The Information System of Evolution Control of Multistage Processes of Production and Technical Systems in Fuzzy Dynamic Environments

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***Abstract*—The article takes up the information model of evolution control of multistage processes in fuzzy dynamic environments. A multistage process is considered as a multiagent system whose efficiency depends on a coordinated behavior of the center and agents, their interest in the search and implementation of solutions, skills of analyze capabilities of evolutionary development. For this model the algorithm of information support of the process is described.**

Keywords—information technologies, evolution control, multiagent systems, innovation solutions, coordinated optimization, algorithms.

I. The control of production and technical systems evolution on basis of innovations

In the articles [1, 2, 3 et al.] it is considered the evolution production problem by force of capitalization knowledge, experience and intellect of industrial personnel and the formal model of the evolution mechanism of intelligent production is proposed and researched.

It is determined conditions which provide progressive production development actively using knowledge.

The base of this development composes innovative activities pointing at searching and new decisions implementations for improving quality of products, technological and industrial engineering development.

Innovative activities include detection of enterprise problems, innovative process realization and innovative activities organization.

Purposeful innovative activities can only be realized in the presents innovative potential which includes production, scientific and technical, intellectual and personnel, marketing, financial and investment and information potentials.

The general task of effectiveness enterprise increasing and long-term enterprise stability during a whole life cycle consist in creation of methods and means for optimal control of production and technical systems evolution in the context of dynamic uncertainty.

Productivity enhancement achieves by virtue of continuous improvement of the technical processes on basis of innovation in the course of production and technical systems evolution.

A control process of production and technical system evolution is characterized a number of features, for examples, an alternative and an uncertainty of goal achievement ways with a high risk, an impossibility of accurate planning, orientation on predictive estimates and contradictoriness in the sphere of economic relations and interests of process participants.

A multistage process underlies a production and technical system and consists of a number of stages. A process state on the output of the every stage is the input of next stage and as a result of using control on the output to form a state whose output value is unknown in advance.

It is only known the fact that output and input variables are linked together by a fuzzy relation with a fuzzy set adjective depending on values of output and input states and a control variable. At each process stage an output and control are linked together by a respective fuzzy relation.

A control objective is set by fuzzy set which defines qualitative indicators of a last stage output. The task consists in finding a control consequentiality which ensures maximal implementation of a fuzzy objective in an each stage.

Modeling of fuzzy multistage process by means fuzzy relations and composition rules permits to realize synthesis of control with feedback and the concerned processes.

A formal model of a production and technical system describes a hierarchical interaction between the center and agents which operate the certain technological stage of a production process.

An each agent has activity and autonomy properties and participates in operating of a certain technological stage of a production process.

The center makes planned decisions about the output on basis of state analysis of production and technical systems. At the same time the center doesn't have an accurate notion about technological capabilities of agents.

In order to form an full agreed plan in view of all global and local restrictions which reflect the center and agents interests it is necessary to develop special procedures of expert information acquisition and an exchange of this information between the center and agents.

In fuzzy dynamic environment a control process of production and technical systems evolution is characterized number of features, for examples, an alternative and an uncertainty of goal achievement ways with a high risk, an impossibility of accurate planning, orientation on predictive estimates and contradictoriness in the sphere of economic relations and interests of process participants.

Modeling of fuzzy multistage process by means fuzzy relations and composition rules permits to realize synthesis of control with feedback of the concerned process.

II. THE INFORMATION SYSTEM OF INNOVATIVE SUPPORT

Methodology of formation of information innovations support system for control of manufactured evolution it can be shown on a particular case of control of n-stages technological process (fig. 1).

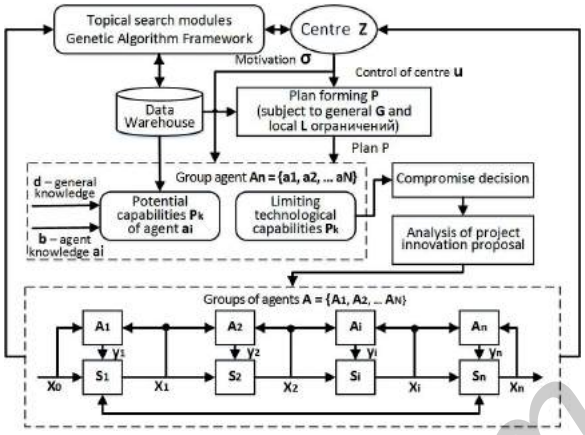

Figure 1. The scheme of control of n-stages technological process

An agents group A_n controls each stage s_n. The centre Z sets the plan p subject to local l and general g limitings and analysis of received information. It controls an agents group A_n when it controls a potential capabilities growth of an each agent a_n (fig. 2).

