and improvement of production.

Relevance of the topic is determined by the need to optimize the organizational structure of enterprise management as a "top-level" task to be primarily settled as a basic component of an effective and successful functioning of any industrial enterprise, regardless of the products purpose and production volumes.

II. ORGANIZATIONAL MODELS FOCUSING ON THE FORMATION OF DIFFERENT APPROACHES AND PRINCIPLES OF PRODUCTION PROCESSES MANAGEMENT

Control of all the production processes is implemented through the creation of a structural diagram of units with specific production factors and other factors discussed above. In current practice, there are the following approaches to the formation of units:

- functional model: one unit corresponds to one function;
- process model: one unit corresponds to one process;
- contracting party-oriented model: one unit corresponds to one counteragent.

Contracting party-oriented model is useful in a limited number of customers and is used by the following scheme: one unit corresponds to one customer or a group of customers.
The most common are the functional and process models as well as their various modifications. The paper shows that the matrix structure combines the principles of functional and process systems construction.

Direct subordination means an employee or a department is directly subordinated to another subject of industrial relations of a higher level. In this case, the head of the unit gives orders to the subordinated subject in order to execute orders on administrative and functional issues. Direct subordination is the basis of creating a hierarchy of positions and departments.

Functional subordination is the subordination of one entity (an employee or a department) to another entity within the implementation of certain functions. In this case, the head of the unit only gives orders to the subordinated subject within the framework of subordinate entity functions.

To simulate the behavior of staff in decision-making when managing production and technological processes, the thesis proposes to use an interactive simulation.

The analysis of interactive gaming simulation revealed the main options for organizing the business game (Fig. 1) and characterological features of the business game (BG), presented in the form of a functional diagram (Fig. 2) [1 – 21].

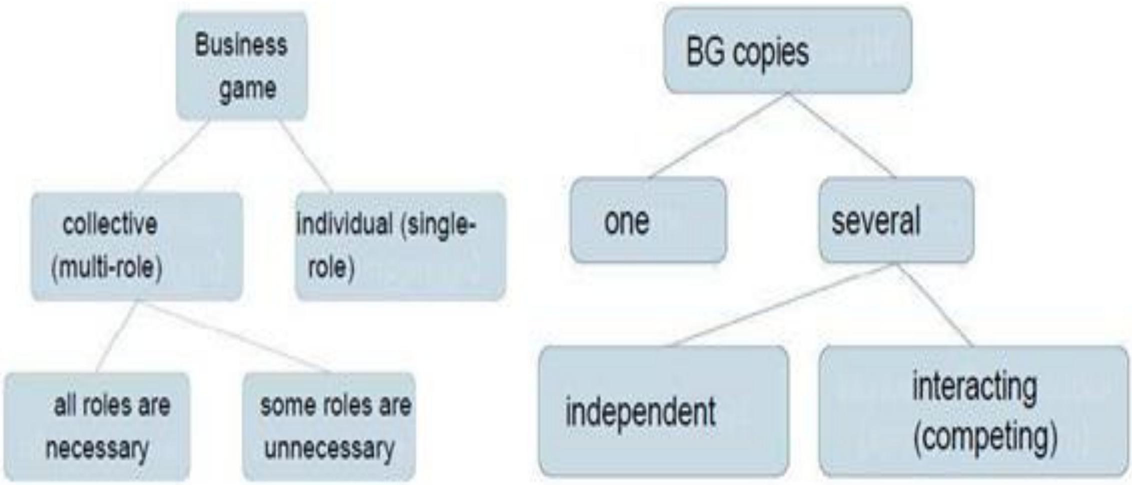


Fig. 1. Types of business games

Mathematical models that describe the technological, organizational, and other processes in the gaming simulation are subjected to numerical investigation with subsequent quantitative decisions taken based on them. The use of computer technology is not a pre-requisite, however, it contributes to the successful implementation of simulation process, providing several advantages [1, 2, 4, 6 – 8].

