UDK 65.012.3

Hennadii O. Oborskyi[1]**,** Doctor of Technical Sciences, Rector E-mail: rector@opu.ua, ORCID: 0000-0002-5682-47684
Oksana S. Saveleva[1]**,** Doctor of Technical Sciences, Professor of the oil gas and chemical engineering Department, E-mail: okssave@gmail.com, ORCID: 0000-0002-0453-4777
Iraida I. Stanovska[1]**,** Doctor of Technical Sciences, Professor of the higher mathematics and systems modeling Department, E-mail: stanovskairaida@gmail.com, ORCID: 0000-0003-0601-7658
Igor A. Saukh[1]**,** master, graduate student of the oil gas and chemical engineering Department, E-mail: isaukhl@gmail.com, ORCID: 0000-0001-5558-1488
[1]Odessa National Polytechnic University, Avenue Shevchenko, 1, Odessa, Ukraine, 65044

The information technology of anti-crisis solutions search in complex dynamic systems management

Abstract. During the life cycle of dynamic complex systems management it is accompanied by crises caused by the internal nature of management processes and external environmental challenges that lead to inhibition, and sometimes to a complete stop of the process. The general space of anti-crisis management parameters is divided into two parts: planned (after the beginning of the life cycle or after each bifurcation) and anti-crisis (crisis identification, anti-crisis decision making and planning of the part of the cycle after bifurcation). The method of morphological and parametric anti-crisis analysis and life cycle management of a dynamic complex system is proposed, which consists in decomposition of the project with selection of the latter parameters, as well as division of the system “crisis event – anti-crisis solution” into elementary parameters. Then there is a convergence of the results of decomposition and identification and the adoption of the final verdict with the adjustment of the current project plan, which allowed to build anti-crisis management on an effective scheme with bifurcations of the plan. The scheme and technology of project crisis vectors step-by-step convergence and of anti-crisis solutions vectors are developed. The information technology of making an anti-crisis decision and continuing the project from the bifurcation point is proposed. The structure of the convergence of “damaged” process parameters of the planned life cycle of dynamic complex systems management and parameters of anti-crisis decisions with a verdict is created. The convergence of the complex multiparameter dynamical systems life cycle crisis parameters with the parameters of anti-crisis solutions is theoretically substantiated. The technology of convergence of crisis parameters of the life cycle of complex multiparameter dynamic systems with the parameters of anti – crisis solutions has been developed in order to optimize the latter. Methods for estimating the degree of closeness between individual sets of different parameters dimensions during their convergence have been developed. Practical tests of research results are carried out. The information technology “DYCOS” of anti-crisis solutions in management of dynamic difficult systems search is developed. “DYCOS” technology is used in anti-crisis restructuring of the educational process during quarantine restrictions.

Keywords: information technology; anti-crisis solutions; complex dynamic systems; convergence; crisis parameters; “DYCOS” technology

For citation: Oborskyi, H.O.., Saveleva, O.S.., Stanovska, I.I.. i Saukh, I.A.. The Information Technology of Anti-Crisis Solutions Search in Complex Dynamic Systems Management. Applied Aspects of Information Technology. Publ. Nauka i Tekhnika. Odessa: Ukraine. 2020, Vol.3, No.2, 72-82. DOI: https://doi.org/10.15276/hait.02.2020.7.

Introduction

As is known from the theory of systems, a dynamical system is a set of elements for which a functional relationship between time and state in the phase space of each element of the system is specified [1]. Such a mathematical abstraction allows studying and describing the evolution of systems in time. The tasks of managing complex dynamical systems, in which the issue of matching a pair to an existing element is solving, arise, as a rule, in various areas of human activity [2]. Such tasks are based on the known parameters of elements that can be deterministic or stochastic. Accordingly, the solution to them can be unambiguous or presented in the form of some recommended series, built according to predefined criteria, allowing the user to introduce a personal leadership style into the process.

Sometimes, while solving tasks mentioned is necessary to involve methods and means of artificial intelligence, when, for example, the selection operation is performed under incomplete data [3].

It is a matter of comparing (converging) a finite number of sets, each of which has a finite number of homogeneous elements, united by common rules. Such a task is also quite trivial and does not require special approaches to its solution. But, as long as the multi-parameter objects [4] exist, in which conditional pairs of sets with dissimilar elements can be distinguished (not a single one matches, the total numbers of elements in the sets differ from one another, for example, the first set: pressure in the pipeline, fluid flow rate, fluid density, and second set: welding machine, equipment for preparing pipes for welding), existing methods cannot solve such a problem. In addition, the individual parameters of individual elements can be interconnected by certain relationships or rules.

Obviously, such tasks, in which neither the number of parameters of the elements nor the

DOI: 10.15276/hait.02.2020.7
ISSN 2663-0176 (Print)
ISSN 2663-7731 (Online)

content of each of them coincides, are solved in two stages: firstly, we need to choose a combination technology (for example, welding or mechanical twisting), and secondly, determine the parameters of these subprocesses.

This article is devoted to the solution of such two-stage tasks.

2. Analysis of recent publications and problem statement

In accordance with the above, let us accentuate for analysis individual conceptual groups of the general direction "information technology for the choosing (development + selection) of anti-crisis solutions in the management of complex dynamic systems":

1) complex dynamic systems, in which at least one parameter depends on time, and which work is constantly exposed to internal or external influences leading to crises in their activities, are:

– technical ones [5-8];

– organizational ones [2; 9-12];

– computer ones [13];

2) information technologies for the development of anti-crisis solutions are:

– identification of "crisis" parameters [14-15];

– intellectual technologies [2; 16-18];

– accounting related parameters [19];

3) information technology of the selection of anti-crisis solutions is:

– a convergence of the sets of parameters of the solutions [20-26].

In science and technology, situations, where it is necessary to compare individual pairs of some elements of two or more groups of sets, are quite common. This happens when there is a congestion of machine parts during their design and manufacture [5-6], a profusion of individual elementary units included in a single machine or apparatus, for example, the compatibility of generators and energy consumers in electrical engineering [7], transport [8], etc.

Similar tasks arise in the changing environment of the parameters of humanitarian and organizational problems: medicine, education, and the like. So, for example, there is a large list of laws and departmental regulations governing decision-making in these areas, but the list of force majeure circumstances are always wider than any law could provide.

