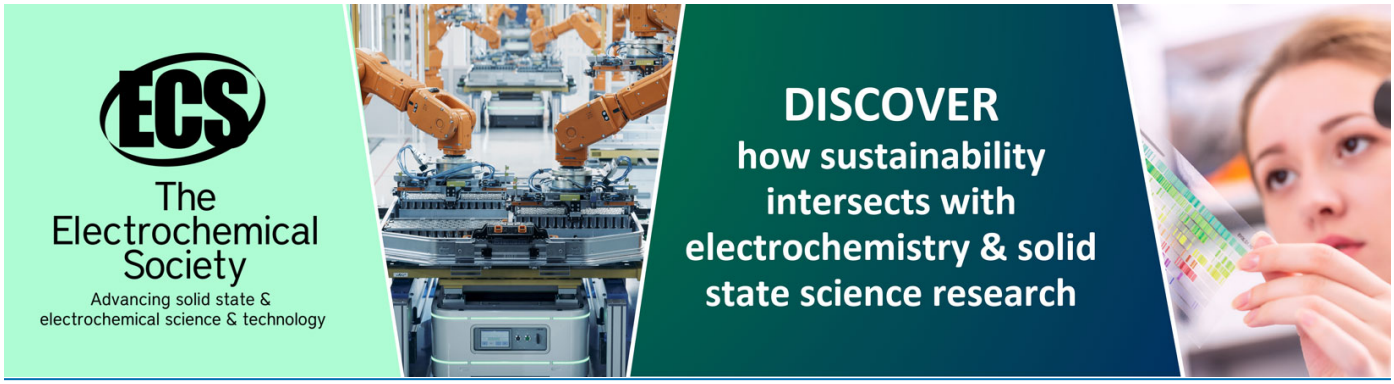
Technology of Effective Polytechnical Training at the Basis of Creation of Ontologies



Technology of Effective Polytechnical Training at the Basis of Creation of Ontologies

V A Dolyatovskiy[1], Y V Gamaley[1], L V Dolyatovskiy[1]

[1]Rostov state economic university, Rostov-on-Don, Russia

E-mail: dvaleri@inbox.ru

Abstract. The problem of growth of volume of engineering knowledge and their difficulties is considered when developing and using high technology productions and high technologies in regions. Growth of requirements to competences of engineering personnel and need of structurization and systematization of knowledge result in need of application of ontologic approach to polytechnic education. The expediency of forming of ontologies of two levels is shown: models of subject domain for understanding of essence of the engineering sphere and the structured set of elements of applied knowledge (ontology of the second order), are formalized the maintenance of simple and expanded ontologies. The formal structure of the virtual training environments for engineering education is defined, examples of the developed virtual environments for all levels of training are provided, the efficiency of their practical application is shown.

1. Introduction

According to the expert opinion [1], up to 40% of GDP developed countries receive as a result of effective education system. So, if in the USA in 1955 the contribution of the intellectual sphere to GDP has made 25%, then in 1980 – more than 60%, in 2007 – more than 70%. The effective education system is necessary for development of economy and society, the higher education has to develop continuously and evolutionarily that will contribute to the maximum accumulation and the development of intellectual and human capital in society. Special importance in the conditions of implementation of difficult technologies has polytechnic education. In it is the most important condition of adaptivity of reproduction of intellectual capital in this sphere. New approach to the organization of training processes is necessary for increase in the index of economy of knowledge. More attention began to be paid to engineering education in recent years about what the national conference on problems of engineering education in NPI [1] speaks. Ontologic approach [2] becomes one of the perspective directions of development of polytechnic education. Ontologies began to be applied to the organization of remote education [3,4], structurization of training materials [5,6], creation of object-oriented management systems by the enterprises [7]. However now in training of engineers technologies of training at fundamentals of ontologies are a little applied. In article approach to expanded application of ontologies in polytechnic education and development on this basis of the virtual training environments (VIOS) is considered.

2. Essence of ontologic approach to training and education

By T. de Chardin's determination, knowledge shares on declarative ("as the world is arranged") and procedural (methods of transformation of the world). In the world of the equipment the understanding of processes in technical systems and the organization of activity of the engineer (fig. 1) is necessary.