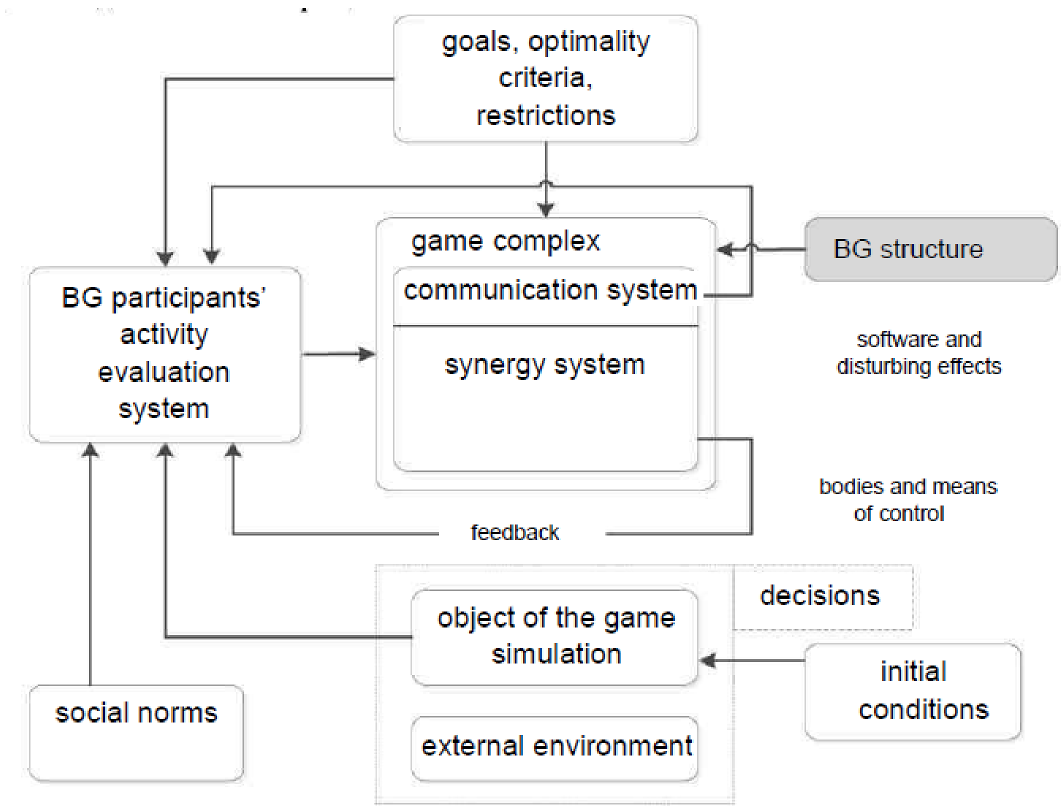


Fig. 2. Business game (BG) functional diagram

The time factor that is present and accounted for in BG imposes certain conditions on the process and outcome of the game. Changing the time scale makes it possible to cut down processing time, measured in days and years, to minutes and hours, respectively. Due to repeated playback of different situations, the presence of feedback in the simulation system enables the participants of the game to learn and subsequently take more effective decisions on the management of production processes through analyzing the results.

The use of BG in the process of personnel training involves the use of didactic methods that are widely used in teaching. Didactic principles of visibility, activity, accessibility, theory and practice connection, science, interest and other principles are successfully used. Each BG implements these principles in appropriate didactics in one way or another.

III. FORMULATION OF THE BUSINESS GAME FRAMEWORK

The main part of the business simulation game (BSG) includes a simulation model of the environment, the virtual game participants and interaction algorithms between these models and real trainees [1 - 15]. The BSG body is constructed out of parallel strings of arbitrary algorithmic complexity, one for each party involved in the BSG. The data separation describing the current status of each role type within this role limits is carried out by means of the fragment, and not at the assembly level of the BSG framework in the structural elements designer.

The mechanism is similar to critical sections based on the blocking thread when synchronizing the variables in a single process (Fig. 3) [3, 5 - 8]. To ensure the synchronization process in the local network, the zero-size file is used as a blocking variable. The presence of the file indicates that the resource is busy, while its absence shows that the resource is available.

