## CREATING A DOCUMENT WORKFLOW FOR EXAMPLE SCIENTIFIC ORGANIZATIONS (p. 4-9)

**Viacheslav Polinovskyy, Vladimir Brustinov, Vera Malkina, Maxim Ogurtsov**

Development methods of workflow for electronic document management systems (EDMS) in scientific organizations were proposed. The main forms of documents in scientific organizations were discovered. The generalized classification of documents according to their types and subtypes was created.

The appropriate keywords for each document category were discovered. EDMS subsystem distribution was completed, their functions and purpose were highlighted. Based on the built architectures of EDMS separate subsystems, the generalized EDMS architecture of scientific institutions was proposed.

This is the architecture of the flow (workflow) of scientific and technical papers of electronic document management system that takes into account the use in scientific institutions. Design and implementation of EDM under the proposed architecture and techniques allow more efficient use of EDMS in scientific organizations. It should be noted the following:

1. Not all of EDF, present on the market today have sufficient flexibility to implement the proposed techniques and architecture.

2. The question of increasing the EDMS efficiency in scientific organizations after implementation of the proposed architecture requires additional study.

In addition, the maximum effect can be achieved by implementing a standardized EDMS in scientific organizations of all levels, ranging from the National Academy of Sciences of Ukraine (NASU ).

In this case, all the scientific workflow in the country will be paperless, will facilitate scientific cooperation between scientific organizations and all levels of scientific management institutions of NAS and make it transparent for users. Sending e-mails will be performed using standardized procedures and protocols of interaction

**Keywords**: electronic document management system, workflow, architecture, electronic documents, categories of documents, scientific organizations

### References

1. Zakon Ukrainy Pro elektronni dokumenty ta elektronnyi dokumentoobih. Vidomosti Verkhovnoi Rady Ukrainy (2003). (Iz zminamy, vnesenymy zghidno iz Zakonom N 2599-IV (2599-15), N 26, st.349).
2. Federalnyi zakon ot 10 yanvaria 2002 hoda N 1-FZ "Ob elektronnoi tsyfrovoi podpysy" (2002). Sobranye zakonodatelstva Rossyiskoi Federatsyy, Vol. 2, 127.
3. Primirna instruktsiya z dilovodstva v mistsevih organah vikonavchoï Vlady (2000). Znannya, 94.
4. Polinovskyi, V. V., Ogurtsov, M. I. (2010). Vprovadzhennia systemy elektronnoho dokumentoobihu v naukovii orhanizatsii. Visnyk Khmelnytskoho natsionalnoho universytetu, Vol. 4, 60–69.
5. Dyatlova, N. (2007). Documentatsiya v informatsionnom obshestve: sovremennye tehnologiyi documentooborota. Archivy i spravavodstva, 1, st. 44–48.
6. Shariff, M., Bhandari, A., Choudhary, V., Majumdar, P. (2009). Alfresco 3 Enterprise Content Management Implementation. Birmingham: Packt Publishing, 573.
7. Kostyuk, O. O. (2010). Virtualne pidpriemstvo: zadachi pobudovi sistemi electronnogo dokumentoobigu. Naukovi pratsi DonNTU, 171, 153–160.
8. Klimenko, I. V. Linov, K. O., Gorbenko, I. D., Onoprienko, V. V. (2009). Electronnuy dokumentoobig v derjavnomy upravlinni: Navchalna posibnik. Vyd-vo "Fort", 232.
9. Wang, Z., ter Hofstede, A. H. M., Ouyang, C., Wynn, M., Wang, J., Zhu, X. (2014). How to guarantee compliance between workflows and product lifecycles. Information Systems, 42, 195–215.
10. Niels, Lohmann (2013). Compliance by design for artifact-centric business processes. Information Systems, Vol. 38:4, 606–618.
11. Sheng, Liu, Yushun, Fan (2014). Workflow performance analysis and simulation based on multidimensional workflow net. Computers in Industry, Vol. 65:2, 333–344.
12. Smanchat, S., Indrawan, M., Ling, S., Enticott, C., Abramson, D. (2013). Scheduling parameter sweep workflow in the Grid based on resource competition. Future Generation Computer Systems, Vol. 29:5, 1164–1183.
13. Accorsi, R., Lehmann, A., Lohmann, N. (2014). Information leak detection in business process models: Theory, application, and tool support. Information Systems, Vol. 41, 67–82.
14. Borgdorff, J., Falcone, J., Lorenz, E., Bona-Casas, C., Chopard, B. Alfons, G. (2013). Hoekstra Foundations of distributed multiscale computing: Formalization, specification, and analysis. Journal of Parallel and Distributed Computing, Vol. 73:4, 465–483.
15. Van Beek, T., Tomiyama, T. (2012). Structured workflow approach to support evolvability. Advanced Engineering Informatics, Vol. 26:3, 487–501.
16. Perelik dokumentiv, shcho utvoriuiutsia v diialnosti NAN Ukrainy ta yii ustanov, iz zaznachenniam strokiv zberihannia dokumentiv (2005). Naukovo-normatyvne vydannia. Natsionalna biblioteka Ukrainy im. V. I. Vernadskoho, 280.
17. Polinovskyi, V. V., Ogurtsov, M. I. (2010). Arkhitektura ta metody system elektronnoho dokumentoobihu naukovoi ustanovy. Inzheneriia prohramnoho zabezpechennia. – Kyiv, Natsionalnyi aviatsiinyi Universytet, Vol. 1 (9), 66–72.
18. Wang, Z., Wang, J., Zhu, X., Wen, L. (2012). Verification of workflow nets with transition conditions. Journal of Zhejiang University SCIENCE C, Vol. 13:7, 483–509.
19. Krukovskyi, M. Yu. (2006). Praktychnyi rozrakhunok efektyvnosti systemy elektronnoho dokumentoobihu. Systemy podderzhky pryniatyia reshenyi. SPPR, Vol. 2, 149–163.