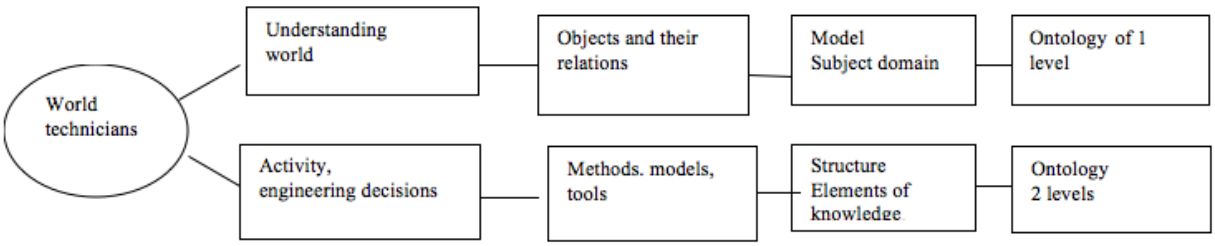


Figure1. Features of the organization of engineering activity.

On the basis of separation of process of acquisition of knowledge use of ontologic approach to the organization of activity of the engineer and to his training is rational. The ontology - the doctrine about real, studying of fundamental bases of life, its basic structure, i.e. ontology gives the general description of any sphere of activity.

In extremely simplified, but rather correct form can define ontology as set of concepts given ON, their properties and communications between them. Justification of ontologies is based on practical experience.

Inspections of levels of knowledge of students of older years of the university have shown that real indicators of their preparation differ from desirable [2,7]. The chart reflecting average estimates of the carried-out questioning is provided on fig. 2.

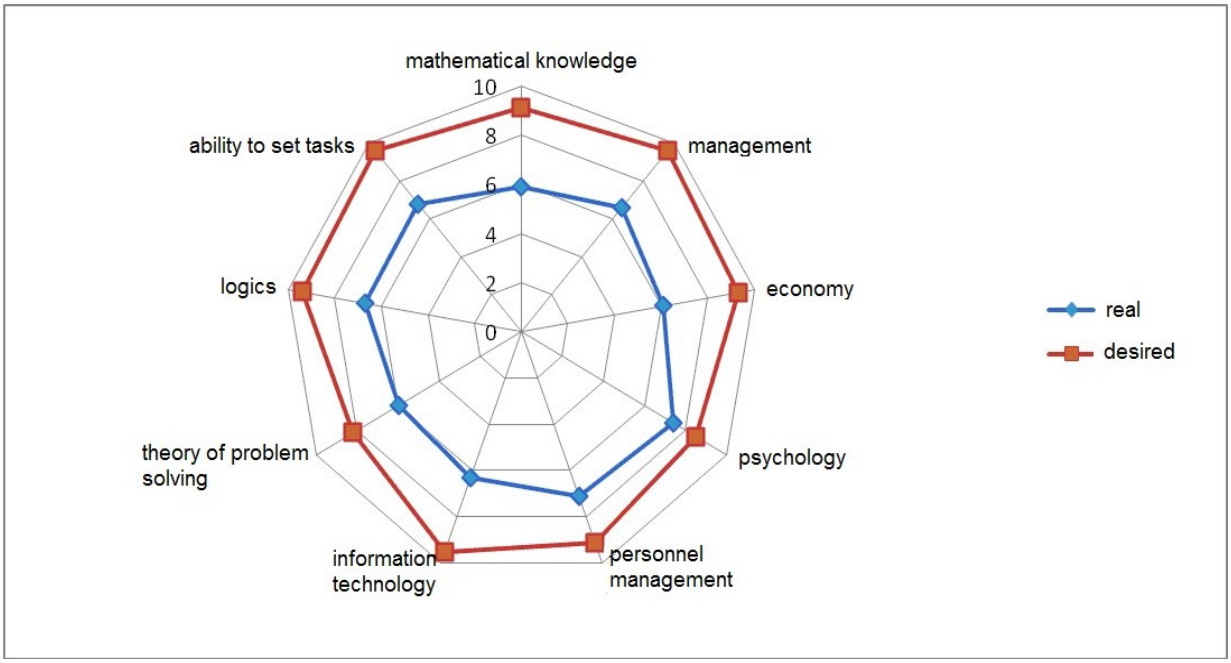


Figure 2. The chart of estimates of knowledge (on the basis of questioning of students).