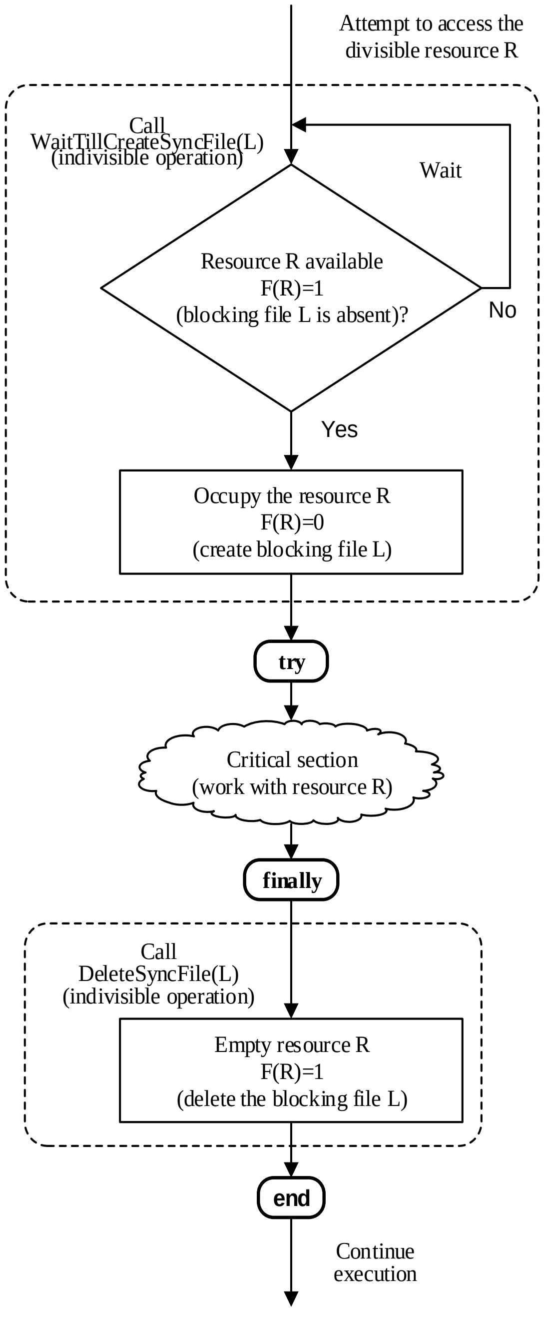


Fig. 3. Mechanism of critical sections based on the blocking variables

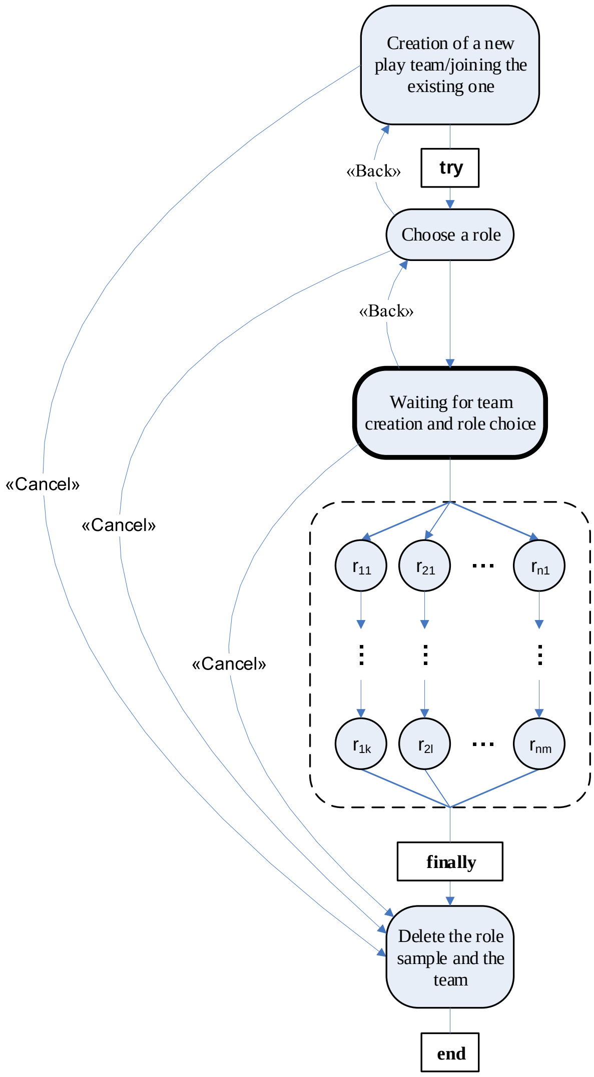


Fig. 4. Schematics of the BSG framework

The BSG frame consists of a set of fragments combined into a scenario generated according to the algorithm. The scenario is assembled in a structural elements designer. The framework is intended to form the organizational and structural environment of the BSG as players register in the BSG and its subsequent dissolution when the player leaves the game. For the user, execution fragments of the frame look like a step-by-step wizard, where he/she can terminate the registration process or return to the previous step at any moment (Fig. 4).

Fig.4 legend: r_{ij} **-** fragments that implement the scenario i-th role; **try ... finally ... end -** exceptions handling at the level of the BSG scenario; it provides guaranteed performance of de-initializing fragment of the frame.

Some fragments constituting the frame are visual and are intended for visual organization of the User Interface during the registration of the player in the BSG. Other fragments are nonvisual and are designed to perform as a support for the operation of the BSG frame.

It is possible to organize the parallel execution of the processes within a given game set to reduce the delays associated with performing lengthy operations (e.g. being in the waiting regime). In this case, the non-visual (auxiliary) process will run in the background. The main thread of the scenario and auxiliary processes can interact (communicate) and sync. Background processes can also interact with each other.

IV. THE PRESENTATION OF TECHNOLOGICAL PROCESSES AS QNM MODELS WITH DESCRIPTIVE ELEMENTS IN THE FORM OF PETRI NETS

A graphical editor that allows to structure parallel-sequential processes (Fig. 5) using visual means has been developed; serving nodes represent the multichannel queuing systems (servers), and the arcs are marked with transition probabilities between them [8].