## MODEL OF THE INFORMATIONAL ENVIRONMENT OF THE VIRTUAL COMMUNITY (p. 10-16)

**Andrii Peleshchyshyn, Ruslan Huminskiy**

The environment, in which virtual communities in social networks function, is analyzed in the paper, and it was found that it corresponds to the information environment properties and functions. Thus, virtual community information environment consists of external and internal information environment. Virtual community information environment model, created using social networking services, consisting of external and internal information environment models is proposed. The virtual community internal information environment model is detailed, and a vector-space model of the virtual community for analyzing its structure and content is built. Methods for determining the virtual community key features, namely the centroids of virtual community and discussion, the compliance measure of thematic direction of messages in the discussion and the matrix of relations between discussions in the virtual community that characterize internal information environment structure and virtual community content and are essential for the information en-

vironment formation, are developed. The developed external and internal information environment models and virtual community key features identifying methods are the basis for further studies of the virtual community functioning process taking into account the content, the number of virtual community participants and the structure of relations between elements (discussions) in the virtual community

**Keywords**: social networks, virtual communities, information environment, discussions, content, model

### References

1. Peleschyshyn, A. M., Serov, U. O., Berezko, O. L., Peleschyshyn, O. P., Tymovchak-Maksymets, O. U., Markovec, O. V. (2012). The process of managing interactive social communication in the Information Society, Lviv: Publishing House of Lviv Polytechnic, 368.
2. Dodonov, A. G., Lande, D. V. (2011). Survivability of information systems, Kiev: Publishing house " Scientific Thought", 256.
3. Peleschyshyn, A. M., Kravets, R. B., Serov, U. O., Fedushko, S. S. (2010). Methods for tracking unwanted information content Web Forum, Proceedings of the National University "Lviv Polytechnic": Information Systems and Networks, Vol. 689, 303-312.
4. Peleschyshyn, A. M., Kravets, R. B., Serov, U. O. (2011). Analysis of existing types of virtual communities on the Internet and build a model of a virtual community-based forum, Proceedings of the National University "Lviv Polytechnic": Information Systems and Networks, Vol. 699, 212-221.
5. Serov, U. O., Kravets, R. B., Peleschyshyn, A. M. (2009). Methods for analyzing the effectiveness of web forums, Proceedings of the National University "Lviv Polytechnic": Information Systems and Networks, Vol. 653, 197-206.
6. Serov, U. O., Peleschyshyn, A. M., Sloboda, K. O. (2009). Analysis of communication processes in Web Web 2.0 community environment, Eastern-European Journal of Enterprise Technologies, Vol. 1, N 3(37), 38-41.
7. Melyuhin, I. S. (1999). The concept of the management of the formation, use, management and protection of the information environment, Moscow: VINITI, 150,
8. Schrader, U. A. (2000). Information processes and information environment, St. Peterburg: Publishing House " Symbol-Plus",169.
9. Lande, D. V. (2006). Fundamentals of integration of information flows, Kiev: Publishing house Engineering, 240.
10. Solton, G. (1979). Dynamic information and Library processing, Moscow: Publishing house "Peace", 558.

## DETERMINATION OF THE SET OF VIRTUAL COMMUNITIES INDICATORS FOR HIGHER EDUCATION INSTITUTIONS (HEI) (p. 16-23)

**Andriy Peleshchyshyn, Roman Korzh, Olha Trach**

Virtual communities of the Internet users are one of the most promising environments of information activities of higher education institution (HEI). However, a significant number of thematically relevant communities for HEI creates the selection problem from the set of those, which are the most relevant from the point of view of the other criteria.

A set of virtual community indicators for higher education institutions, namely: technological, quantitative, social relevance, communication values, communication complexity and thematic relevance, is defined in the paper. Groups of characteristics, which are included in the directory model of virtual communities and which are the basis for determining indicators, are considered. The given groups of indicators and characteristics are obtained as a result of the direct analysis of virtual communities, are in fact the primary data on communities and further characterize them compared to traditional websites. These characteristics allow increasing opportunities to optimize a staffing process and quality control

of performing the duties as they are included in the formal model and in the architecture of the management system of HEI information activities

**Keywords**: virtual community, technological

### References

1. Kalashnukov, L. (2005). Channels of communication cooperation of institution of higher learning with society: short analysis. Management of sociology. Sir.Special of and of a particular branch sociology. Doneck: DONDUU, 125–134.
2. Grigoryev, S., Grishkun, V., Krasnova, G. (2004). Basic principles and methods of using portals system in educational process. Collection of scientific articles Internet portals: content and technology, 56–84.
3. Gridina, I., Chunnova, I., Yakuvchuk, I. (2006). Metadata specifications for the storage and transport of digital educational resources of unified collection of e-learning materials for the systems of General and primary professional education. Proceedings of the international conference «Information technologies and telecommunications in education and science», Vladivostok, 35–38.
4. Savchenko, Z. (2010). Formation and use of electronic informational scientific-educational resources. Information technologies and means of teaching. Vol. 4 (18). Available at: http://www.ime.edu-ua.net/em.html.
5. Antonenko, I., Barkova, O. (2010). Electronic resources as the object cataloging background, terminology, aspect software. National library of Ukraine named. Century Vernadsky. Kiev. Available at: http://sasl.at.ua/publ/8-1-0-44.
6. Peleshchyshyn, A., Syerov, Yu., Berezko, O., Peleshchyshyn, O., Tymovchak-Maksymets, O., Markovets, O. (2012). Procesy upravlinnya interaktyvnymy social'nymy komunikaciyamy v umovax rozvytku informacijnogo suspil`stva. Lviv Polytechnic National University Publishing House, 368.
7. Peleshchyshyn, A. (2007). Pozytsionuvannia saitiv u hlobal'nomu informatsiinomu seredovyshchi. Lviv Polytechnic National University Publishing House, 258.
8. Fedushko, S., Peleschyshyn, O., Peleschyshyn, A., Syerov, Yu. (2013). The verification of virtual community member's socio-demographic characteristics profile. Advanced Computing: An International Journal (ACIJ), 29–38. Available at: http://airccse.org/journal/acij/papers/4313acij03.pdf.
9. Shelestova, A. M. (2010). Electronic debenture communication of modern university: progress trends. Announcer of the Book chamber, 9, 27–33.
10. Robert, I., Panykova, S., Kyznecov, A., Kravcova, A. (2008). Information and communication technologies in education : teaching method. Manual. Moscow, Bustard, 312.
11. Braslavski, P., Braslavski, P., Vovk, E., Maslov, M. (2002). Faceted organization of the Internet-catalogue and automatic genre classification of documents. Computational linguistics and intellectual technologies seminar "Dialogue-2002", 83–93.
12. Kavalec, M., Svàtek, V. (2002). Information Extraction and Ontology Learning Guided by Web Directory. Machine Learning and Natural Language Processing for Ontology Engineering. Lyon, France.