At average value of level of knowledge 6,54 desirable were equal 9,14 (the corresponding values $\sigma 1 = 0{,}51$, $\sigma 2 = 0{,}42$, results are reliable with $p = 0{,}9$) and deviations of points are provided in fig. 3.

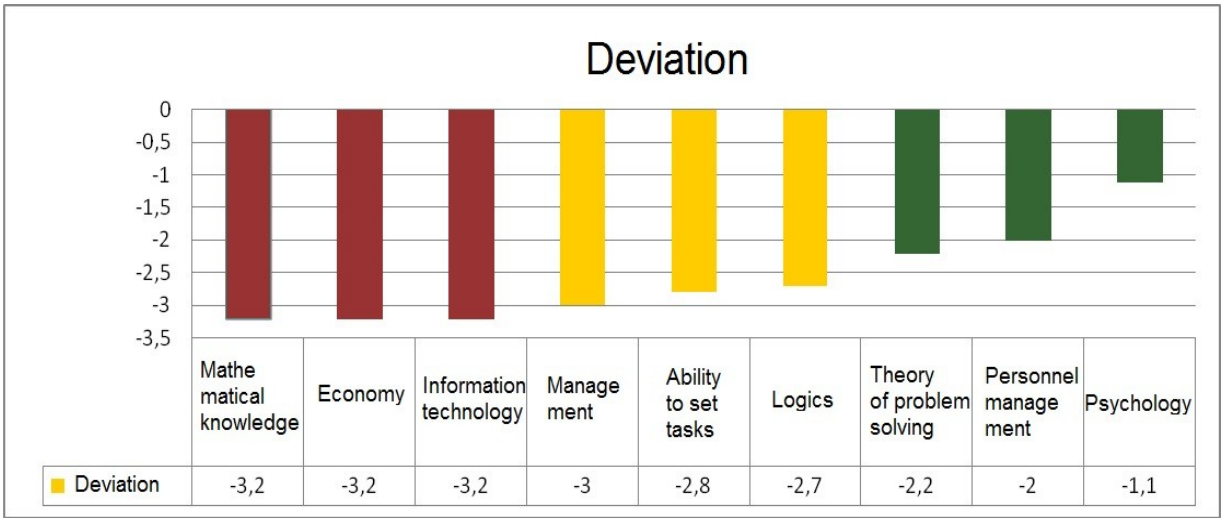


Figure 3. Results of AVS – variance analysis of indicators of levels of knowledge.

Conclusion that weak points in knowledge of disciplines - economy, mathematics of knowledge and information technologies follows. Are the reasons of this provision, in opinions of students, insufficient structuredness and constructibility of concepts and elements of knowledge (methods, models, tools of the solution of tasks), not systemacity of teaching, old technologies. Transition to the new concept of training allowing to eliminate contradictions between is necessary for the existing and demanded training systems.

3. The system of knowledge and the virtual training environments

In practice of human activity it is important to have opportunity to quickly gain knowledge of certain sphere of activity. For this purpose there have to be accurate descriptions of concepts and their communications. The accurate description assumes compliance between the designated object (denotaty) and its description. For such compliance several tools (fig. 4) are used.

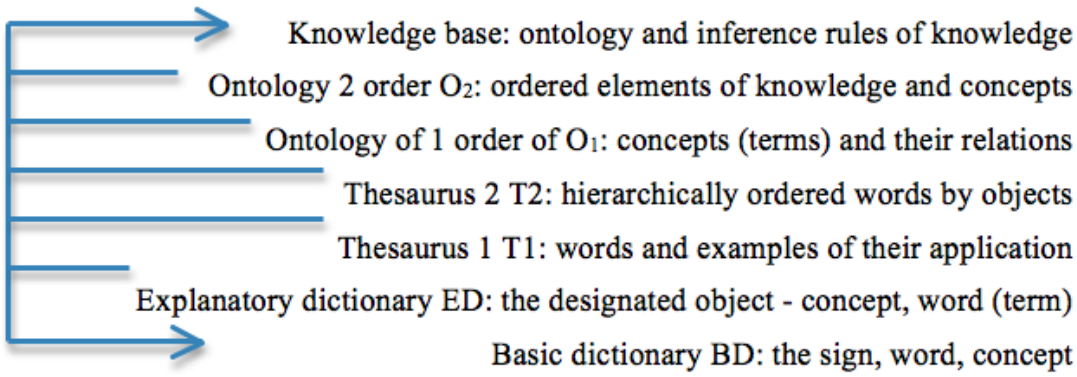


Figure 4. Means of systematization of objects (concepts, objects, knowledge).