For example, the educational process in the institution of higher education is carried out in accordance with the Constitution of Ukraine, the laws of Ukraine "On Higher Education", "On Education", "On Scientific and Scientific-Technical Activities" and other regulatory legal acts, as well as with the international treaties of Ukraine concluded in the manner prescribed by law, the state education standards and other regulatory documents. It is believed that the result of the educational process is the formation of a body of knowledge, skills and other competencies, acquired by a person in the learning process according to a specific professional or scientific educational program that can be identified and quantified [11].

The ability of an educational institution to carry out educational activities is established as a result of passing the accreditation (licensing) procedure. Both licensing and accreditation are mandatory and standardized procedures, the general purpose of which is to confirm the possibility of a higher education institution to provide quality educational services to applicants.

Given the mission and goals of the institution of higher education, the implementation of educational activities by the university in general, and for each individual educational program in particular, can be considered as an educational project, which has a beginning and an end, a limited duration, a predetermined amount of funding, as well as unique goals and objectives [9-10].

Each stage of the implementation of this project (initiation of an educational program, planning and development, implementation, monitoring and control, finishing) has a certain sequence of actions that must be analyzed, evaluated and completed.

The decision to start (initiate) a specific educational program by a higher education institution is made based on an analysis of the needs of the job market, the demand of finite consumers (employers, applicants), the human resources available university's scientific and material base, and the establishment of compliance with the technological and organizational requirements of licensing conditions.

Unfortunately, an unexpected external intervention in this process – a pandemic of a dangerous disease – significantly changed these standards and required a significant and rapid transition to other, anti-crisis areas of development of this activity.

Similar problems also dramatically changed the "pre-crisis", planned methods used in medicine, in the understanding that the transition to new treatment plans had to be quick, accessible within certain limits and effective [2; 16-18]. If there are several such anti-crisis measures, then the choice of the optimal solution in a fast, preferably automated mode is reduced to selecting the "best" action, i.e.

comparing the parameters of the crisis and the parameters of the action, as well as urgently changing the structure and parameters of the control object.

Thus, it can be argued that in modern conditions, with an eye to fast-moving processes, controlled and potential accident objects of observation, such comparison needs to be made rapidly, and its results should be automatically processed into effective solutions for changing the structure and parameters of processes management.

To searching and implement such solutions, information technologies have been created in the field of automated comparisons by means of sequential convergence of the parameters of the sets mentioned [19-26]. At the same time, the principles and methods of convergence of the parameters of organizational, technical or humanitarian elements in anti-crisis conditions are not sufficiently developed.

3. The purpose, objectives and scientific novelty of the study

The aim of the work is the development and implementation of new technologies for morphological and parametric analysis of organizational and technical systems for crisis management of the development processes of complex objects to increase the effectiveness of such management. Management effectiveness is understood as an improvement in comparison with the plan of such key process indicators as time, cost, product quality parameters, interaction with the environment, relationships in the management team and the preservation of planned indicators in crises.

To achieve this goal, the following tasks were solved:

1. The theoretical substantiation of the process of choosing the "optimal" anti-crisis verdict due to the fast computer-processed convergence of the crisis life cycle parameters of complex multi-parameter dynamic systems with anti-crisis decision parameters.

2. The development of information technology for convergence of crisis life cycle parameters of complex multi-parameter dynamic systems with parameters of anti-crisis solutions in order to optimize the latter.

3. The practical testing of the results of the study and evaluation of their effectiveness.

The scientific novelty of the work lies in the fact that for the first time a method of morphological and parametric anti-crisis analysis and process control is proposed, which consists in decomposing the process with the allocation of its parameters, as well as identifying the elementary parameters of the triad "crisis event – crisis process – anti-crisis solution"), after which there is a convergence of the results of decomposition and identification and the final verdict with the adjustment of the current process plan, which allowed to build crisis management according to an effective scheme with a plan bifurcation.

4. Methods of preparation and implementation of convergence of facility parameters and anti-crisis measures

4.1 The choice of the "optimal" anti-crisis verdict due to the fast computer-processed convergence of the crisis life cycle parameters of complex multi-parameter dynamic systems with anti-crisis decision parameters

Throughout the entire life cycle of managing complex systems or processes, they are accompanied by crises caused by the internal nature of control processes and external environmental challenges, leading to inhibition, and sometimes to a complete halt of the process. We divide the common space of crisis management parameters into two parts: planned (after the start of the process or after each bifurcation) and anti-crisis (identification of the crisis, adoption of a crisis management decision and planning of the process after bifurcation). To obtain a list of parameters of the first part, it is necessary after the start of the process and each of its anti-crisis changes to decompose the current part of the last one. As a result, we obtain the *r* set of parameters of process pp, sequentially or parallel approximating the achievement of its goal

$$\boldsymbol{PP}=\{pp_1, \ldots, pp_r\}. \quad (1)$$

The list of process parameters (1) is set during planning. It can be expanded if necessary to respond to various crisis situations.

When executing a process, the most vulnerable part of the latter is the parameters included in sets (1). It is enough to go beyond the permissible limits of at least one planned parameter (for example, financing) - and the process may stop. Therefore, the fulfillment of the inequalities

$$\forall pp_i \in PP(pp_{i\min} \le pp_i \le pp_{i\max}) \quad (2)$$

is a prerequisite for a "crisis-free" process.

Fulfilment of conditions (2) is a necessary procedure for any crisis management. If it turns out that (2) is not fulfilled for at least one planned parameter, then it is transferred to the depository of crisis problems (there can be more than one such crisis-related parameters), and at the same time, anti-crisis actions begin, which will be discussed later.

The list of such parameters can be represented

ISSN 2663-0176 (Print)
ISSN 2663-7731 (Online)

by a vector:

$$\boldsymbol{PP_{cr}}=\{pp_{cr1}, \ldots, pp_{crr}\}, \quad (3)$$

with whom the anti-crisis manager works further.