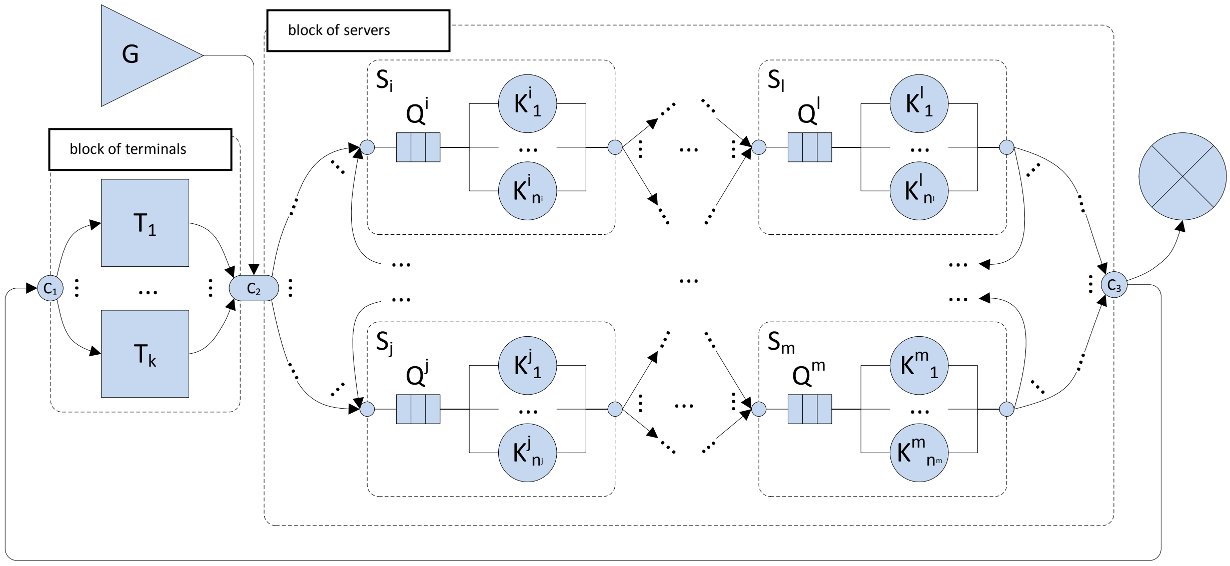


Fig. 5. The general structure of QNM supported by simulation modeling tool environment

Server block may have any structure and consist of an arbitrary number of nodes. The terminal block can also consist of an arbitrary number of nodes connected in parallel. Points C_1, C_2, C_3 in the QNM diagram are fixed nodes of the diagram, intended to be connected to a single generator network, terminal block, server block and a circuit network by snapping to them with arrows of the corresponding blocks. Each server S_i in the diagram editor is represented as a single unit. Placement sequence of blocks in the diagram and their connection is arbitrary.

The transition probabilities along the arcs between the network nodes are bound by the following restrictions: $\sum P(C_2, \bullet)=1$, $\sum P(S_\bullet, \bullet)=1$, the transition probabilities for all other arcs equal to 1.

The multitude ***X*** of all parameter nodes in the system can be represented as:

$$\boldsymbol{X}=P^{(g)} \cup \bigcup_{i=1..M^{(t)}} P^{(t)}_i \cup \bigcup_{i=1..M^{(s)}} P^{(s)}_i \,, \qquad (1)$$

where $P^{(g)}$ is the multitude of generator parameters; $P^{(t)}_i$ – the multitude of *i*-terminal parameters; $M^{(t)}$ – the number of parameters in the QNM; $P^{(s)}_i$ – the multitude of *i*-server parameters; $M^{(s)}$ – the number of servers in the QNM.

The multitude ***Y*** of all system characteristics is represented as:

$$\boldsymbol{Y}=H^{(sys)} \cup \bigcup_{i=1..M^{(s)}} H^{(s)}_i \,, \qquad (2)$$

where $H^{(sys)}$ is the multitude of system characteristics; $H^{(s)}_i$ – the multitude of *i*-server characteristics; $M^{(s)}$ – the number of servers in the QNM.

The following set of parameters is formed for the construction of functional relationships

$$Y^{(v)}=f(X^{(v)}, X^{(c)}, c^1_{start}, t^1_{end}, c^{cm}_{start}, t^{cm}_{start}), \qquad (1)$$

$X^{(v)}=\{x^{(v)}_j\}$ – the multitude of system nodes' variable parameters,

$j=1..K^{(v)}$, with $K^{(v)}$ being the number of system nodes' variable parameters,

$X^{(v)} \subseteq \boldsymbol{X}$, with $\boldsymbol{X}$ being – the multitude of all parameter nodes in the system.

$X^{(c)}=\{x^{(c)}_j\}$ – the multitude of system nodes' invariable parameters,

$j=1..K^{(c)}$, with $K^{(c)}$ being the number of system nodes' invariable parameters,

$X^{(c)}=\boldsymbol{X}/X^{(v)}$, $K^{(v)}+K^{(c)}=|\boldsymbol{X}|$

$Y^{(v)}=\{y^{(v)}_j\}$ – the multitude of dimensional vectors N, one per each output (the one for which to the relation of variable parameters and system nodes is built) system or node characteristic.

