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Diagnostics of Inventive Thinking based on TRIZ methods

Abstract of TRIZ Master degree dissertation

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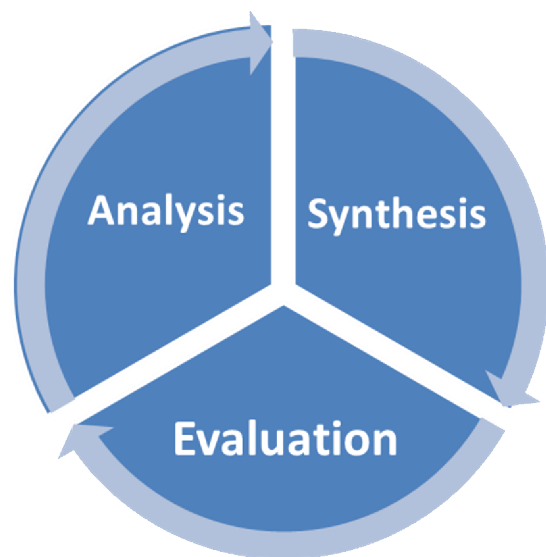
General characteristic of research

Inventive creativity as a process of formulation and solving of inventive problems is a logical stage in thinking evolution. This process, like many other complicated processes, developing in living matter, could be studied and described at the level of qualitative models.

The formation of inventive thinking of high level is the main goal of TRIZ training. The inventions of level 1-2 according to classification of G.S .Altshuller don't require inventive thinking, while divergent (creative) thinking is sufficient for creating them. In order to attain significant results, it is necessary to compose the training process in such a way, so that the level of development of all inventive thinking qualities should gradually increase, taking into account the individual peculiarities of the trainees, taking into account the age, professional experience, etc. In order to solve this problem, methodology of diagnostics of inventive thinking development was created.

As a source hypothesis a proposition was made that the model of inventive problem solving process, which forms the base for ARIZ, can be looked upon as a pattern of efficient inventive thinking. In order to verify this hypothesis, the analysis of reference sources was performed, a card catalogue of protocols of inventive problem solving was collected and the verification of practice of diagnostics methodology application was performed.

Based on the analysis of all modifications of ARIZ and other TRIZ tools, we developed a model of inventive thinking. It includes three main stages of solving an inventive problem: ANALYSIS of the system being modified, SYNTHESIS of a new



system, EVALUATION of proposed modifications. This model is implemented via using all TRIZ tools required for inventive problem solving, for example, techniques for resolving contradictions, standards for inventive problem solving. Certain thinking qualities are required for each stage. Based on the inventive thinking model, the system of Inventive Thinking Features (SITF) was developed. SITF enables to analyze the structure of inventive thinking and to obtain a detailed description of stages of inventive thinking evolution.

The proposed methodology is applied for diagnostics of inventive problem solving with children from 6 years of age, school graduates and grown-ups: with students of various specialties, with TRIZ courses trainees, teachers, engineers, software engineers, managers, etc. The research on the topic of diagnostic evolution is performed since 2000. Currently more than 1000 protocols of diagnostic work have been collected.

Inventive activity in a broad sense of this term is understood as finding a non-obvious solution in any kind of activity. The level of inventive thinking evolution could be evaluated by the results of creative activity, in other words, by the level of identified and solved inventive problems. We set the task of studying the stages of inventive systems evolution in the evolution of mankind and to single out those main types of inventive thinking.

Relevance of the topic of research

High-quality training of TRIZ specialists is the basis both for the development of TRIZ methodological component and for successful application of TRIZ methods in inventive activity in fairly different areas. TRIZ training programs should be based on such efficient tools as ARIZ, standards, TESE (Trends of Engineering Systems Evolution), function analysis. Currently TRIZ training and practice of applying efficient TRIZ tools is more and more often substituted by the general development of creative capacities, which does not offer high results in training and becomes the reason for decrease in quality of specialists

training. The problem of efficiency and quality of training makes it vital to create a reliable methodology of inventive thinking diagnostics.

SITF enables to identify the regularities of inventive thinking evolution in phylo- and ontogenesis.

Based on SITF, typology of inventive thinking was developed, which enables to forecast the peculiarities of formation and development of inventive thinking with trainees attending TRIZ training courses.

Goal and tasks of the research

The main goal of the research is to create a methodology of inventive thinking diagnostics based on TRIZ methods. It is proposed to use a set of inventive thinking features as main parameters for tracing the process of forming the inventive thinking.