Based on the fact that one crisis event may have several crises, and each of them can be eliminated by several fundamentally different anti-crisis solutions s, a set of such solutions $\boldsymbol{S}$ can be described, for example, as follows:

$$\begin{aligned}
&\boldsymbol{S_{11}}=\{s_{111}, \ldots, s_{11q}\}; \boldsymbol{S_{12}}=\{s_{121}, \ldots, s_{12s}\}; \ldots, \boldsymbol{S_{1n}}=\{s_{1n1}, \ldots, s_{1nt}\}.\\
&\boldsymbol{S_{21}}=\{s_{211}, \ldots, s_{21q}\}; \boldsymbol{S_{22}}=\{s_{221}, \ldots, s_{22s}\}; \ldots, \boldsymbol{S_{2n}}=\{s_{2n1}, \ldots, s_{2nt}\}.\\
&\ldots\\
&\boldsymbol{S_{n1}}=\{s_{n11}, \ldots, s_{n1q}\}; \boldsymbol{S_{n2}}=\{s_{n21}, \ldots, s_{n2s}\}; \ldots, \boldsymbol{S_{nn}}=\{s_{nn1}, \ldots, s_{nnt}\}.
\end{aligned} \quad (4)$$

Now we can move on to solving the main anti-crisis problem: having vectors (3) of the parameters of the planned process “damaged” by the crisis and a set of vectors of anti-crisis solutions parameters (4), we match vectors (4) in turn with vector (3), that is, we perform step-by-step convergence [27] vectors (4) and (3) (Fig. 1), and according to the results of convergence, we make the final anti-crisis decision (verdict).

The execution of the verdict forms a bifurcation point at which a new, anti-crisis subprocess “diverges” in the process space with the initial planning process. From this point, a new life of the process begins – its initial plan is cancelled, and the countdown of anti-crisis actions begins again.

In particular, the decomposition of a new process plan is being performed again etc. It should be noted that elementary crises can intersect and can serve as events for other crises, which, of course, complicates the scheme shown in Fig. 1.

This solution can significantly complicate the task, but at the same time, it does not negate its main advantage: “fighting” crises at an elementary level is easier and more effective!

When the second event occurs, its parameters after identification also undergo convergence with the result of decomposition of the new (after the next bifurcation) plan and so on - until the process is completed.

As a result, we have the following options for the results of anti-crisis measures (Fig. 2):

– overcoming the crisis without structural (morphological) changes in the process;

– overcoming the crisis with structural (morphological) changes in the process from the bifurcation point with the development of a new process plan;

– crisis completion (interruption) of the process;

– scheduled completion of the process.

If, when solving the second crisis, a coincidence is found with any element of the first solution, then the transition directly to it is performed.

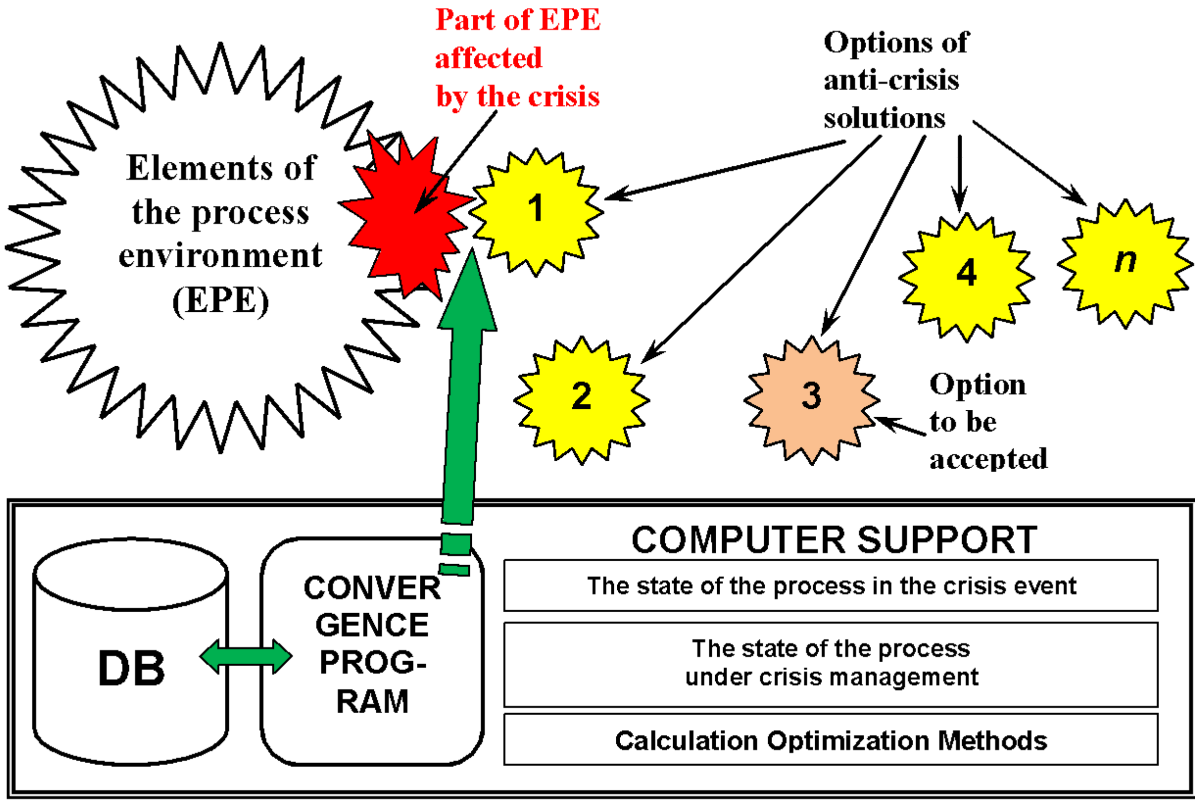

Fig. 1. Stepwise convergence of crisis and crisis management vectors

4.2. Information technology for support the process of convergence of crisis parameters of the life cycle of complex multi-parameter dynamic systems with parameters of anti-crisis solutions in order to optimize the latter

Depending on which variant of the anti-crisis decision is chosen, one of the following verdicts can be adopted (Fig. 2):

– adjusting the parameters of the process without changing its current structure;

– adjusting the structure of the process;

– determining the point of the process bifurcation (or the breakpoint of the planned process).

Next, clarifications should be given about changing the process plan after the bifurcation point. Depending on the depth of plan adjustments, this process may occur in parallel with the main process, or the latter will have to be temporarily stopped for this. It is important that such an adjustment should be carried out as faster as possible and completed as fully as possible by a process team, temporary or permanent, which has the comprehensive competence for such work. In this case, computer decision support for such specialists is especially valuable and effective.