## DEVELOPMENT OF THE SUBJECT DOMAIN ASSOCIATION METHOD WITH THE ONTOLOGICAL OBJECTS (p. 23-28)

**Volodimir Malyshkin**

One of the text recognition problems in the Internet is the use of diverse sources of information when searching. For solving this problem, it is necessary to teach the system to coordinate sources in the application context.

This research suggests to consider the concept of automatic data extraction method using the text recognition and meaning of any subject area. The concept is based on using ontological systems and existing algorithms of syntactic and morphological text analysis. The system is designed to extract meaning from a text based on the text decomposition algorithms. Various kinds of relationships between the

elements of ontologies for creating a link between them are given. Thus, it is possible to describe information sources by ontologies to obtain the necessary information as data and concepts.

This system offers the user only important information, which clearly and precisely responds to the user request, which was addressed to the system

**Keywords**: ontology, specification, context, technology, object, class, link, text

### References

1. Bellandi, A., Nasoni, S., Tommasi, A., Zavattari, C. (2010). Ontology-Driven Relation Extraction by Pattern Discovery. In Information Process, and Knowledge Management, 2010. eKNOW 10. Second International Conference, 1–6.
2. Carlson, A., Betteridge, J., Kisiel, B., Settles, B., Hruschka Jr., E. R., Mitchell, T. M. (2010). Toward an Architecture for Never-Ending Language Learning, Proc. of Conference on Artificial Intelligence (AAAI).
3. Skvortsov, N., Kalinichenko, L. (2000). An Approach to Ontological Modeling and Establishing Intercontext Correlation in the Semistructured Environment 2-nd Russian Scientific Conference. Digital Libraries: Advanced Methods and Technologies, Digital Collections. Protvino, Russia.
4. Kalinichenko, L., Skvortsov, N. (2002). Extensible ontological modeling in 4-th Russian Scientific Conference Digital Libraries: Advanced Methods and Technologies, Digital Collections. Dubna, Russia.
5. Kalinichenko, L., Skvortsov, N. (2004). Ontology reconciliation in terms of type refinement in 6-th Russian Conference, Digital Libraries RCDL2004. Pushchino, Russia.
6. Jannink, J. (1999). An Algebra for Semantic Interoperation of Semistructured Data, IEEE Knowledge and Data Eng. Exchange Workshop. Los Alamitos, Calif.
7. Xue, D., Palmer, M. (2007). Automatic semantic role labeling for verbs in 6-th Nineteeth International Joint Conference, Artificial Intelligence.
8. Borgest, N. (2010). Ontology design: theoretical foundations. Part 1. Concepts and principles. Samara, Russia.
9. Asnicar, F., Tasso, C. (1997). A prototype of user model-based intelligent agent for document filtering and navigation in the World Wide Web in 6-th International Conference on User Modeling, Adaptive Systems and User Modeling on the World Wide Web. Chia Laguna, Italy.
10. Guarino, N., Welty, N., Welty, C. (2000). Ontology-Driven Conceptual Modeling In Proceedings of ECAI-2000. The European Conference on Artificial Intelligence. USA.
11. Guarino, N. (1998). Formal Ontology and Information Systems in 1st International. The International Conference. Trento, Italy.
12. Martin, D., Burstein, M., Lassila, O., Paolucci, M., Payne, T., McIlraith, S. (2013). Describing Web Services using OWL-S and WSDL in 6-th International Conference. Massachusetts, US.
13. Kogalovskii, M., Kalinichenko, L. (2012). Conceptual modeling and ontological models. Proceedings of the Symposium. Zvenigorod, Russia.
14. Rizzo, G., Troncy, R., Hellmann, S., Bruemmer M. (2012). NERD meets NIF: Lifting NLP Extraction Results to the Linked Data Cloud, Proc. of 5th Workshop on Linked Data on the Web (LDOW).

## SOFTWARE AND INFORMATION SUPPORT OF DIAGNOSIS DURING MAINTENANCE OF RADIO ELECTRONIC MEANS (p. 29-33)

**Kostiantyn Kasian, Mykola Kasian**

Despite the widespread use of automation means during design of radio electronic means (REM), little attention is still paid to automation means during maintenance of REM. The ways to automate the processes of monitoring and diagnosing the technical condition of REM during maintenance are proposed in the paper. In the process of diagnosing, it is necessary to solve the problem, opposite to the design problem, i.e. to determine the values of REM internal parameters by the values of output characteristics. It is possible to do at the presence of an effective and scalable computer-aided design (CAD) system, as well as a clear methodology for selecting informative test input actions and controlled output characteristics of RES. Thus, the success of the subsequent diagnosis and maintenance as a whole, is laid during the REM design, when it is necessary to have as much accurate mathematical models of the elements that make up the REM as possible, and ensure the REM diagnosability by determining what test actions to feed and what output characteristics to measure.

The diagnosis problem is proposed to solve by the parametric optimization method based on the root-mean-square criterion using functions of REM output characteristics sensitivity to change in the values of its internal parameters. Building network systems, based on already used CAD systems, with an open distributed architecture would allow to solve the design and maintenance problems more efficiently in terms of both replenishing the element model libraries, and reducing the computation time