In order to achieve this goal, it is necessary to solve the following problems:

- to analyze the methods of creative thinking diagnostics, which are accepted in psychology, identify specific features, which exist in TRIZ as applied to modeling the inventive creativity process;
- to create a qualitative model of inventive thinking process based on the analysis of different modifications of ARIZ and other TRIZ tools;
- to identify the main features of inventive thinking and to develop SITF, taking into account the levels of development of these features;
- to identify and to describe the stages of forming inventive thinking in ontogenesis, using SITF;
- to perform practical test of inventive thinking diagnostics methodologies, which were developed based on SITF;
- to identify and to describe the stages of phylogenies of inventive thinking using SITF;
- to develop the typology of inventive thinking based on SITF.

In diagnostic of inventive thinking such typology enables to forecast, at which level of inventive problems the activity of this or that person might be oriented and to offer recommendations for improvement of inventive thinking.

Scientific novelty of the research

- A hypothesis is offered concerning the possibility of using the model of inventive problems solving process, on which TRIZ tools are based, as a reference pattern of inventive thinking;
- SITF has been developed: detailed study of inventive thinking model, including the features of inventive thinking and the levels of their development;
- Methodology of SITF-based inventive thinking diagnostics has been developed and practically tested;
- Based on SITF typology of inventive thinking has been developed;
- The model of thinking evolution of the human is offered, which includes the formation of inventive thinking as an independent stage.

Practical significance of research

The main goal of TRIZ training is the formation of inventive thinking. To achieve this goal, the methodology of inventive thinking diagnostics has been created, which enables:

- to identify prime level of inventive thinking with trainees of TRIZ training courses;
- to correct the contents of TRIZ training sessions in keeping with the individual peculiarities of the trainees;
- to develop training programs, which enable to gradually form the inventive thinking level and to enhance this level;
- to evaluate the methodologies for developing creative capacities from the standpoint of inventive thinking formation;
- to select specialists, which are characterized by inventive thinking, for working on the projects;

– to select an individual program for independent work on the enhancement of inventive thinking level.

Formation of inventive thinking is a new stage in the evolution of mentality of the humans. Typology of inventive thinking, developed on the basis of SITF, enables to study the regularities of this stage of thinking evolution.

Main provisions of the present thesis

The model of inventive thinking has been created, which describes the solving of inventive problems as an interaction of processes for system ANALYSIS, SYNTHESIS of new systems and EVALUATION of proposed changes.

The System of Inventive Thinking Features has been created based on the analysis of ARIZ and structural pattern of the inventive creativity process.

SITF is the basis for development and research of:

- inventive thinking structure;
- methodology of diagnostics of inventive thinking development;
- methodological grounds for system of inventive thinking formation;
- main principles for evaluating the methods of developing creative capacities from the standpoint of inventive thinking formulation;
- stages of inventive thinking phylogenies;
- basic types of inventive thinking.

Personal contribution of the applicant

In order to trace the results of TRIZ training, the applicant set the task of identifying such features of thinking, which are necessary for fulfillment of successive steps of ARIZ and other TRIZ tools. After that, using the structural pattern of inventive creativity, which was proposed by G.S.Altshuller, levels of development of inventive thinking features were singled out and the System of Inventive Thinking Features (SITF) was developed.

The author singled out the following features of inventive thinking.

1. Analysis.

- A. Component analysis.
- B. Entrance to supersystem.
- C. Singling out of interactions and interdependences.
- D. Variation of systems in time.
- E. Sensitivity to contradictions.
- F. Ideal modeling.

2. Synthesis.

- G. Use of resources.
- H. Use of analogies.
- I. Flexibility (ability to generate vast number of various ideas).
- J. Application of techniques for resolving contradictions.

3. Evaluation.

- K. Sensitivity to resolving contradictions.
- L. Criticality.
- M. Uniqueness.

Based on SITF, the author created the methodology for diagnostics, using which it is possible to study the peculiarities of inventive thinking of trainees of TRIZ courses, correct the training programs and evaluate the level of inventive thinking of TRIZ specialists. Training programs for different age groups and for different specialties of TRIZ courses trainees were developed with regard to SITF. The work on studying the typology of inventive thinking has been started.

Testing of the work

Methodology of diagnostics of inventive thinking development was created for tracing the results of TRIZ training with junior schoolchildren in the gymnasium No.17 of the city of Petrozavodsk. After that the methodology of diagnostics was used for evaluation of works, which were submitted to MA TRIZ competition in solving creative problems for schoolchildren and students since 2000 till 2005. The first results of using the methodology were published in the materials of MA TRIZ conference “Creativity for the sake of dignified life”, Velikiy Novgorod, 2001.