Fig. 3 shows the convergence technology in more detail.

The block diagram of the convergence process consists of five components. Three of them: monitoring of process control parameters, identifying the parameters of crisis events and generating anti-crisis solutions – are among the previous ones that support convergence. The convergence itself and the adoption of its result – the verdict to change the process plan – are the fourth and fifth blocks of the structure of the convergence process.

In the first block, the system takes turns bypassing all process parameters and, if at least one of them is beyond the tolerance, this parameter is placed in the crisis repository (repository). At the same time, the crisis beginning is declared. Other existing parameters that come into a crisis (went beyond the tolerance) (Fig. 3) are moved to the same repository (repository) simultaneously with the first one.

Then, if necessary, a search is made for the events that led to the crisis, and their parameters are identified.

ISSN 2663-0176 (Print)
ISSN 2663-7731 (Online)

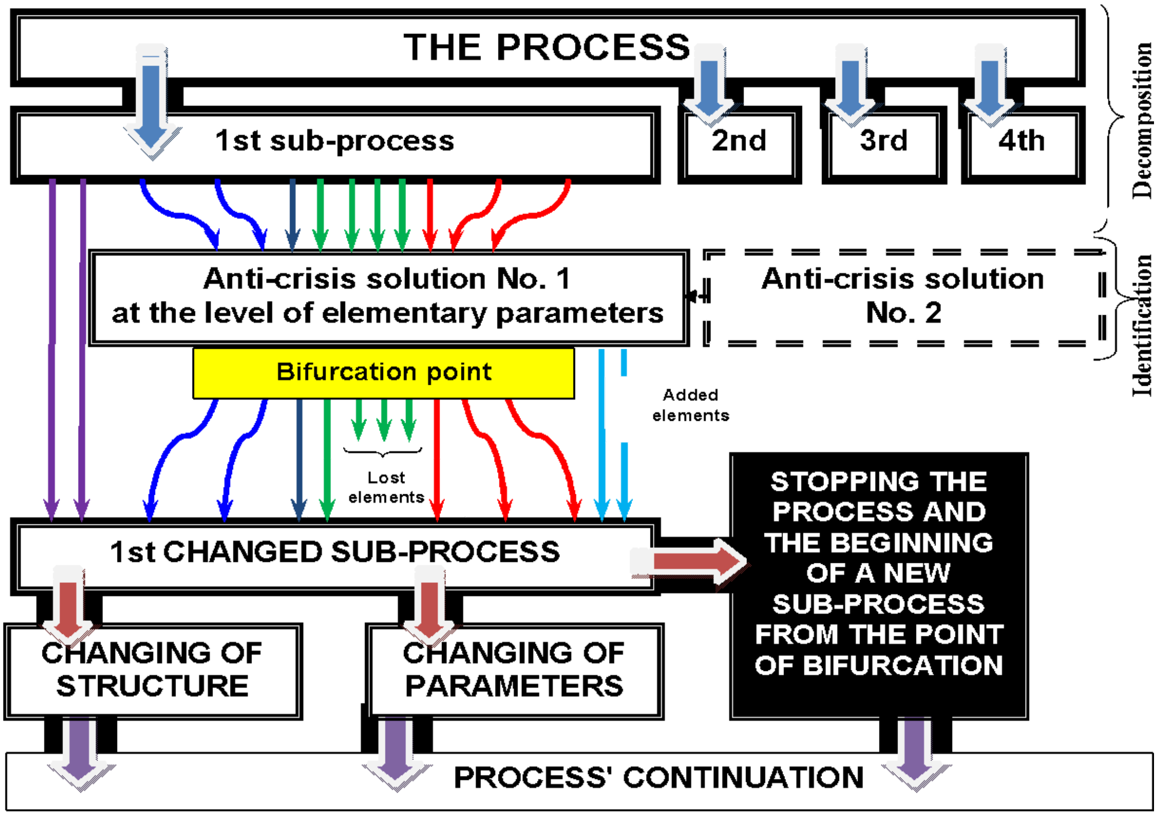

Fig. 2. The scheme of information technology for the adoption of anti-crisis decisions

These events may be more or less obvious (for example, a crisis – water pressure dropped, an event – a pipe burst; or lack of funding – the fluctuation of the exchange rate), but those events must be found and the full vector of their parameters must be identified.

In the third block, for each event, all possible crisis solutions that are available for management are prepared, and a vector of their parameters is built for each solution (Fig. 3). The sources of solutions are different: the experience of managers and the electronic database of previous solutions, or the creative origin, up to inventions.

In the process of convergence (the fourth block), a measure of closeness between the crisis parameters and the parameters of each solution is determined, the most approximate solution is selected and the corresponding verdict is issued (the fifth block).