At the same time it is known that an agent has general knowledge d. This knowledge is known by both an agent a_n and the centre Z. In addition an agent has knowledge b which is known by only an agent a_n. And an agent a_n has knowledge, receiving as result of searching algorithms using. This knowledge is used by an agent for forming of information about its capabilities during execution of technological functions.

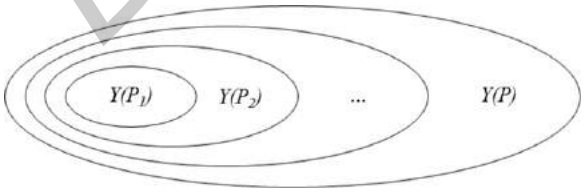

Figure 2. The growth of limiting capabilities agent during control process

The control algorithm of production and technical system evolution involves following blocks:

- a description of general tasks of technological system functioning. This part describes supporting subsystem such as means of production, resources, executives; technological means as mean technique, specific means, support of technological system performance and others.
- a description of a computational process in the performance of a tasks of information processing and control of equipment, apparatus, supervision systems. There are presented structure elements of technological system and their interaction.
- a description tasks of system evolution control. This part describes basic control ways of evolution technological system:
  - on basis of control of personnel potential capabilities increase, for example, new methods of motivation control and forming by personnel information about their capabilities (studying an experience of other analogous enterprises, professional development, studying new professional literature and etc.);
  - on basis of control of limit technological capabilities increase (for examples, an introduction of new ways and possibilities of equipment exploitation, production units, existing equipment modernization, technological stages adjustment etc.);
  - on basis of execution of production plan (for examples, solutions introduction which influence limitation)

The general algorithm description contains a description of block connections by output and input information [4]. The scheme of information processing in control process of evolution of a continuous industrial process which contains several technological subprocesses presents in the figure 3.

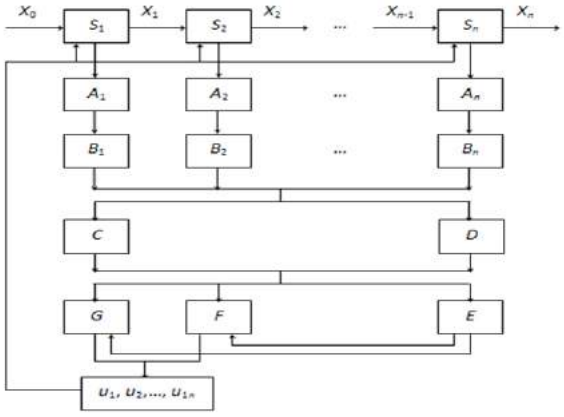

Figure 3. The scheme of information processing in control process of evolution

A continuous industrial process contains stages $S_1, S_2, \ldots, S_N$, where x_n – input process state of n stage, $x_n + 1$ - output process state.

$A_1, A_2, \ldots, A_N$ – first stage of information gathering concerned with manufacturing equipment and supporting subsystems. In addition, information about system state of control

instrumentation is received by means of predefined time interval.

$B_1, B_2, \ldots, B_N$ - second stage of information gathering. Data B received on the first stage classify by characteristic group and information receipt time.

C – on basis of checking and analysis of a data set received on the stage B it forms conclusion about moral and technical state of equipment, supervision systems by means comparison actual data and the best characteristics of analogous production.

D – on this stage it realizes quality results check of an each stage of technological system.

Next stage of evolution control involves contraction following information:

E – search for innovative solutions for evolution control of a fuzzy system.

This stage is one of the most importance stage for technological system control, because deficient values of quality production parameters, supporting systems parameters and a deficient level of manufacturing equipment are discovered in the course of technological system functioning.

Therefore enterprise managers have to form a control decision for improving technological system state.

There are a lot of subsidiary information in data depositories of distributed information systems. Besides an every technological system contains an intellectual resource which can use by skillful construction of motivational control.

A task of searching, collection , generalization and synthesis of control solutions and preanalysis of innovation offers results for effectiveness increase of system functioning in the large is the challenge for enterprise managers at different level.

F – planning of collection and generalization source information functioning, applications processing of supporting systems. In accordance with technical regulation a chart of receiving and further processing primary information is forming. As appropriate an adjustment of this chart is realized.

In the monitoring of production system along with general tasks of receive information about stages of concerned technological system and their stable support it need to solve additional tasks about support of equipment operability, controlling and measuring apparatus systems and check of their state.

Applications for solving similar tasks cluster to priorities table

- 1 – applications of primary information processing;
- 2 – a list of periodical applications of secondary information;
- 3 – a list of official applications.