In the course of later work the requirements to two types of diagnostics methodologies were formulated: standardized tests for evaluation of general level of inventive thinking with a whole group of trainees of the courses and the methodology intended for expert evaluation of the level of inventive thinking development with a particular person. Since 2002 the methodology for diagnostics of inventive thinking development has been successfully used by the teachers of junior forms. In 2004 diagnostics was performed with pupils of the 5th and 6th forms, later on the methodology was used by the teacher of biology; it was also tested with the graduates of gymnasium – a scientific paper was read at the pedagogical conference held at the gymnasium.

In 2009 diagnostics was performed with a group of trainees of courses from an IT company. The idea of developing a computer program for automatic counting of results appeared. For this purpose standardized tests were developed; and the forms of summing up the results were offered as inventive thinking development diagnostics summary.

In 2009 and 2010 diagnostics was performed as part of the seminars intended for engineers, managers and teachers. Comparison of all results obtained yielded a diagram of distribution of evaluations of inventive thinking stages. An idea appeared to study phylogenies of inventive thinking.

An important stage of the research was performing the diagnostics with the students of Winter school of Saint-Petersburg State University in 2010 and students of Summer School of Moscow Physical-and-Technical school in 2011. Introductory diagnostics and diagnostics based on the results of training were performed for the purpose of studying the individual growth of level of inventive thinking features with trainees of TRIZ courses. High-quality seminar on TRIZ increases the level of IT (Inventive Thinking) averagely by 0.5 point (approximately by 10%).

The work with schoolchildren continues. An approximate plan of monitoring the development of inventive thinking during the academic year with a permanent group of children. Training sessions were performed with teachers in Saint-

Petersburg Center of Children's (Youth) engineering creativity aimed at teaching the use of inventive thinking diagnostics methodology. The teachers of the Center use this methodology in their work.

Possibilities of further development of performed research

Further development of research in the field of inventive thinking could take the following directions:

- creation of basic inventory of tasks for diagnostics with the analysis of using these tasks at various stages of training;
- refinement of database of methods of inventive thinking features development with a detailed methodological analysis of using them for development of inventive thinking features;
- creating a computer program for processing the results of diagnostics; for this purpose it is necessary to prepare standardized tests for express diagnostics;
- studying the biographies of creative personalities from the standpoint of inventive thinking typology;
- studying the interdependence between trends of engineering evolution and regularities of phylogenies of inventive thinking.
- application of stages of phylogenies of inventive thinking for identifying the regularities of development of different areas of culture: science, art, politics, etc.

Publications of the author on the topic of research

1. Rubina N.V. Use of TRIZ methods for diagnostics of creative thinking. Petrozavodsk, 2001. <http://temm.ru/ru/section.php?docId=4378>
2. Rubina N.V. Use of TRIZ methods for diagnostics of creative thinking. MA TRIZ conference "Creativity for the purpose of dignified life", Veliky Novgorod, 2001. <http://triz.natm.ru/articles/rubina/rubina01.htm>
3. Rubina N.V. Use of TRIZ methods for diagnostics of creative thinking in gymnasium No. 17 of the city of Petrozavodsk. Summaries of papers read at the

Fourth international scientific and practical conference “Development of creative capacities of children involving the use of TRIZ elements”. Tchelyabinsk, June 25-27 2001. http://www.trizminsk.org/e/2350002_41.htm

4. N.V. Rubina, M.S. Rubin. TRIZ-education – experience of the Future. ETRIA World Conference, TRIZ FUTURE 2002, Strasbourg, France.

5. Rubina N.V. Scale for the talents. Diagnostics of creative thinking development. Summaries of papers read at “TRIZ-Fest-2009”, Saint-Petersburg, 2009.

6. Rubina N.V. System of Inventive Thinking Features (SITF). Methodology of inventive thinking diagnostics. Saint-Petersburg, 2009. <http://temm.ru/ru/section.php?docId=4454>

7. Murashkovsky Yu. S., Rubina N.V. Pedagogics: novelty and “novelty”. – “Narodnoye obrazovaniye”. M., 6/2009.

8. Rubina N.V. Inventive thinking: Formation and Diagnostics. International research conference “TRIZfest-2012”, Lappeenranta, Finland. August, 2-4, 2012.

9. Rubin M.S., Rubina N.V. Phylogenesis of inventive thinking. TRIZ-Summit-2013. Collection of materials, Kiev, 2013.

10. Rubina N.V. Structure of inventive thinking. TRIZ-Summit-2013. Collection of materials, Kiev, 2013.

Structure and volume of research

The work consists of introduction, five main sections, conclusion and three appendices with the description of inventive thinking monitoring, embracing 67 pages; it includes 11 figures, 8 tables, list of reference sources consisting of 35 titles and list of the publications of the author on the topic of the present thesis.