Dictionaries (glossaries) are necessary instruments of systematization and explanation of sense of the concepts used in training course. The glossary is, in fact, ontology of zero order in which there are no relations of concepts. The term "thesaurus" by origin linguistic, in Latin designates wealth. In it there were examples of the uses of rare Latin words in the beginning, it is the thesaurus-1 (T1). Further there was thought - to arrange these words on their objects (denotat) and to classify them in hierarchic-

al structures. Then it will be the thesaurus of other type - the thesaurus-2 or T2. For example, the thesaurus of NASA contains millions of terms on rocket and space engineering and the concepts integrated to them. On the basis of thesauruses the problem of effective communication in the course of productive activity is solved. Increase in the index of human development also demands change of the concept of training, increase in knowledge intensity and practical orientation of training.

The general ontology is kind of network model of knowledge and is determined by the four:

Oextended = { Omt, (Opr, Otc), MC }, (1)

where Omt – ontology of the higher order (metaontology), operates with the general concepts,

Opt – subject ontology, objects, the relations, interpretation,

Otc – ontology of elements of knowledge, methods, models, tools of the solution of tasks,

MC - output machine model.

The information stream contains information noise in training process + useful knowledge, the ontology allows to reduce noise at the expense of pulling like distribution of knowledge. On the basis of the analysis of requirements of employers it is possible to allocate priorities of knowledge and to estimate the required depth of preparation by the size of ontologies.

4. Creation of the training virtual environments

In training process the student has to create mobile problem-oriented knowledge bases under professional tasks. Knowledge bases create skills and abilities, define systems thinking. Four basic elements (fig. 5) participate in educational process. they are aimed at development in the student of skills of allocation, assimilation and use of knowledge in different problem situations.

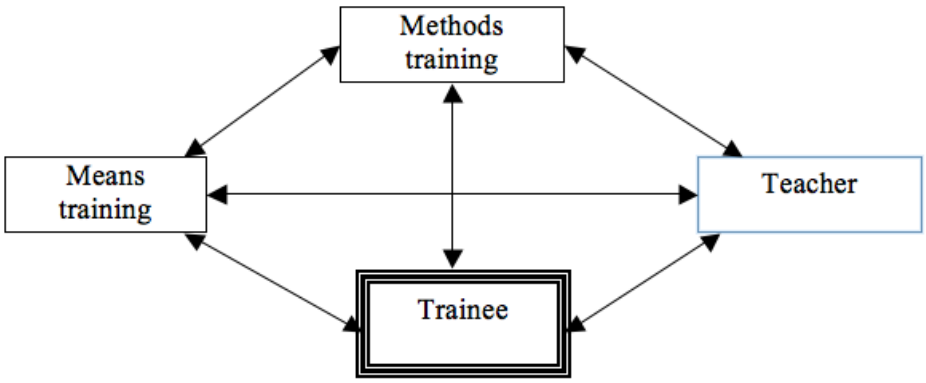


Figure 5. Training system Elements.

Therefore training provides acquisition of knowledge and forming of abilities, on the basis of abilities the specialist solves set of professional problems, on this basis competences (fig. 6) form.

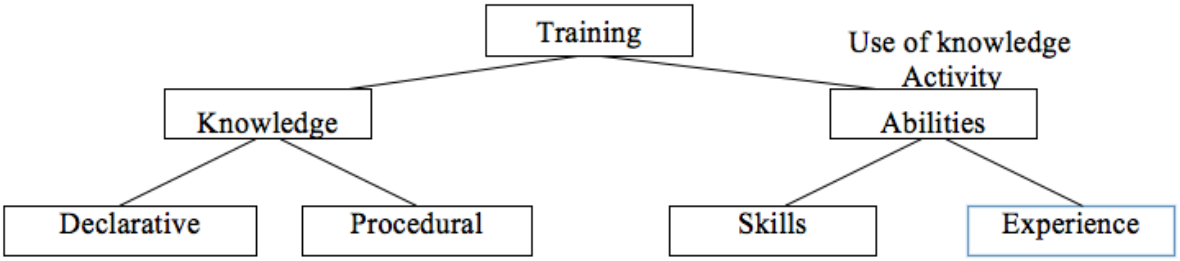


Figure 6. System of Forming of Competences.