$Y^{(v)} \subseteq \boldsymbol{Y}$, with $\boldsymbol{Y}$ being the multitude of all system and node characteristics.

$|\{i\}|=|x^{(v)}_j|=|y^{(v)}_j|=N$

$<c^1_{end}, t^1_{end}>$ – value of the number of processed applications and modeling time for stop condition of one model run;

$<c^{cm}_{start}, t^{cm}_{start}>$ – value of the number of applications processed and simulation time for the condition to start collecting statistics during each model run.

Thus, there has been developed a simulation model in the form of a nine-phase QNM (Fig. 6) for the registration process, accounting and control of components repair order execution (Fig. 7). FIFO is used as a service discipline [6 – 12].

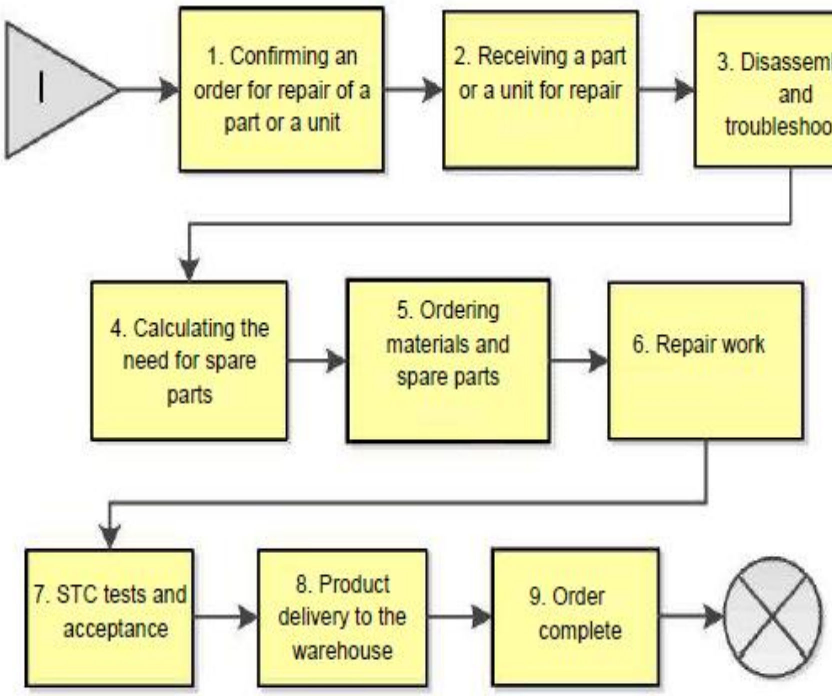


Fig. 6. Nine-phase QNM model for order execution

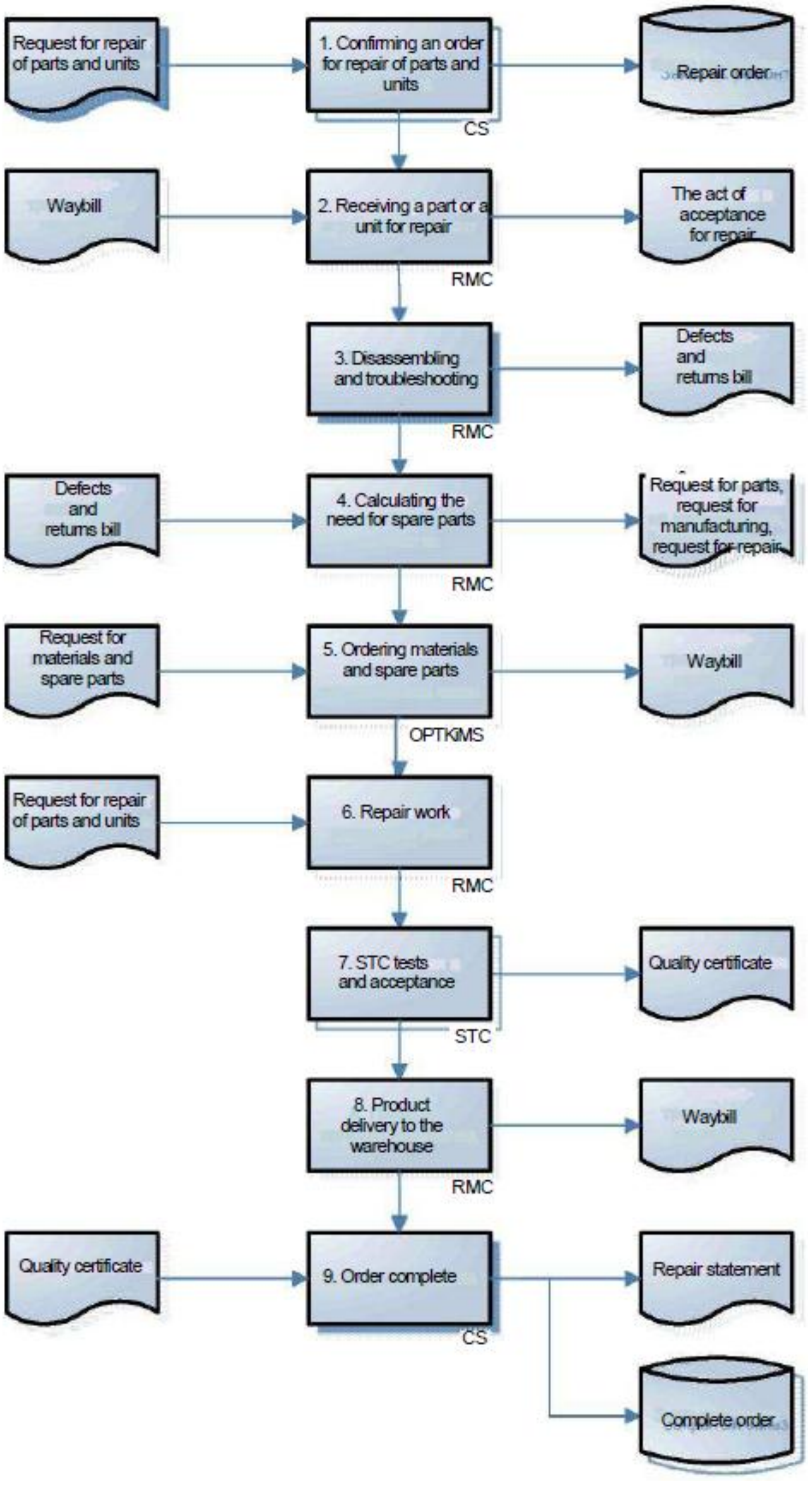
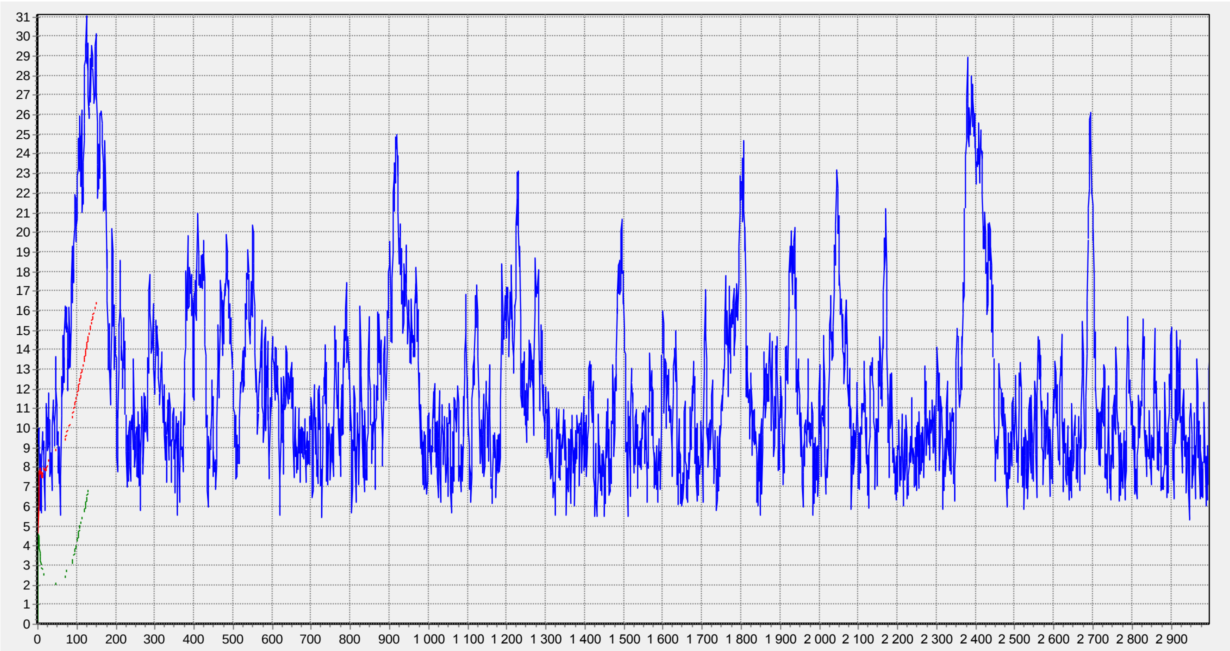
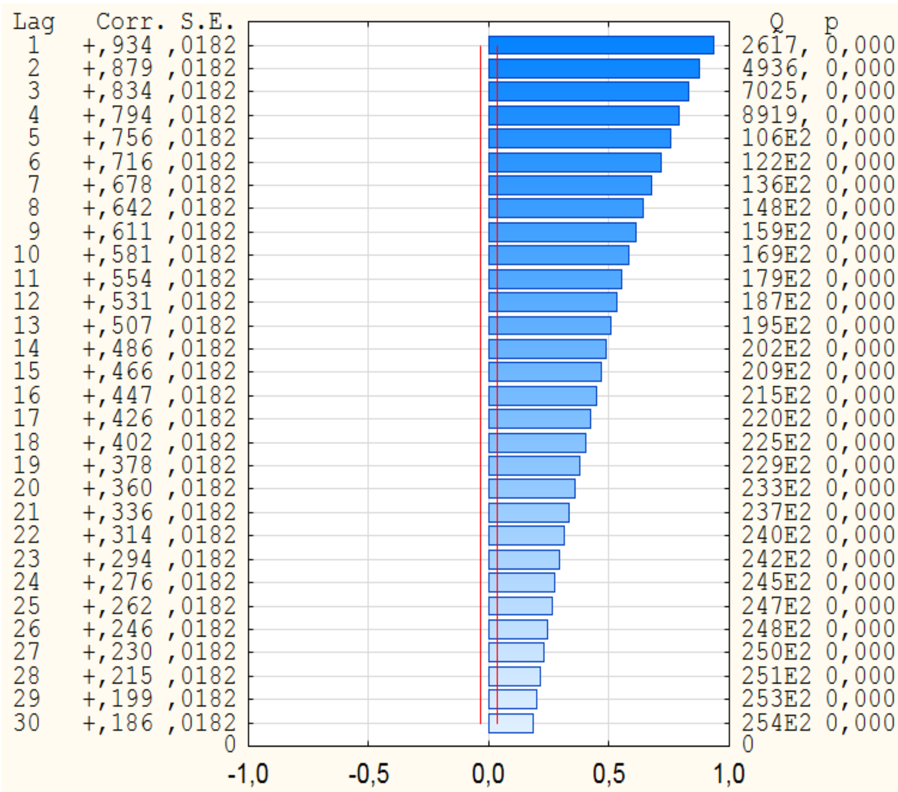