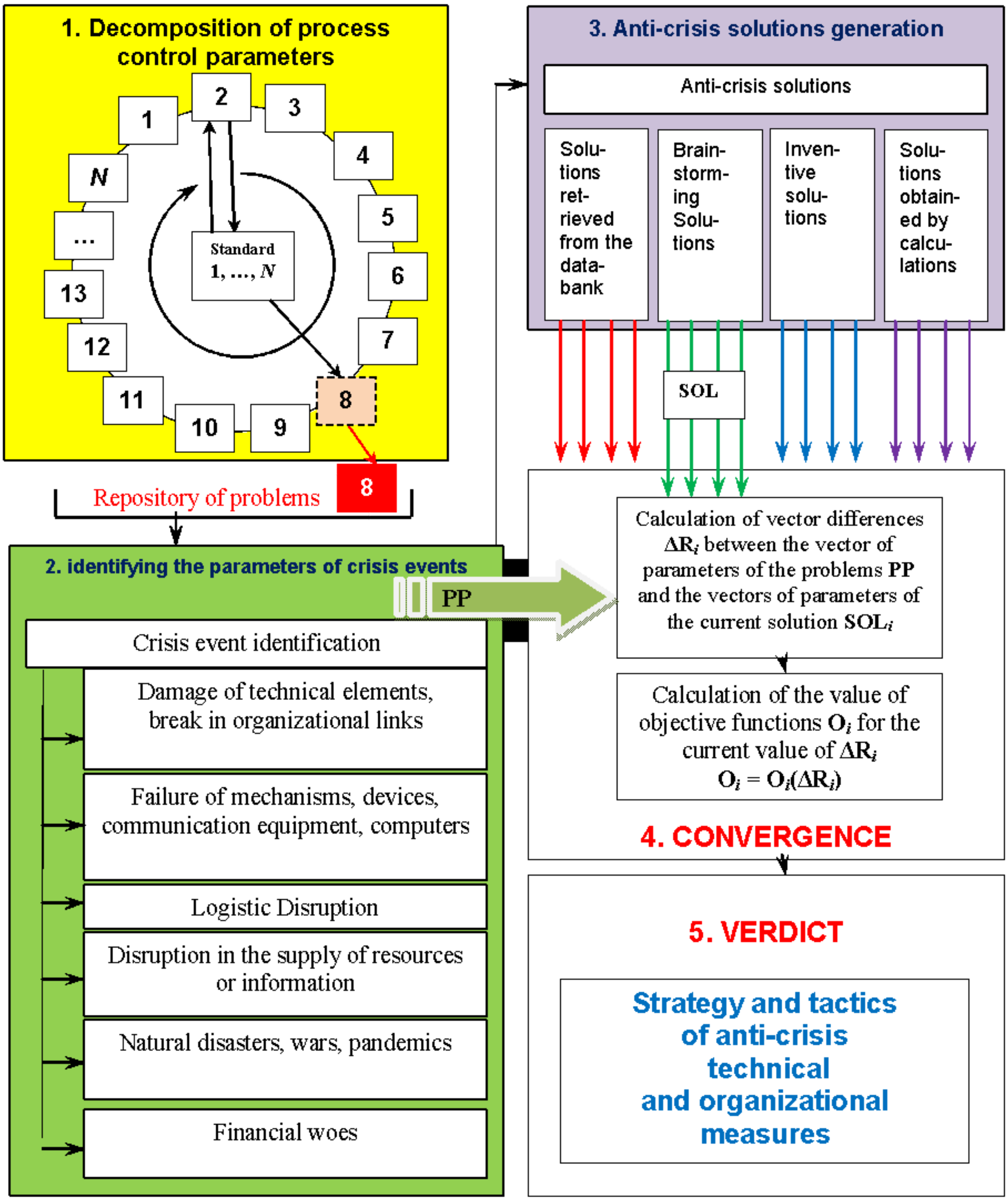

Fig. 3. The structure of the process of convergence of "damaged" parameters of the planning process and the parameters of anti-crisis decisions with the verdict

To determine the measure of closeness, any rule of choice to compare two sets of different dimensions can be applied.

To do this, operations are performed on sets (intersection, union, difference, complement), the results of which are reduced to one ranked number.

The maximum (minimum) value of this number is determined by a certain verdict: this particular pair – "a set of crisis parameters – a set of parameters of anti-crisis measures" can be chosen as an anti-crisis solution.

It should be noted that the measure of closeness is understood here not only in the vector-mathematical sense. Sometimes the main role in determining this closeness can be played by financial, temporal, and even social or based on relationships arguments. For example, a problem can be solved easily by calling a person, but the manager will avoid this option (will not choose it as a verdict) since the person mentioned he personally insulted

ISSN 2663-0176 (Print)
ISSN 2663-7731 (Online)

him the day before.

Fig. 3 also shows the vectors of the solutions' parameters; here are four of them, for example. This number in management is a very important value that characterizes the degree of creativity. If only one solution is found in the search process, then this is no longer a process, but a technological instruction. Thus, the activity of managing multi-parameter processes has at least two components: the implementation of the process plan, as well as anti-crisis actions. If the anti-crisis part of the process is performed poorly, then such additional, unplanned subprocesses sometimes begin to harm the flow of planned activity so much that they can stop it completely.

4.3. Practical tests of research results and assessment of their effectiveness

Medical applications of the research results in the humanitarian area relate mainly to the search for pairs of various drugs dangerous to human health [27-32].

The search for anti-crisis solutions in education was based on the need to introduce urgent changes related to the mentioned external circumstances into the educational process, divided into two terms of 15 training weeks each [33-34].

In addition, in accordance with the found anti-crisis solution, it was urgent to make adjustments to the planned educational process, ensuring its high-quality implementation under previously undefined conditions both for students and teachers: remote learning in synchronous or asynchronous modes.

The new conditions can be described as follows: the possibilities of physical visits to higher education institutions by students and teachers are limited or absent, traditional instruments of interterm control and attestation cannot be used due to force majeure (natural disasters, quarantine measures and other force majeure circumstances).

Assessment of learning outcomes cannot occur by known means, but is moved to the level of application of Internet technologies, telephone communications, i.e. carried out in remote mode.

It is necessary to resolve the issue of urgent reformatting of current tests in the discipline module, ways to get student results, the objectivity of the criteria for verifying the results of tests, assessments in asynchronous and synchronous modes using chat, forum, remote polling, questionnaires, etc.

It is necessary to pay attention to the level of software knowledge of students and teachers, the level of communication and its stability, technical and communicative capabilities of participants in the educational process.

The teacher, making a decision on the measures for conducting the current and final control, must qualitatively change the description of control tests in order to exclude their solving by copying existing answers from other sources.

Practical test of the research results. The information technology “DYCOS” was developed for searching and implementing anti-crisis solutions in the management of complex dynamic systems.

The “DYCOS” technology was used in the anti-crisis restructuring of the educational process during the quarantine. As a result, the following results were obtained:

– the curriculum was changed only in the context of laboratory work;

– all types of control of mastering the materials of lectures and practical exercises were carried out;

– the distance defenses of course papers and dissertations were conducted;

– the production and distribution of all types of supporting documentation were provided.

5. Conclusions

1. The convergence of the crisis life cycle parameters of complex multi-parameter dynamic systems with anti-crisis solution parameters is theoretically substantiated. As a rule, the task of choosing one anti-crisis solution from the set proposed for overcoming the crisis on the path of development of the life cycle of complex multi-parameter dynamic systems consists in sequentially “matching” the next solution to the crisis parameters (convergence) and calculating the objective function of the result of such convergence with the statement of the extreme value of the function as a verdict.