**Keywords**: life cycle, maintenance, technical condition, diagnosis, sensitivity function

### References

1. Norenkov, I. P., Kuzmik, P. K. (2002). Information support of high technology products. CALS-technologies. Moscow: Publisher MSTU N.E. Bauman, 320.
2. Fitzpatrick, D. (2012). Analog Design and Simulation using OrCAD Capture and PSpice. Newnes, 344.
3. Attia, J. O. (2010). SPICE and MATLAB for Electronics: An Integrated Approach, Second. CRC Press, 356.
4. Keoun, J. (2008). OrCAD PSpice. Analysis of electric circuits. Moscow: DMK Press; St. Petersburg: Piter, 640.
5. Sabunin, A. E. (2009). Altium Designer. New solutions in the design of electronic devices. Moscow:Solon-Press, 432.
6. Wang, L., Chang, Y., Cheng, K. (2009). Electronic Design Automation: Synthesis, Verification, and Test. Morgan Kaufmann, 971.
7. Maheswari, L. K., Anand, M. M. S. (2009). Analog electronics. PHI Learning Pvt. Ltd., 704.
8. Sedra, A. S., Smith, K. C. (2010). Microelectronic Circuits (Oxford Series in Electrical and Computer Engineering) (6th Edition). Oxford University Press, 1456.
9. Wilson, P. (2013). Model-Based Engineering for Complex Electronic Systems. Elsevier Science, 536.
10. Palade, V., Bocaniala, C. D., Jain, L. (2006). Computational Intelligence in Fault Diagnosis. Springer, 362.
11. Blanke, M., Kinnaert, M., Lunze, M. J. (2006). Diagnosis and Fault-Tolerant Control. Springer, 691.
12. Witczak, M. (2007). Modelling and Estimation Strategies for Fault Diagnosis of Non-Linear Systems. From Analytical to Soft Computing Approaches. Springer, 223.
13. Ding, S. X. (2008). Model-based Fault Diagnosis. Springer, 493.
14. Halderman, J. D. (2012). Diagnosis and Troubleshooting of Automotive Electrical, Electronic, and Computer Systems (6th Edition). Pearson Education, Inc, 528.
15. Mazur, G. A., Proctor, T. E. (2010). Troubleshooting Electrical. Electronic Systems. ATP, 592.
16. Kasyan, K., Kasyan, N. (2006). Diagnosing of the radio-electronic equipment with the help of traditional systems of the automated designing. International conference TCSET'2006, 33–35.
17. Kasian, K. N. (1998). Development of a method of diagnosing electroradioelements analog functional units at the production stage. Publisher Moscow State Institute of Electronics and Mathematics (Technical University), 21.
18. Bunday, B. D. (1988). Basic Optimization Methods. Moscow: Radio and Communication, 128.
19. Nazarov, A. V., Loskutov, A. I. (2003). Neuronetwork algorithms of forecasting and optimization. Moscow: Science and technology, 384.

20. Petrov, D. V. (2002). Network system thermal design of microelectronic devices, multivariate relative constructively technological performance. Lviv: Publisher National Univ. "Lviv Polytechnic", 20.
21. Anisimov, D. A. (2013). Research and development of methods for constructing distributed CAD systems based on web services technology. St. Petersburg: Publisher St. Petersburg State Electrotechnical University "LETI", 18.

## RESEARCH OF MODELS OF ARCHITECTURES FOR SERVER APPLICATIONS OF CORPORATE INFORMATION SYSTEMS (p. 34-38)

**Dmitry Mikhnov, Elena Kurilina**

Analysis of existing models of architectures, used to design and build server applications of corporate information systems was conducted in the paper.

Currently, corporate information systems are widely used to improve efficiency and minimize costs of administration. Modern level of various software offers of the server part of information system promotes the development and improvement of these systems.

Therefore, the task of choosing a rational model of architecture for the server application of corporate information system is urgent.

As a result of studies, it was found that non-linear models of architectures are expedient to use for corporate information systems. Modification, based on allocating from the queue those inquiries to the system, which require connection to the database for recording, was proposed. This modification has allowed to improve the system indicators such as inquiry processing time, horizontal scalability, bandwidth.

Thus, more flexible model of the architecture for server applications of corporate information systems, which allows to reduce the total cost of the developed software due to more flexible load distribution on the hardware was obtained.

**Keywords**: model of architecture, simulation, integral criterion of efficiency, modified model

### References

1. MacCormack, A. (2013). The True Costs of Software. Available at: http://www.computerworld.com/s/article/81590/The_True_Costs_of_Software?pageNumber=1/.
2. Fowler, M. (2006). Patterns of Enterprise Application Architecture. Addison Wesley, 560.
3. Brown, K. (2003). Enterprise Java Programming with IBM WebSphere. IBM Press, 960.
4. Deepak, A. (2001). Core J2EE Patterns: Best Practices and Design Strategies. Sun Microsystems Press, 393.
5. Parsons, D. (2004). An Architectural Pattern for Designing Component-Based Application Frameworks. Institute of Information and Mathematical Sciences, 449.
6. Marinescu, F. (2002). EJB Design Patterns. Wiley Computer Publisher, 259.
7. Sztrik, J. (2012). Basic Queueing Theory. University of Debrecen, Faculty of Informatics, 193.
8. Gorov, A. (2009). Monitoring of Hardware Server. Available at: http://ashirobokov.blogspot.com/.
9. Norenkov, I., Fedoruk, E. (1999). Simulation modeling of queuing systems. Moscow State Technical University Of Bauman. Available at: http://gpss.h11.ru/norenkov.php.
10. Astakhov, A. Concise (2009). Dictionary of major legal, economic and environmental terms and concepts. Publishing House "Williams", 383.
11. Gubar, Y. (2012). Introduction to mathematical modeling, Lecture 5: "Computer simulation. Statistical simulation." Intuit.ru, 223.
12. Sharov, P. (2013). Total Cost of Ownership and IT Available at; http://userdocs.ru/informatika/754/index.html?page=4.

## EXPERIMENTAL PERFORMANCE EVALUATION OF USING MULTISET METRICS IN INFORMATION RETRIEVAL PROBLEMS (p. 38-43)

**Dmytro Nehurytsia**

The problem of the comparative experimental performance evaluation using multiset metrics in information retrieval problems is considered in the paper. The main purpose of the studies is to prove on the basis of actual experimental data, the feasibility of using multisets, as a fundamentally new mathematical tool, in information retrieval problems. As a result of the preliminary statistical analysis of the available data set ''Anonymouswebdatafromwww.microsoft.com'', specific features and problems of information search in the Internet space are identified. As the main performance indicator of information retrieval the "half-life of usefulness", which predicts the user the usefulness of a list of recommended facilities, taking into account the user's partial view of a list of recommendations, is used. The calculated values of the performance indicator of information retrieval are compared with the results of similar studies on the effectiveness of traditional, alternative methods of information retrieval. It is shown that the use of metric multisets in information retrieval problems improves the quality of information retrieval