Fig. 7. Process description

For the uniform intensity distribution of applications received and the implementation of the operations λ~R(1.5, 5), μ_1~R(0.2, 0.5), μ_2~R(0.3, 0.5), μ_3~R(1, 3), μ_4~R(0.3, 0.6), μ_5~R(0.4, 0.5), μ_6~R(1, 5), μ_7~R(0.5, 1), μ_8~R(0.5, 0.6) and μ_9~R(0.1, 0.2), sample path diagram of the process and the autocorrelation function of its implementation time are shown in Fig. 8.



a) sample path of the process



b) autocorrelation function

Fig. 8. Characteristics of repair order execution

Analysis of the process time autocorrelation function showed that it has overextended nature, i.e. the process is rather slow.

V. CONCLUSION

Thus, we have carried out a systematic analysis of the methods and models used to describe production and technological processes in industrial enterprises and associations, organizational structures, process control and business games aimed at assessing the personnel qualifications in terms of the effectiveness of decision-making.There has been developed a formalized process-oriented description of the parallel to serial execution of process flow diagrams' individual stages in the common space of resources (such as technological lines, personnel, energy resources, etc.), which allows to implement the mechanisms of modeling and parameterization of local environments of the individual processes.

REFERENCES

[1] K.A. Barinov, A.V. Ostrouh, M.N. Krasnyanski, P.S. Rozhin, N.E. Surkova Implementing the innovative multimedia methodological complexes in the learning process // Vestnik MADI (GTU), issue 1 (8) / MADI (GTU). – M., 2007. – pp. 89-94.

[2] K.A. Barinov, A.V. Ostroukh, N.E. Surkova Implementation of the business games in computer-based learning systems // Open and distance learning, № 3 (27), Tomsk state university 2007. – pp. 28-33.

[3] K.A. Barinov, D.A. Burov, M.N. Krasnyanski, A.V. Ostroukh Development and testing of electronic educational resources of new generation distance learning // Nauchnyj vestnik MGTU-GA, issue №141 / MGTU GA. - M., 2009. - pp. 181-188.

[4] K.A. Barinov, A.V. Bugaev, D.A. Burov, A.V. Ostroukh Development of role playing games for training and re-training of the production plant and transportation of industry personnel // Nauchnyj vestnik MGTU GA, issue №141 / MGTU GA. - M., 2009. - pp. 189-197.

[5] K.A. Barinov, D.L. Dedov, M.N. Krasnyanski, A.V. Ostrouh, A.A. Rudnev Virtual training complexes for the training of the chemical and Virtual'nye trenazhernye kompleksy dlja obuchenija i treninga personala himicheskih i mechanical engeneering industries // Vestnik TGTU. Volume 17. № 2. - Tambov, 2010. - pp. 497-501.