2. A convergence technology has been developed for the crisis parameters of the life cycle of complex multi-parameter dynamic systems with parameters of anti-crisis solutions in order to optimize the latter. The technology consists of monitoring the control parameters of complex systems, identifying the parameters of crisis events and generating anti-crisis solutions. Next comes the convergence itself and the adoption of its result - a verdict to change the process plan. After that, for each event available for management possible solutions to crises are described, and a vector of their parameters is compiled for each decision.

3. In the process of convergence, a measure of closeness between the crisis parameters and the parameters of each solution is determined, the most approximate solution is selected and the corresponding verdict is developed. The following verdicts are possible depending on the convergence results: make adjustments to the process parameters without changing its current structure; make adjustments to the structure of the process, determine the bifurcation point of the process (the stopping point of the planned process).

4. Methods have been developed for assessing the degree of closeness between individual sets of parameters of various dimensions during their convergence, in particular, the method of virtual models, intelligent methods, and the like ones. The

features of convergence of sets with related parameters and their use in the problems of finding crisis management solutions are considered.

5. Practical testing of the results of the study. The information technology “DYCOS” for the search for anti-crisis solutions in the management of complex dynamic systems has been developed. The DYCOS technology was used in the anti-crisis restructuring of the educational process during the quarantine.

References

1. Lynch, Stephen. (2018). “Dynamical Sys-tems with Applications using Python”, *Springer International Publishing.*

2. Nesterenko, S. A., Daderko, O. I. & Saukh, I. A. (2018). “Ecological component of the intellectual method for recognizing the closest pair in fuzzy conditions”, *Scientific and practical journal “Environmental Sciences”,* No. 20. Volume 1, pp. 143-146.

3. Nesterenko, S. A., Stanovskyi, A. A. & Daderko, O. I. (2015). “IntelektualnI metodi v dIagnostitsI bezdrotovih komp'yuternih merezh” [Intelligent methods in the diagnosis of wireless computer networks], *II International scientific and technical Internet-conference “Modern methods, information, software and technical support of management systems of organizational, technical and technological complexes”,* Kyiv, Ukraine, 64 p. (in Ukrainian).

4. Kovalev, I. V., Tynchenko, C. V., Zavyalova, O. I. & Laikov, A. N. (2009). “System of support for multi-attribute decision making in the management of complex systems”, *Software products and systems,* No. 2, pp. 142-144.

5. Stanovskyi, A., Naumenko, Y., Saukh, I. & Abu Shena O. (2016). “The virtual models in equal-stressed machine parts dosing”, *Bulletin of Kremenchug National University named after M. Ostrogradsky,* Kremenchuk, Ukraine, No. 6/2016 (101), Ch. 1, pp. 59-60.

6. Stanovsky, A. L., Naumenko, E. A. & Abu Shen Osama. (2017). “Matematicheskoe modelirovanie i optimizatsiya v SAPR odinakovo napryazhennyih detaley mashin” [Mathematical modeling and optimization in CAD of equally stressed machine parts], *High technologies in mechanical engineering: NTU “KhPI”*, No. 1 (27), pp. 143-154 (in Russian).

7. Stanovskyi, O., Shvets, P., Bondarenko, V., Naumenko, I., Walid Sher Husain & Dobrovolska, V. (2017). “The systems “fuel electrical generator – electrical motor” optimization in CAD”, *International scientific journal “Technology audit and production reserves”,* No. 2/1 (34), pp. 46-50.

8. Shvets, P., Toropenko, A., Naumenko, I. & Walid Sher Husain. (2017). “Mathematical modeling in CAD elements vehicles food and chemical industry”, *Ukrainian Journal of Food Science*. Vol. 4, Is.2, pp. 339-349.

9. Shpak, O. (2010). “Osobennosti menedzhmenta v sovremennoy sisteme vyisshego obrazovaniya” [Features of management in the modern system of higher education], *Youth and the market,* No. 12(71), pp. 10-13 (in Ukrainian).

10. Morgulets, O. V. (2016). “Kontseptualnyie osnovyi upravleniya universitetom kak sub'ektom ryinka obrazovatelnyih uslug” [Conceptual principles of university management as a subject of the market of educational services], *Efficient economy.* No. 3. http://www.economy.nayka.com.ua/?op=1&z=5219 (in Ukrainian).

11. Revenko, T. V. (2018). “Suschnost i osnovnyie sostavlyayuschie obrazovatelnogo protsessa v vyisshih uchebnyih zavedeniyah Ukrainyi” [The essence and main components of the educational process in higher education institutions of Ukraine], *Theory and practice of public administration,* Vol. 3, pp. 44-53 (in Ukrainian).

12. Larshin, Vasily P. & Lishchenko, Natalia V. (2019). “Educational technology information support”, *Herald of Advanced Information Technology, Information Technology in Education,* Odessa, Ukraine, *Publ. Science and Technica,* Vol. 2. No. 4, pp. 317-327. DOI: 10.15276/hait.04.2019.8.

13. Velykodniy, Stanislav S., Burlachenko, Zhanna V. & Zaitseva-Velykodna, Svitlana S. (2019). “Software for automated design of network graphics of software systems reengineering”. *Herald of Advanced Information Technology, Designing Information Technologies and Systems,* Odessa, Ukraine, *Publ. Science and Technica,* Vol. 2. No. 2, pp. 95-107. DOI: 10.15276/hait.02.2019.2.

14. Stanovska, I., Stanovskyi, O. & Saukh I. (2020). “Information technology of problems solutions support in a complex system management”. *Journal of EUREKA: Physical Sciences and Engineering* (Estonia), No. 3, pp. 30-43.

15. Oborskyi, G. A., Stanovsky, A. L., Prokopovich, I. V. & Dukhanina, M. A. (2014). “Vyibor metrologicheskogo obespecheniya dlya upravleniya slozhnyimi liteynyimi ustanovkami s trudnoizmerimyimi parametrami” [The choice of metrological support for the management of complex foundry facilities with difficult to measure parameters], *East European Journal of Advanced Technology*. Kharkov, Ukraine, No. 6/3 (72), pp. 41-47 (in Russian).