**Keywords**: WEB-oriented systems, adaptive algorithms, information retrieval, performance criteria, multiset

### References

1. Beck, J., Stern, M., Woolf, B. (1997). Using the student model to control problem difficulty. User Modeling, UM97, 277–288.
2. Ivanchenko, D. A. (2005). System analysis of distance learning. Union, 192.
3. Petchurai, O. Sombunsukho, S., Nanthawong, C., Atanan, T., Wechsopon, S., Atanan, Y. (2011). Developing on-line information systems for searching digital media. WIETE Annual Conference on Engineering and Technology Education. Pattaya, 43-45.
4. Wood, D. (2010). Linking Enterprise Data, Springer, 317.
5. Mourlas, C., Germanakos, P. (2009). Intelligent User Interfaces: Adaptation and Personalization Systems and Technologies, IGI Global Snippet, 426.
6. De Bra, P., Houben, G. J. , Wu, H. (1999). AHAM: A Dexter-based Reference Model for Adaptive Hypermedia, Proceedings of the ACM Conference on Hypertext and Hypermedia, Darmstadt, Germany, 147–156.
7. Fink, J. (2004). User Modeling Servers: Requirements, Design, and Evaluation, IOS Press, 189.
8. Seffah, A., Javahery, J. (2005). Multiple User Interfaces: Cross-Platform Applications and Context-Aware Interfaces, Wiley & Sons, 414.
9. Kules, B. User Modeling for Adaptive and Adaptable Software Systems. Available at: http://www.otal.umd.edu/UUGuide/jingwu/ usermodel.htm.
10. Kobsa, A. Supporting User Interfaces for All Through User Modeling. Available at: http://www.ics.uci.edu/%7Ekobsa/papers/1995-HCI95-kobsa.pdf.
11. Yakovlev, Yu. S., Kurzantseva, L. I. (2006). On the application of ontologies to build a model user of information systems. Computer facilities, networks and systems, 5, 109–116.
12. Dening, V., Essing, G., Maas, S. (1984). Interactive system "man-computer." Adapting to the user's requirements. Mir, 110.
13. Skakun, S. V., Kussul, N. N. (2004). Neural network model of users of computer systems. Cybernetics and Computer Science, 143, 55–68.
14. Petrovskiy, A. B. (2003). Space sets and multisets. Editorial URSS, 248.
15. Vovk, O. L. (2008). Application multisets for ranking. Herald HNTU, 1 (30), 498–502.
16. Petrovsky, A. B. (1995). Metric spaces multisets. Reports of the Academy of Sciences, № 2, 175-177.

17. Anonymous. Available at: www.microsoft.com, http://kdd.ics.uci.edu/databases/msweb/msweb.data.html.
18. Breese, J. S., Heckerman, D., Kadie, C. (1998). Empirical analysis of predictive algorithms for collaborative filtering. Uncertainty in Artificial Intelligence (UAI-98). Morgan Kaufmann, San Francisco, 43–52.

## DEVELOPMENT OF EXPERT SYSTEM PROTOTYPE FOR FLEXIBLE REORIENTATION WOMEN'S OUTERWEAR PRODUCTION (p. 43-49)

**Svitlana Shapovalova, Olga Mazhara**

The garment industry quickly becomes a highly developed branch due to the rapid development of technologies that contribute to high-quality design, cutting, manufacture. However, some design stages have not yet been formalized. For solving unformalized tasks, the expert systems are used. The research deals with developing the expert system prototype for rapid reorientation of women's outerwear production. To form a subject environment, the textual method is used. Factor and cluster analyses are used to structure the subject environment. Thus, the main objective of the study is achieved by forming twelve individual tasks according to the number of individual groups, allocated in the subject environment of rapid reorientation of women's outerwear production. Selection rules of transformation chain and values of additions at the level of chest, waist and hips are formed in tables. In each table, results are obtained at the intersection of several conditions.

The expert system prototype for flexible reorientation of women's outerwear production is designed by using the empty expert system "Rapana". The expert system prototype implements a dialogue with the user as a series of questions and answers of the user. Some answers can have a degree of confidence. The user can revise the way of decision-making after obtaining the results. Thus, necessary conditions for further development of artificial intelligence methods in the garment production design training management and for reducing risks of wrong decision-making in conditions of rapid change in project situations are created

**Keywords**: transformation chain, expert system, flexible reorientation, production model, knowledge base

### References

1. Tamble, M., Kalp, D., Rosenbloom, P. S. (1991). Uni-rete: Specializing the rete match algorithm for the unique-attribute representation. Scholl of Computer Science, Carnegie Mellon University. Pittsburg : Computer Science Department, 30.
2. Gupta, A. (1987). Parallelism in Production Systems. London : Pitman, 255.
3. Friedman-Hill, E. (2003). Jess in Action: Java Rule-Based Systems. Greenwich: Manning Publications Co, 480.
4. Forgy, C. L. (1979). On the Efficient Implementation of Production System : PhD thesis. Computer Science Department, Carnegie Mellon University. Pittsburg, 356.
5. Brant, D. A., Gose, T., Lofaso, B., Miranker, D. P. (1991). Effects of database size on rule system performance: Five case studies. Morgan Kaufmann Publishers Inc. San Francisco, 287–296.
6. Miranker, D. P., Lofaso, B. J. (1991). The organization and performance of a treat-based production system compiler. IEEE Transactions on Knowledge and Data Engeneering, 3(1), 3–10.
7. Perlin, M. (1991). Incremental binding-space match: The linearized matchbox algorithm. Tools for Artificial Intelligence. IEEE Computer Society Press. San Jose, 468–477.
8. Wright, I., Marshall, J. (2003). The execution kernel of rc++: Rete*, a faster rete with treat as special case. International Journal of Intelligent Games and Simulation, 2 (1), 36–48.
9. McDermott, J., Newell, A., Moore, J. (1978). The efficiency of certain production system implementations. Pattern-Directed Inference Systems, 67, 155–176.
10. Miranker, D. P. (1990). TREAT: A New and Efficient Match Algorithm for AI Production Systems. London : Pitman/ Morgan Kaufmann, 144.
11. Nayak, P., Gupta, A., Rosenbloom, P. (1988). Comparison of rete and treat production matchers for soar (a summary). Artificial Intelligence. The MIT Press. Cambridge, 693–698.
12. Miranker, D. P. (1987). Treat: A better match algorithm for AI production systems. Artificial Intelligence. The MIT Press. Seattle, 42–47.
13. Wang, Y. Hanson, E. N. (1992). A performance comparison of the rete and treat algorithms for testing database rule conditions. IEEE Computer Society Press. Washington, 88–97.
14. Hanson, E. N., Hasan, M. S. (1993). Gator: An optimized discrimination network for active database rule condition testing. University of Florida. Gainesville : CIS Departement, 27.
15. Perlin, M., Debaud, J. (1989). Match box: Fine-grained parallelism at the match level. IEEE Computer Society Press. Fairfax, 428–434.
16. Lee, P., Cheng, A. M. K. (2002). Hal: A faster match algorithm. IEEE Transactions on Knowledge and Data Engeneering, 14 (5), 1047–1058.
17. Tan, J., Maheshwari, M., Srivastava, J. (1990). Gridmatch: A basis for integrating production systems with relational databases. IEEE Computer Society Press. Herndon, 400–407.
18. Dzharrantano, Dzh., Rajli, G. (2007). Jekspertnye sistemy: principy razrabotki i programirovanie. I.D. Vil'jams, 1152.
19. Scales, D. J. (1986). Efficient matching algorithms for the soar/ops5 production system. Scholl of Computer Science, Carnegie Mellon University. Pittsburg : Computer Science Department, 36.
20. Doorenbos, R. (1995). Production matching for large learning systems. Computer Science Department, Carnegie Mellon University. Pittsburg, 208.
21. Ishida, T. (1994). Parallel, Distributed and Multiagent Production Systems. Michigan : Springer, 172.
22. Kang, J. A., Cheng, A. M. K. (2004). Shortening matching time in ops5 production systems. IEEE Transactions on Software Engineering, 30 (7), 448–457.
23. Liu, D., Gu, T., Xue, J. (2010). Rule Engine based on improvement Rete algorithm. Apperceiving Computing and Intelligence Analysis. IEEE Computer Society Press. Chengdu, 346–349.
24. Sellis, T., Lin, C. C., Raschid, L. (1988). Implementing large production systems in a DBMS environment: concepts and algorithms. ACM Press. New York, 404–423.
25. Berstel, B. (2002). Extending the RETE algorithm for event management. Representation and Reasoning. IEEE Computer Society Press. Washington, 49–51.
26. Doorenbos, R. (1995). Production Matching for Large Learning Systems. Computer Science Department, Carnegie Mellon University. Pittsburg, 208.
27. Kang, J. A. (2004). Shortening matching time in OPS5 production. IEEE Transactions on Software Engineering, 30 (7), 448–457.
28. Scales, D. (1986). Efficient Matching Algorithms for the SOARlOPS Production System. Computer Science Department, Stanford University. Stanford, 58.
29. Kelly, M., Seviora, R. (1989). An evaluation of DRete on CUPID for OPS5 matching. Morgan Kaufmann Publishers. San Francisco, 84–90.
30. Batory, D. (1994). The LEAPS Algorithms. Computer Science Department, The University of Texas. Austin, 15.