An objective of grouping applications is possibility of operative decision-making for addressing and prevention emergency situations with the support of technology regulation implementation and an adjustment of introduced innovative technology.

G – analysis, modeling and forecasting stage. This stage solve a problem of introduced innovations purposefulness in technological process and forming of control impacts connected with technological system evolution.

In developing programme complex realized algorithm of control of production and technological system evolution it need to use typical software which consist:

- components of primary fuzzy information processing;
- components of secondary fuzzy information processing;
- complex of exchange information with equipment and controlling and measuring apparatus and automatic systems;
- complex of technical state equipment check;
- complex of jobs planning involving components of forming of timing chart for control system functioning;
- complex of analysis, modeling and planning;
- complex of innovative solutions searching for improving a technological process;
- complex of results production check (economic efficiency, production quality and other)

The task solution of effective control of industrial production substantially depend on information support of innovations at an enterprise.

An enterprise information potential provides quality realization of all the other potential.

The information receiving by topical retrieval is used for:

- control of the growth centre of potential and limiting manufacturing capability of the agent;
- production plan developing by the centre;
- forming of information by the agent about its capabilities;

For information influence on intellectual agents subject conception it used searching and knowledge extraction means from distributed data warehouse and their implementation in decision support systems

Creating system of intellectual information innovations support at the enterprise is based on mechanisms integration of innovative solution searching, appropriate data warehouse, control methods of industrial production evolution with the use of the created warehouse of innovative solution including information exchange means in accordance with coordinated optimization algorithms and identification manufacturing characteristics.

Creating those systems is the central problem occurring during creation of enterprise evolution control system.

Effective use of global information knowledge stream includes competitive analysis and technological development

forecasting which are based on scientometric analytical services and semantic systems of searching commercial valuable information.

In this connection a key role is play by effective algorithms oriented to an expert topical search of innovative solutions both in global and in local data specialized warehouse.

Execution of topical searching in documentary warehouse is the well-known procedure [5, 6, 7].

Documentation topical retrieval establishes document selection goal, containing coordinated information (interrelated facts, their retrospection and perspective) in a thematic segment or by the given object.

The result of this retrieval is document aggregate which are integrally relevant given themes not only information about specific cases, objects, phenomena.

Ranges of topical retrieval application: innovative solution searching, determination of new direction for business, information gathering about clients, competitive analysis and exploration, reviews of scientific and technical data source, project examination, patent research and instructional materials.

When topical retrieval is being realized, the key role is played by effective searching algorithms inasmuch as users impact with problems series troubling necessary information searching.

The effective searching algorithm is proposed in [8].

III. Conclusion

Example of how to use this approach for evolution control of chemical and technological systems on basis of innovations is proposed in [4].

Use of information system of innovative support permits to find and make a decision about inclusion in a technological scheme additional operations and raw material handling stages.

In addition, on basis of additional information analysis it made the decision about need of certain substances substitution, taking part in a technological process on stage n by other similar substances which have improved properties.

It allowed increasing a volume of production, indices of quality of finished products at the same time a finished products cost reduced on account reducing of an indirect material purchase cost for this stage.

Increase in profit occurred on account increasing enterprise functioning.

In this way, intellectual information support of innovations at an enterprise, based on integration of searching mechanisms of innovative solutions, models and methods of manufactured evolution control, use of coordinated optimization algorithms for manufacturing characteristics, allows to stimulate innovative searching and thereby improves technological and economical indices of enterprise functioning.

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ИНФОРМАЦИОННАЯ СИСТЕМА УПРАВЛЕНИЯ ЭВОЛЮЦИЕЙ МНОГОСТАДИЙНЫХ ПРОИЗВОДСТВЕННО - ТЕХНИЧЕСКИХ СИСТЕМ В НЕЧЕТКОЙ ДИНАМИЧЕСКОЙ СРЕДЕ

Палюх Б.В., Ветров А.Н., Егерева И.А., Козлова Ю.Г.

Рассмотрена информационная модель управления эволюцией многостадийных производственно - технических систем в нечеткой динамической среде. Многостадийный процесс рассматривается как многоагентная система, эффективность управления которой зависит от согласованного поведения центра и агентов, их заинтересованности в поиске и внедрении инновационных решений, умения анализировать возможности эволюционного развития. Для представленной модели описан алгоритм информационной поддержки процесса эволюционного развития. Рассмотрены вопросы осуществления экспертного тематического поиска инновационных решений в глобальных и локальных специализированных хранилищах данных. Приведены компоненты типового программного обеспечения необходимого для разработки программного комплекса, реализующего алгоритм управления эволюцией производственно-технологической системы.