16. Nesterenko, S. A., Daderko, O. I. & Saukh I. A. (2018). “Intellektualnyie metodyi kompyu-ternogo raspoznavaniya sinergeticheski opredelennyih par” [Intelligent methods of computer recognition of synergistically determined pairs], *Proceedings of the XXVI scientific and technical seminar “Modeling in applied research”.* Odessa, Ukraine, ONPU, pp. 25-27 (in Russian).

17. Stanovsky, A. L., Bondarenko, V. V., Dobrovolskaya, V. V., Abu Shena O. & Saukh I. A. (March 10 – 12, 2016). “Optimizatsiya sistem s

sootvetstvuyuschimi argumentami" [Optimization of systems with related arguments], *Proceedings of the VII All-Ukrainian scientific-practical conference "Informatics and systems sciences".* Poltava, Ukraine, pp. 290-292 (in Russian).

18. Savelyova, O. S., Stanovsky, A. L., Stanovskaya, I. I., Berezovskaya, E. I., Kheblov, I., Guryev, I. N. & Saukh I. A. (2016). "Formalizatsiya prostranstva upravleniya proektom" [Formalization of the project management space], *Bulletin of the National Technical University "KhPI", Series: New solutions in modern technologies,* Kharkiv, Ukraine, NTU "KhPI", No. 42 (1214), pp. 154-159 (in Russian).

19. Kolesnikov, Oleksii E., Lukianov, Dmytro V., Sherstyuk, Olha I. & Kolesnikova, Kateryna V. (2019). "Project manager job description as one of project management key success factors", *Herald of Advanced Information Technology, Project, Program and Portfolio Management Methodology,* Odessa, Ukraine, *Publ. Science and Technica,* Vol. 2, No. 3, pp. 215-228. DOI:10.15276/hait.03.2019.5.

20. Bushuev, S. D., Bushueva, N. S. & Unknown, S. I. (2012). "Mehanizmyi konvergentsii metodologiy upravleniya proektami" [Mechanisms for convergence of project management methodologies], *Management of complex systems development,* Kyiv, Ukraine, *KNUBA,* No. 11, pp. 5-13 (in Russian).

21. Bainbridge, W. S. & Roco, M. C. (2016). "Handbook of Science and Technology Convergence". *Springer reference,* 1154 p.

22. Bainbridge, W. S. & Roco, M. C. (2016). "Science and technology convergence: with emphasis for nanotechnology-inspired conver-gence", J. Nanoparticle Res. 18 (7): 211. Bibcode:2016JNR....18..211B. DOI:10.1007/s1 1051-016-3520-0.

23. Roco, Mihail C. (2015). "Principles and Methods That Facilitate Convergence", *Handbook of Science and Technology Convergence,* Cham: *Springer International Publishing,* pp. 1-20. DOI: 10.1007/978-3-319-04033-2_2-2. ISBN 9783319040 332.

24. (2015). "What is network convergence? – Definition from WhatIs.com", Search IT Channel, Retrieved 17 June 2015.

25. Park, Sangin. (2007). "Strategies and Policies in Digital Convergence", *Hershey, PA: Idea Group Reference,* 106 p.

26. Roco, M. C., Bainbridge, W. S., Tonn, B. & Whitesides, G. (2014-02-11). "Convergence of Knowledge, Technology and Society: Beyond Convergence of Nano-Bio-Info-Cognitive Techno-logies", Science Policy Reports, *Springer Interna-tional Publishing*.

27. Paltsev, M. A. (2005). "Molekulyarnyie mehanizmyi nezhelatelnyih effektov lekarstv". *Publishing House "Russian Doctor",* Moscow, Russian Federation, 294 p. (in Russian).

28. Reichart, D. V. (2007). "Oslozhneniya v farmakoterapii", *Adverse reactions of drugs. Litterra,* Moscow, Russian Federation, Vol. 1. 256 p. (in Russian).

29. Lavryashina, M. B., Tolochko, T. A. & Volkov, A. N. (2006). "Alloantigenyi krovi cheloveka" [Alloantigens of human blood], Kemerovo, Russian Federation, *Practical transfusiology*, 2005 (in Russian).

30. Belousov, Yu. B. & Gurevich, K. G. (2005). "Klinicheskaya farmakokinetika. Praktika dozirovaniya lekarstv" [Clinical pharmacokinetics. The practice of dosing drugs], Special issue of the series "Rational Pharmacotherapy", *Litterra.* Moscow, Russian Federation, 268 p. (in Russian).

31. Viktorov, A. P. (2000). "Eda i lekarstva, lekarstva i produktyi pitaniya. Lechenie i diagnos-tika" [Food and medicine, medicine and food. Treatment and diagnosis], No. 1, pp. 48-57 (in Russian).

32. Krylov, Yu. F. & Vyshkovsky, G. L. (2005). "Vzaimodeystvie lekarstv" [Drug Inter-action], *Medicines-PATENT*, Moscow, Russian Federation. 240 p. (in Russian).

33. "Search for a pair of numbers optimally close to a given constant number" [Electronic Resource]. – Available: https://www.mql5.com/en/forum/216667. – Active link – 01.04.2019.

34. (2018) "Aktualnyie problemyi obrazo-vatelnogo protsessa v kontekste evropeyskogo vyibora Ukrainyi: sbornik materialov Vseukra-inskogo kruglogo stola" [Current issues of the educational process in the context of the European choice of Ukraine: a collection of materials of the All-Ukrainian round table], (Kyiv, April 17, 2018), Kyiv, Ukraine, *KNUBA,* 364 c. (in Ukrainian).