## CHOOSING OPTIMAL PATTERN MATCHING ALGORITHM FOR DESIGNING PRODUCTION SYSTEM (p. 50-55)

**Oksana Zakharkevich, Anastasiya Pochuprin**

The main purpose of this study is to formalize the principles of representing the features of the production system and antecedents of productions for implementing the optimal pattern matching algorithm. Optimality of this choice deter-

mines the production system efficiency since the problem of pattern matching is the most memory and time-consuming.

When analyzing the experimental studies of the existing pattern matching algorithms, the main problem is that they involve different performance indicators, i.e. the characteristics for comparison may be selected so that they give preference to one of the algorithms in advance. Sample of universal characteristics of production system, taking into account the features of the solvable application task, including the properties of the antecedents of productions is proposed in the research. Based on the values of these characteristics, the estimate of each of the existing pattern matching algorithms can be calculated using the proposed schemes. The maximum value corresponds to the preferred algorithm. This choice, in turn, allows to determine or modify existing software tools for implementing computational formalism, based on the production model. An example of using the methodology for implementing a software module to define the technical state of NPP facilities is given. The research results can be used in designing the production system, aimed at solving the pre-formalized application task, mainly of technical and medical diagnostics

**Keywords**: production system, pattern matching, antecedent representation, production system shell

### References

1. Zakharkevich, O. V. (2013). Main approaches to developing of conceptual model of the expert system for rapid change in production of women's outerwear. Herald of Khmelnytskyi national university, 1, 207-211.
2. Slavinskaya, A. L. (2012). Methods of typical design : study guide. Khmelnitsky: Khmelnitsky national university, 159.
3. Slavinskaya, A. L., Shtompil, A. M. (2012). The concept of regulation flexibility of design and technological preparation of updated product range in terms of enterprise. Herald of Khmelnytskyi national university, 4, 173-178.
4. Zakharkevich, O. V. (2012). Developing of rational transformations chains of the women's shoulder clothing. Herald of Khmelnytskyi national university, 2, 73-76.
5. Zakharkevich, O. V. (2010). Development of joint basic design of the typological range of women's shoulder clothing. Proceedings of the Scientific Conference of the faculty of Technology and Design by results of research in 2009-2010. Khmelnitsky, 11–12.
6. Gnidenko, A. V, Yudin, L. P., Kuzmichev, V. E. (2007). Architecting expert system of quality assessment of clothes' designs. Sewing Industry, 5, 52-54.
7. Nigmatova, F. W., Alimov, H. A. (2009). Formation of industrial range of garments based on expert system. Sewing Industry, 2, 27-28.
8. Expert system for clothing style selection (2010-2012). Retrieved November 16, 2012 from moscow state university of design and technology, division of garments technic. Rushightech. know-how from russia. Available at: http://www.rushightech.com/en/technology/expert-system-clothing-style-selection.html.
9. Hao, Kuang-rong, Dong, Miao, Chen, Bin, Ding, Yong-sheng (2010). An Expert System for Special Body Shapes Recognition in Apparel Made-to-Measure. IEEE Xplore Digital Library. Available at: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5459854&url=http%3A%2F%2Fieeexplore.ieee.org.
10. Michele, Santos, Francisco, Rebelo (2007). An expert system to support clothing design process. ACM Digital Library. Retrieved March 20, 2014. Available at: http://dl.acm.org/citation.cfm?id=1784393.
11. Gavrilova, T. A., Khoroshevskiy, V. F. (2000). Knowledge Bases of Intelligent Systems. St. Petersburg, Peter, 384.
12. Expert system "Rapana". Available at: http://esrapana.narod.ru/.
13. Zhuravlev, Y. I., Ryazanov, V. V., Senko, O. V. (2005). "Recognition". Mathematical methods. Software system. Practical applications. Moscow. Fazis, 159.

## CONTROL SYSTEMS

**THE SYNTHESIS OF SYSTEM OF AUTOMATIC CONTROL OF EQUIPMENT FOR MACHINING MATERIALS WITH HYDRAULIC DRIVE (p. 56-60)**

Yana Sokolova, Nataliia Azarenko, Volodymyr Sokolov

The issues of automatic control of equipment for machining materials with rotary hydraulic drive are considered in the paper. The main objective of this study is the development of a mathematical model and synthesis of the automatic control system of equipment.