[6] K.A. Barinov, A.B. Vlasov, V.Yu. Stroganov, G.G. Yagudaev Formation of the organizational management structure of the production plant using multipart business games. // Science and Education. Moscow State Technical University named after N. E. Bauman. Electronic magazine 2011. № 8. Online access: http://technomag.edu.ru/doc/206805.html (connection date 27.09.2013).

[7] K.A. Barinov, A.A. Solncev, P.A. Timofeev, V.M. Rachkovskaya Application of business game tools to the problems of the management of production in the highly competitive environment. // Science and Education. Moscow State Technical University named after N. E. Bauman. Electronic magazine 2011. № 9. Online access: http://technomag.edu.ru/doc/207618.html (connection date 27.09.2013).

[8] K.A. Barinov, B.S. Goryachkin, L.V. Ivanova, A.B. Nikolaev Formal models of representation and organization of business games // Moscow State Technical University named after N. E. Bauman. Electronic magazine 2011. № 9. Online access: http://technomag.edu.ru/doc/207391.html (connection date 27.09.2013).

[9] K.A. Barinov, O.B. Rogova, D.V. Stroganov Correlation between the educational plan modules. // The world of Scientific discoveries, issue № 9 (21) / Scientific Research Center – Krasnoyarsk, 2011. – pp. 28-34.

[10] K.A. Barinov, L.V. Ivanova, E.Yu. Tolkaev, G.G. Yagudaev Intellectualization of the test controls in the open education // The world of Scientific discoveries, issue № 9 (21) / Scientific Research Center – Krasnoyarsk, 2011. – pp. 86-92.

[11] K.A. Barinov, M.I. Kartashev Methods and algorithms of adaptive computer-based testing / // The world of Scientific discoveries, issue № 9 (21) / Scientific Research Center – Krasnoyarsk, 2011. – pp. 93-106.

[12] K.A. Barinov, L.V. Ivanova, K.A. Nikolaeva Quality evaluation of the heterogeneous testing // The world of Scientific discoveries, issue № 9 (21) / Scientific Research Center - Krasnoyarsk, 2011. - pp. 126-130.

[13] K.A. Barinov, M.N. Krasnyanski, A.Yu. Malamut, A.V. Ostroukh, G.G. Yagudaev Algorithm of the virtual training complex for re-training of petrochemical company personnel // The world of Scientific discoveries, issue № 2.6 (26) / Scientific Research Center - Krasnoyarsk, 2012. - pp. 168-174.

[14] K.A. Barinov, A.V. Ostroukh Application of the module-competentive approach in development of electronic educational resources for an e-learning system of professional education institution // Engineering Competencies - Traditions and Innovations. Proceedings, 37-th International IGIP Symposium 2008. - Moscow, Russia, 7-10 September, 2008. - C. 253-254.

[15] K.A. Barinov, M.N. Krasnyanskiy, A.J. Malamut, A.V. Ostroukh Algorithm of the Virtual Training Complex Designing for Personnel Retraining on Petrochemical Enterprise // International Journal of Advanced Studies 2, № 3 (2012). DOI: 10.12731/2227-930X-2012-3-6.

[16] D. Astakhov, A.V. Budikhin, A.V. Ostroukh Distance training as the basic form of the educational process // Information and Telecommunication Technologies in Intelligent Systems: Proceeding of Third International Conference. June 02 - 09, 2005, Santa Ponsa/Mallorca, Spain. pp. 169-173.

[17] E.N. Malygin, M.N. Krasnyansky, S.V. Karpushkin, Y.V. Chaukin, A.V. Ostroukh Application of virtual simulators for training students of the chemical technology type and improvement of professional skills of chemical enterprises personnel // Vestnik TSTU. - 2007. - V.13. – No 1B. - pp.233-238.

[18] K.A. Barinov, O.V. Chudina, A.V. Ostroukh, L.G. Petrova Methodical approach to the development of innovative multimedia teaching complex on material science // Joining Forces in Engineering Education Towards Excellence Proceedings, SEFI and IGIP Joint Annual Conference 2007. July 1-4, 2007, Miskolc, Hungary, pp. 127-128.

[19] L.G. Petrova, Y.P. Shkitskiy, A.V. Ostroukh Application of multimedia resources for technical teachers training // Engeneering competencies –tradition and innovation. Proceedings of the 37th International IGIP Symposium, September 7-10, 2008, Moscow, Russia. - pp. 117-118. - ISBN 978-5-7962-0093-3.

[20] Ostroukh A.V., Nikolaev A.B. Development of virtual laboratory experiments in iLABS environment. International Journal Of Applied And Fundamental Research. – 2013. – № 2 – URL: www.science-sd.com/455-24313 (20.11.2013).

[21] Ostroukh A.V., Nikolaev A.B. Development of virtual laboratory experiments in iLabs // International Journal of Online Engineering (IJOE). 2013. Vol. 9, No 6. pp. 41-44. DOI: 10.3991/ijoe.v9i6.3176.