Received 15.05.2020
Received after revision 08.06.2020
Accepted 14.06.2020

УДК 65.012.3

[1]**Оборський, Геннадій Олександрович,** доктор технічних наук, професор, ректор,
E-mail: rector@opu.ua, ORCID: 0000-0002-5682-47684
[1]**Савєльєва, Оксана Степанівна,** доктор технічних наук, професор, професор кафедри нафтогазового та хімічного машинобудування, E-mail: okssave@gmail.com,

ORCID: 0000-0002-0453-4777
[1]**Становська, Іраіда Іванівна,** доктор технічних наук, професор, доцент кафедри вищої математики та моделювання систем, E-mail: stanovskairaida@gmail.com, ORCID: 0000-0003-0601-7658
[1]**Саух, Ігор Анатолійович,** магістр, аспірант кафедри нафтогазового та хімічного машинобудування, E-mail: isaukhl@gmail.com, ORCID: 0000-0001-5558-1488
[1]Одеський національний політехнічний університет, проспект Шевченка, 1, Одеса, Україна, 65044

ІНФОРМАЦІЙНА ТЕХНОЛОГІЯ ПОШУКУ АНТИКРИЗОВИХ РІШЕНЬ В УПРАВЛІННІ СКЛАДНИМИ ДИНАМІЧНИМИ СИСТЕМАМИ

Анотація. *Протягом життєвого циклу управління динамічними складними системами його супроводжують кризи, викликані внутрішньою природою процесів управління і зовнішніми викликами довкілля, що призводять до гальмування, а іноді і до повної зупинки процесу. Загальний простір параметрів антикризового управління розділено на дві частини: планову (після початку життєвого циклу або після кожної біфуркації) та антикризову (ідентифікація кризи, прийняття антикризового рішення та планування частини циклу після біфуркації). Запропонований метод морфологічного та параметричного антикризового аналізу та управління життєвим циклом динамічної складної системи, який полягає в декомпозиції процесу із виділенням параметрів останніх, а також розбиття системи «кризова подія – антикризове рішення») на елементарні параметри. Далі відбувається конвергенція результатів декомпозиції та ідентифікації та прийняття підсумкового вердикту із корегуванням поточного плану процесу, що дозволило побудувати антикризове управління за ефективною схемою із біфуркаціями плану. Розроблено схему та технологію покрокової конвергенції векторів процесної кризи та векторів антикризових рішень. Запропоновано інформаційну технологію прийняття антикризового рішення та продовження виконання процесу від точки біфуркації. Створено структуру процесу конвергенції «пошкоджених» параметрів планового життєвого циклу управління динамічними складними системами та параметрів антикризових рішень із винесенням вердикту. Теоретично обґрунтовано конвергенцію кризових параметрів життєвого циклу складних багатопараметричних динамічних систем із параметрами антикризових рішень. Розроблено технологію конвергенції кризових параметрів життєвого циклу складних багатопараметричних динамічних систем із параметрами антикризових рішень з метою оптимізації останніх. Розроблено методи оцінювання міри близькості між окремими множинами параметрів різної розмірності під час їхньої конвергенції. Здійснені практичні випробування результатів дослідження. Розроблено інформаційну технологію "DYCOS" пошуку антикризових рішень в управлінні динамічними складними системами. Технологія "DYCOS" використана при антикризовій перебудові учбового процесу під час карантинних обмежень.*

Ключові слова: *інформаційна технологія; антикризові рішення; складні динамічні системи; конвергенція; кризові параметри; технологія "DYCOS"*

УДК 65.012.3

[1]**Оборский, Геннадий Александрович,** доктор технических наук, профессор, ректор, E-mail: rector@opu.ua, ORCID: 0000-0002-5682-47684
[1]**Савельева, Оксана Степановна,** доктор технических наук, профессор, профессор кафедры нефтегазового и химического машиностроения, E-mail: okssave@gmail.com, ORCID: 0000-0002-0453-4777
[1]**Становская, Ираида Ивановна,** доктор технических наук, профессор, доцент кафедры высшей математики и моделирования систем, E-mail: stanovskairaida@gmail.com, ORCID: 0000-0003-0601-7658
[1]**Саух, Игорь Анатольевич,** магистр, аспирант кафедры нефтегазового и химического машиностроения, E-mail: isaukhl@gmail.com, ORCID: 0000-0001-5558-1488
[1]Одесский национальный политехнический университет, проспект Шевченко, 1, Одесса, Украина, 65044

ИНФОРМАЦИОННАЯ ТЕХНОЛОГИЯ ПОИСКА АНТИКРИЗИСНЫХ РЕШЕНИЙ В УПРАВЛЕНИИ СЛОЖНОЙ ДИНАМИЧЕСКОЙ СИСТЕМОЙ

Аннотация. *В течение жизненного цикла управления динамическими сложными системами их сопровождают кризисы, вызванные внутренней природой процессов управления и внешними вызовами окружающей среды, приводящие к торможению, а иногда и к полной остановке процесса. Общее пространство параметров антикризисного управления разделено на две части: плановую (после начала жизненного цикла или после каждой его бифуркации) и антикризисную (идентификация кризиса, принятие антикризисного решения и планирование продолжения цикла после бифуркации). Предложен метод морфологического и параметрического антикризисного анализа и управления жизненным циклом динамической сложной системы, который заключается в декомпозиции процесса с выделением параметров последних, а также разбивке системы «кризисное событие – антикризисное решение») на элементарные параметры. Далее* *происходит конвергенция результатов декомпозиции и идентификации и принятие итогового вердикта с корректировкой текущего плана процесса, что позволило построить антикризисное управление по эффективной схеме с бифуркацией исходного плана. Разработана схема и технология пошаговой конвергенции векторов процессного кризиса и векторов антикризисных решений. Предложена информационная технология принятия антикризисного решения и продолжения выполнения процесса от точки бифуркации. Создана структура процесса конвергенции «поврежденных» параметров планового жизненного цикла управления сложными динамическими системами и параметров антикризисных решений с вынесением вердикта. Теоретически обоснована конвергенция кризисных параметров жизненного цикла сложных многопараметрических динамических систем с параметрами антикризисных решений. Разработана технология конвергенции кризисных параметров жизненного цикла сложных многопараметрических динамических систем с параметрами антикризисных решений с целью оптимизации последних. Разработаны методы оценки степени близости между отдельными множествами параметров различной размерности при их конвергенции. Осуществлены практические испытания результатов исследования. Разработана информационная технология “DYCOS” поиска антикризисных решений в управлении сложными динамическими системами. Технология “DYCOS” использована при антикризисной перестройке учебного процесса во время карантина.*

***Ключевые слова**: информационная технология; антикризисные решения; сложные динамические системы; конвергенция; кризисные параметры; технология “DYCOS”*

Oborskyi, Hennadii
Research field: Metrological support of technical and organizational systems

Saveleva, Oksana
Research field: Information support of technical and organizational systems

Stanovska, Iraida
Research field: Crisis management of technical and organizational systems

Saukh, Igor
Research field: Information technology in technology and society