On the basis of such separation of process of acquisition of knowledge use of ontologic approach to training is rational. The ontology - the doctrine about real, studying of fundamental bases of life, its basic structure, i.e. ontology gives the general description of any sphere of activity. In information science the ontology gives schemes of conceptualization of knowledge where in the form of concepts objects of the real world and communication between them are used. Formally the ontology of sphere of activity of the specialist can be described the six of sizes:

O = <T, S, Z, EZ, Sez, R> (2)

where T-set of terms (objects) characterizing subject domain

S - set of semantic links in subject domain,

Z - set of the professional tasks solved by the specialist

EZ - set of elements of knowledge applicable for the solution of problems of Z,

SEZ - communications of the applied elements of knowledge of EZ,

R - results of the solution of professional tasks.

The ontology of specific objective consists of set of objects - basic terms and their communications and the applied elements of knowledge (fig. 7). Knowledge is set of the data forming the complete description corresponding to some level of awareness on the described subject, event, problem, etc. Besides knowledge has such property as activity, that is they are not static element, and change eventually and allow to bring out of them new knowledge. Knowledge applied by the engineer has declarative and procedural character (fig. 7).

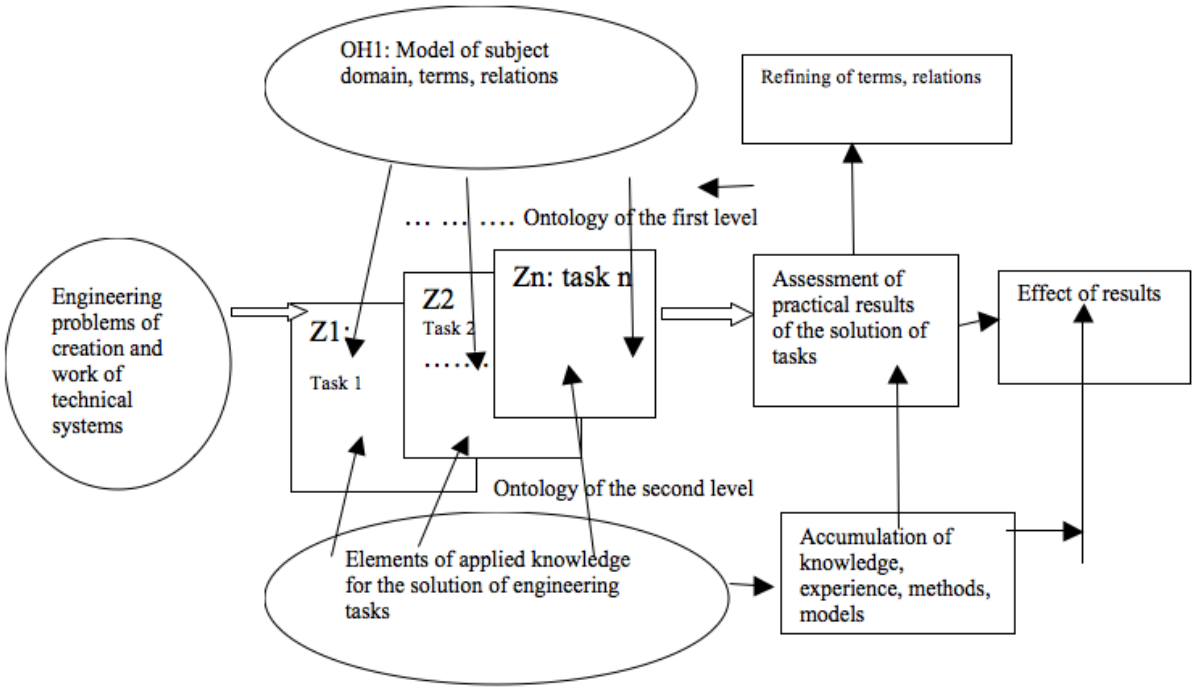


Figure 7. Scheme of professional activity of the engineer.

The engineer in the professional activity solves number of problems of

Z = [Z1, Z2 , … Zm] (3)

The space of these tasks creates field of activity P in which the engineer uses set of terms (concepts) Wij connected with tasks Zi and elements of knowledge E31 … E3K, which integrate in classes of knowledge of NDK (fig. 7).