The methodological basis of the research is a systems approach to modeling drives of process equipment using control theory methods.

Based on the accepted approach, the authors have developed the mathematical model of the equipment for machining materials with the rotary hydraulic drive as an object of automatic control and performed the synthesis of automatic control system, taking into account the stochastic perturbation and observation noise.

Given that the stochastic excitation, applied to the control object, appears irrespective of the control signal, the synthesis of the automatic control system of equipment is executed taking into account additive noise. Therefore, solving the problem of stochastic optimal system with incomplete information about the state according to the separation method was divided into two: the problem of synthesizing optimal observer and deterministic problem of synthesizing optimal system.

The research results can be used in creating new and modernizing existing process equipment.

The results, presented in the work, can extend the functionality and efficiency of equipment for machining materials

**Keywords**: hydraulic drive, mathematical model, transfer function, time constant, transfer factor, block diagram, stochastic perturbation, observation noise, automatic control system

**References**

1. Navrotsky, K. L. (1991). Theory and designing hydro-and pneumodrives. Mechanical engineering, 384.
2. Sokolova, Ya. V., Azarenko, N. G., Greshnoy, D. S. (2014). Improving of electrohydraulic actuators of engineering equipment: monograph.Lugansk: East Ukrainian National University named after Volodymyr Dahl, 100.
3. Sokolov, V. I. (2012). Simulation of the power unit automatic electrohydraulic drive with variable displacement. Messenger of the East Ukrainian National University named after Volodymyr Dahl, 260.
4. Bratan, S. (2008). Analysis of the impact vibrations transmitted through the foundation of the machine, at the quality of the grinding process. Journal of STU «HPI»: collection of scientific papers. Kharkov, Issue, 22, 13–22.
5. Novoselov, Yu. (2007). Stochastic diagnostics of interaction of tool and workpiece in round external grinding. Modern technology in engineering: collection of scientific papers. Kharkov: Journal of STU «HPI», 102.
6. Popov, D. N. (1982). Non-stationary's hydromechanical processes . Mechanical engineering, 240.
7. Sveshnikov, V. K, Usov, A. A. (1988). Moustaches hydro-drives: the Directory. - 2 publ. Mechanical engineering, 512.
8. Azarenko, N. G. (2013). Experimental setup for the study of static and dynamic characteristics of automatic electrohydraulic actuators. Messenger of the East Ukrainian National University named after Volodymyr. Dahl, 5.
9. Kim, D. P. (2004). Automatic Control Theory. V. 2. Multidimensional nonlinear optimal and adaptive systems: tutorial. Physical and mathematical literature, 464.
10. Plohotnikov, K. (2009). Computational methods. Theory and practice of using MATLAB Publishing house «Hot Line – Telekom», 496.

**ALGORITHM OF MULTIOBJECTIVE OPERATIONAL CONTROL OF MICROGRIDS (p. 61-68)**

Vladimir Popov, Olena Yarmoluik, Petro Zamkovyi

One of important energy development directions, as evidenced by the global practice, is the intellectualization of generation, transmission and distribution of energy, formation of the so-called microgrids. In this regard, the results of the research, related to developing the method for prompt operational control of the sources of distributed generation of autonomous microgrid are given in the paper. Solving such problems in Ukraine is complicated by limited availability of material resources for the fundamental technical modernization of the industry, the lack of adequate information environment, the imperfection of legal and regulatory bases. These circumstances make the issues of forming adequate mathematical models, used to solve the problems of determining the optimal structure of microgrids and their operational control especially relevant.

Given this, the necessity of comprehensive consideration of the uncertainty factor, including considering the uncertainty of source information, objectives and conditions, when analyzing the specified problem is substantiated in the paper. For this purpose, a series of objective functions, reflecting the economic, technical and environmental aspects of the microgrid operation, which were originally presented in a linguistic form that allows to take into account both the information uncertainty, and multicriterion nature of the problem is formed. Capacity allocation among individual sources is implemented based on a modified non-local search algorithm.

Thus, accounting multicriteriality is performed using the Bellman-Zadeh approach, which allows to obtain a solution, belonging to the region of compromise, where the optimality principle lies in the maximum satisfaction of all purposes. The proposed algorithm allows to flexibly and effectively consider both quantitative and qualitative characteristics, represented, in particular, by linguistic assessments, differentiate the importance degree of individual criteria, which allow to ensure the maximum adequacy and validity of the obtained solutions and, as a consequence, guarantee the actual efficiency of using generating equipment, installed in the microgrid

**Keywords**: microgrids, resource allocation, distributed generation, multicriteria decision-making, Bellman-Zadeh approach

**References**

1. Stohhnii, B. S., Kyrylenko, O. V., Prahovnyk, A. V., Denysiuk, S. P. (2012). Evolution of the smart electricity networks and their prospects in Ukraine. Technical Electrodynamics, Kyiv, IED NASU, 5, 52–67.
2. Hatziargyrion, N. Asano, H., Iravani, R., Marnay, Ch. (2007). Microgrids: An overview of ongoing research, development and demonstration projects. IEEE power and energy magazine, 78–94.
3. Kobets, V. V., Volkova, I. O. (2010). Innovacionnoe razvitie jelektrojenergetiki na baze koncepcii Smart Grid. Moskow, IATS Energiia, 208.
4. Qiao, L. (2013). A summary of optimal methods for the planning of state alone Microgrid System. Energy and Power Engineering, 5, 992–998.

5. Hu, M., Chen, Y., Chang, Y. (2014). Operating Strategies and Management for Smart Microgrid Systems. Journal of Energy Engineering, 140, 1, 356–364.

6. Dilihenskii, N. V., Dymova, L. H., Sevastianov, P. V. (2004). Fuzzy modeling and multi-criteria optimization of production systems under uncertainty: technology, economy, ecology. – Moskow, Mashynostroeniie, 397.

7. Asai, K., Sugeno, M., Terano, T. (1994). Applied Fuzzy Systems. New York, Academic Press, 302.

8. Hanss, M. (2005). Applied fuzzy arithmetic. An introduction with engineering applications, Berlin, Springer-Verlag, 270.

9. Zholen, L., Kifer, M., Didri, O., Valter, E. (2005). Applied interval analysis. Moskow, Izhevsk, Institute of Computer Science, 468.

10. Dubov, Yu. A., Travkin, C. I., Yakimetc, V. N. (1986). Multicriteria Models for Forming and Choosing System Alternatives. Moscow, Nauka, 296.

11. Hwang, C. L., Masud, A. S. (1979). Multiple Objective Decision Making: Methods and Applications. Berlin, Springer-Verlag, 366–379.

12. Ehrgott, M. (2005). Multicriteria optimization. Berlin, Springer-Verlag, 323.

13. Nohin, V. D. (2004). Multicriteria decision making environment: a quantitative approach. Moscow, Fizmalit, 176.

14. Popov, V. A., Ekel, P. Ya., Fuchs, M. (1998). Fuzzy logic in real time state estimation of distribution systems. Methodologies for the Conception, Design, and Application of Intelligent Systems, Singapore, New Jersey, London, World Scientific, 2, 136–139.

15. Popov, V. A., Yarmoliuk, O. S., Banuzade Sakhragard, S., Zhurpvlov, A. O. (2011). Principles of the consideration of the initial information uncertanly for loads modelling in distribution networks. Enerhetyka: ekonomika, tekhnolohii, ekolohiia, Kyiv, NTUU «KPI», 1, 61–66.

16. Popov, V. A., Yarmoliuk, O. S. (2012). Heuristic algorithm for modeling the integrated distribution system modes of operation considering initial information uncertainty. Works IED NASU, Kyiv, IED NASU, Special Issue, 40–46.

17. Pedrycz, W., Ekel, P., Parreiras, R. (2011). Fuzzy Multicriteria Decision-Making: Models, Methods, and Applications. New York, John Wiley & Sons, 338.

18. Bellman, R. E., Zadeh, L. A. (1970). Decision-making in a fuzzy environment. Management Science, 17, 141–164.

19. Zimmermann, H. J. (1990). Fussy set theory and its application. Boston, Kluwer Academic, 400.

20. Beliakov, G., Warren, J. (2001). Appropriate choise of aggregation operators in fuzzy decision support systems. IEEE Transactions on Fuzzy Systems, 9, 773–784.

21. Bellman, R., Giertz, V. (1974). On the analytic formalism of the theory of fuzzy sets. Information Science, 5, 149–157.

22. Zharkin, A. F., Popov, V. A., Tkachenko, V. V., Banuzade Sakhragard, S. (2013). Functional equivalenting electrical networks in assessing the impact of distributed generation sources in their modes. Electronic modeling, Kyiv, Institute of problem modelling in energy GE Pukhov University NAS of Ukraine, 35, 99–111.

23. Raskin, L. G. (1976). Analysis of complex systems and elements of the theory of optimal control. Moskow, Soviet radio, 344.

24. Gelfand, I. M., Tsetlin, M. L. (1962). Some methods of control for complex systems. Advances of Mathematical Sciences, 17 (103), 3–25.

25. Ekel, P. Ya., Martins, C. A. P. S., Pereira, Jr. J. G. (2006). Fuzzy set based multiobjective allocation of resources and its application. Computers and Mathematics with Applications, 52, 197–210.

## SYNTHESIS OF MODAL CONTROL OF MULTIDIMENSIONAL CRYSTALLIZATION PROCESS BY VAN DER WOUDE (p. 68-72)

**Yuriy Kozmin**

Using the systems of non-adaptive control, in particular, modal for high-quality control over linear dynamic objects is discussed and some results of our research in this area are given in the paper.

The primary objective of the study is to solve the problem of modal control synthesis for a multidimensional object based on the Van der Woyd's generalized approach, as well as on using the knowledge in the field of control, obtained from different sources, for the process of growing single crystals using the Czochralski method on the "GROWTH"-type setups. Using modern methods and tools for analyzing the properties of linear controllable systems leads to the need of using modal controllability of the system and solving the problem of synthesis of modal control over the multidimensional object.

In the paper, generalization of the Van der Woyd's theorem in terms of band matrices for the case of MIMO-system modal control is given in the form of the algorithm, difference vectors of coefficients of specified and initial characteristic polynomials with respect to the growing process as the control object are described and parameterized. Using the graphical representation of the transfer characteristics of the object and closed-loop system in trajectory areas for analysis allows to obtain important information about the high-quality system control.

It is proposed to use this method for increasing the dynamic quality of control over inertial objects, which is the process of growing crystals in order to increase the efficiency of control systems for modern growth setups in conditions of producing these crystals.

The research results can be applied by specialists in the field of modal control over material, energy and information flows in control systems for modern technological processes, integrated into the technical environment of these processes

**Keywords**: optimization, modal control, single crystal, crystallization, parameterization, synthesis of regulators, multilinked process

### References

1. Wonham, W. (1967). On pole assignment in multi-input controllable linear systems. IEEE Trans. Automat. Control, Vol. 12, 660–667.

2. Simon, D., Mitter, S. (1968). A theory of modal control. Inform. Control, Vol. 13, 316–353.

3. Kalman, R., Ho, Y., Narendra, K. (1962). Controllability of linear dynamical systems Contrib. Differ. Equations, Vol. 1 (2), 189–213.

4. Ackermann, J. (1972). Der entwurf linearer regelungssysteme im zustandsraum. Regelungestechnik und Prozessedaten verarbeitung, Vol. 7, 297–300.

5. Van der Woude, J. (1988). A note on pole placement by static output feedback for single input systems. Systems & Control Letters, Vol. 11, 285–287.

6. Bukov, V., Ryabchenko, V., Kosyanchuk, V., Zibin, Ye. (2002). Resheniye matrichnikh uravneniy metodom kanonizatsii. Vestnik Kievskogo universiteta. Seriya : Phiz.-mathem. Nauki, Issue 1, 19–28.

7. Misrikhanov, M. (2005). Lentochnie kriterii upravlyayemosti i nabludayemosti lineynikh dinamicheskikh system. A & T, 2, 93–104.

8. Misrikhanov, M., Ryabchenko, V. (2009). Analiz i cintez lineynikh dinamicheskikh sistem na osnove lentochnikh formul. Vestnik IGEU, 2, 81–84.

9. Misrikhanov, M., Ryabchenko, V. (2009). Metod sinteza stabiliziruyushego upravleniya dinamicheskoy sistemoy na osnove razvitiya idei Van der Vouda. Trudi IGEU. Sistemi upravleniya i avtomatizatsii, Issue IX, 383–399.

10. Goriletsky, V., Grinev, B., Zaslavsky, B. (2002). Rost kristallov. Kharkov: AKTA, 535.