The model of subject domain represents structure of the applied terms and transactions of their semantic conclusion.

It is formally possible to write down in terms of object grammar of the relation of objects:

Profit: = (Income of TR) - (Complete costs)
Income: = (Price p) * (Quantity)
Complete costs of ST: = (Fixed costs of CF) (Variable costs of CV)
Price:: = (Cost value of ACV) + (Specific profit of b)
Quantity of Q:: = (the extent of demand) + (Stock for implementation),

Real data in economy have the structure consisting of object ωκ and predicates P different types: time, place, appointment, etc.:

$$D = \omega\kappa\ Pt\ .Pp.Pn \quad (4)$$

so when forming the database it is necessary to add the necessary predicates to objects.

Thus, for forming of competences for the solution of separate professional tasks it is necessary to create semantic structure of subject domain in consciousness of the trainee and to give skills of the choice and application of necessary elements of knowledge. That is the curriculum has to form on the basis of declarative components in the form of model of subject domain and procedural knowledges at the level of sets of elements of knowledge which have to create the system of skills in special courses.

5. Implementation of the offered concept

The concept of development of the virtual training environments (VIOS) for higher education institution is implemented at design of ontologies of training of specialists of different levels: bachelor, master, graduate student, MBA [6-9]. The virtual training environment represents the structure consisting of sets of the structured special courses constructed by the modular principle:

Course = <the electronic textbook, practical work, the thesaurus, cases, tests of three levels of complexity, video cases and clips according to sections of courses, trainings, the system of the automated control> /

Concepts are systematized in training courses in the form of model of subject domain: terms and their ratios are presented in the grammar form. The knowledge base has appearance:

$$BZ = <EZ, SEZ, Rez/z> \quad (5)$$

where, Rez/z – display of professional tasks to elements of knowledge.

For example, the economy course for managers [9] contains 24 elements of knowledge in the knowledge base which define methods of the solution of complex of professional tasks of the engineer manager and create necessary competences for economic case of the made decisions:

EZ1 - method of the choice of decisions for receiving maximum yield of firm in the known market,
EZ2 - method of calculation of the mode of firm providing the minimum cost value of product
EZ3 - method of calculation of the decisions providing the maximum profit in the known market
EZ4 - method of determination of the mode of steady work of firm, etc.

Application of such approach to structurization of knowledge and to forming of the virtual training environments has shown outstanding performance of assimilation of knowledge by students of specialty management. Achievement quotients have on average increased by 20% that has affected also quality of final qualification and term papers.

6. References

[1] 2017 Fundamental bases of engineering education in Russia Materials national ion. Scientific conf., YuRGTU (NPI) devoted to the 110 anniversary of M. Platov Novocherkassk: *YuRGTU* 302
[2] Gavrilova T A, Leshcheva I A, Leshchev D V 2000 Use of ontologies as didactic means *Artificial intelligence* **3** 34-39
[3] Danchenko A L Development of ontologic model of representation of the known remote courses http://semanticfuture.net/index.php
[4] Conceptual modeling of educational theories: an ontological approach http://iadisportal.org/digital-library/conceptual-modelling-of-educational-theories-an-ontological-approach

[5] Gruber T R The role of common ontology in achieving sharable, reusable knowledge bases http://www.cin.ufpe.br/~mtcfa/files/ 10.1.1.35.1743.pdf.
[6] Dolyatovskiy V A 2006 The virtual training Master of Management environment Certificate **7404** M.:*INIM RAO-OFERNIO*
[7] Dolyatovskiy V A, Sergeenko G S 2002 Introduction to intellectual systems for managers Monograph Rostov-on-Don: *MYRTLE* 168
[8] Dolyatovskiy V A, Dolyatovskiy L V, Polukhina T I, Chebotaryov Yu A, Scheff A A 2008 The virtual training Bachelor of Management environment Certificate No. 10389 of 18.04.2008 M.:*INIM RAO-OFERNIO*
[9] Dolyatovskiy L V, Dolyatovskiy V A, Sushchenko S A, Scheff A A 2016 Kompleks of programs of ontologic design of economic enterprise management Certificate No. 21763-from 12.04.2016 M.: *IUO of Russian joint stock company - OFERNIO*

Acknowledgments
The reported study was funded by RFBR according to the research project № 18-010-00663.