New Models and Methodology for Teaching OTSM[1]-TRIZ

Nikolai Khomenko
Alexander Sokol

ARIZ as a contradiction-resolving tool is the core of TRIZ. People who know and fully understand ARIZ-85-C (Last version of ARIZ made by Altshuller himself) can apply this tool not only to engineering problem solving. However, a number of problems arise when we turn to teaching TRIZ and ARIZ. In 1985 on the TRIZ conference in Petrozavodsk Altshuller pointed out that it was necessary to develop a new methodology for TRIZ education. This methodology was supposed to help teach people who did not have engineering education. That is why the given research was started. In order to solve the problem raised by Altshuller we had to provide lots of special research that helped us rearrange the system of TRIZ knowledge and add some new points [1-6]. This work was done under Altshuller's supervision. The given paper is the first English language information on the methodology we have developed and used at the TRIZ Technologies Center (Minsk, Belarus) since the end of 1980s. During last years our colleagues in various parts of the world started to employ the methodology in TRIZ education in their countries.

1. Key Contradiction

It is necessary to learn to make separate steps of ARIZ in order to learn to work with ARIZ and TRIZ as a whole. However, in order to make separate steps correctly, it is necessary to be able to work with ARIZ and TRIZ as a whole understanding connections and interactions between them, as every step of ARIZ implies working with the lines of contradiction analysis, resource analysis and ideal final result simultaneously.

The situation is getting even more complicated if we take into account that in the process of solving difficult problems we deal with the whole system of problems hidden under the one we seem to be solving. This explains most of difficulties connected with acquiring ARIZ and TRIZ as universal instruments of problem solving.

2. Ideal Final Result

It is necessary to develop a teaching methodology which will allow students to master separate elements and steps of the contradiction resolving algorithm and at the same time provide an opportunity to acquire basic elements of TRIZ, fundamental knowledge necessary for problem solving and additional models.

[1] At the beginning of 1980s more and more people started applying TRIZ not only to engineering problem solving but to different kinds of problem even in their private life. That is why Altshuller started writing in his articles and manuscripts that TRIZ had to be transformed into the General Theory of Strong Thinking. OTSM is a Russian abbreviation for the theory and at the same time the name given by Altshuller himself. As our research was provided under his supervision and he approved of our results, in July 1997 Altshuller granted N.Khomenko a permission to use the name OTSM for his research. This was done under the condition that every time the name was going to be used, its history must be explained. That is why this comment appears here.

3. Possible Solution

Additional models were developed to raise the efficiency of applying TRIZ-technologies beyond the field of engineering, i.e. to management, education, linguistics etc. (see pictures 1 and 2)

These models are based on the set of fundamental skills comprising everything that has been developed within the domain of TRIZ. The emphasis is put on the skills essential for contradiction resolving on the basis of objective laws of system evolution, for resolving contradictions underlying a specific problematic situation appears the most universal tool of a successful problem solving process.

The given methodology has been developed since 1985. During this time it was put to the test with various professional audiences starting from scientists and engineers to pre-school teachers and managers. Some key elements and technologies were piloted with pre-school and school pupils. The key contradiction was always resolved. Moreover, two other problems essential for TRIZ education were automatically resolved when the proposed methodology was employed:

- Students understood how TRIZ could be applied beyond the field of engineering;
- Students acquired the method of parallel analysis of the whole complex of interconnected problems. This brought us to solution of internal contradictions of ARIZ connected with the choice of resources and transition from Physical Contradiction to its resolution.

In the given paper we would like to propose a list of skills that can be acquired by means of our original training and educational technology. During our classes students master a number of problem solving skills which are not limited to the field of engineering. These skills can be applied to all types of problems that can be presented in terms of contradicting requirements.

The proposed set of skills helps us apply TRIZ methodology to make a thorough analysis of both problem situation and resources that can be used for solving a particular problem. These skills help us compose an image (abstract description) of solution and then to transform the abstract and general description of solution into a specific solution of the initial problem.

Our theoretical and educational methodology was developed to describe general knowledge about the problem solving process and, more importantly, to define how to apply this general knowledge to obtain specific solutions to specific problems in different areas of human activities.

Group 0 – Skill Number One

- Ability to ask a strong question that can reduce the *Solution Search Space.*

Group 1 – The Model Vision of the World

- ability to think in terms of models;
- ability to see the Applicability Limits of a given Model;
- ability to compose unlimited number of models of a given Element, each with different degree of abstraction and accuracy from different points of view (using the Full Scheme Model);
- ability to employ Models which break causal relationships between the events;
- ability to withdraw from individual experience and peculiarities of personal perception of a situation. Ability to simultaneously view the situation from the vantage point of other participants and an impartial observer.

Group 2 – The Main Model for Description of an *Element* (substantial or non-substantial): ELEMENT – NAME OF FEATURE – VALUE OF FEATURE

- ability to describe an Element as a set of Features;
- ability to describe a Feature as an Element that has a Name and a Value: one Name of

Feature and several various Values of Feature;

- ability to describe Process as an Element;
- ability to describe Fact as a change of one Value to another under the same Name of Feature;
- ability to describe Phenomena or Objective Laws of System (Element) Evolution as causes and effects of several Facts: one or several effects is a cause of at least one other effect;
- ability to see Laws of Evolution, Phenomena, Effect or Function as a result of interaction of several Elements (using the Full Scheme Model);
- ability to see the Function of a System (or an Element) as one of its Features: the Systemshape Feature;
- ability to describe a System as a set of Elements (using the Full Scheme Model) providing the given Systemshape Feature;
- ability to vary the Values of Element Features on a large scale and track the changes in the Full Scheme Model of Elements (i.e. in the world). Ability to track the qualitative changes of other features caused by the procedure of varying the values. Such changes which lead to the qualitative leap in the Full Scheme Model;
- ability to find Elements using their description presented as a List of Features or/and List of Values of Features.

Group 3 – The Full Scheme Model of World Elements

- ability to recognize Elements using the Full Scheme Model;
- ability to employ impossible, exceptional, fantastic. Ability to think beyond possible and real;
- ability to employ mechanisms allowing free but controlled mental move from a specific real situation towards a fantastic situation and backwards from the fantastic situation to the real one. Ability to make distinctions between real and imaginary. Ability to use fantastic, fairy and any other imaginary transformations for problem solving. Ability to turn fantastic assumptions to reality ("The Golden Fish" technique);
- ability to broaden the area of the considered variants beyond known and naturally possible to the field of unknown and impossible where causal relationships are broken;
- ability to navigate in the space of Objective and Subjective Factors. Ability to differentiate between them;
- ability to describe Elements at different Levels of Abstraction;
- ability to see an Element as a whole of other Elements and a part of a larger set of elements;
- ability to see an Element in the process of its transformation in accordance with Objective Laws, regularities and effects;
- ability to see an Element in the Hierarchy of Elements of the world;
- ability to see Evolution of an Element – how the Past could predetermine the Present and how the Present can predetermine the Future2;
- ability to see an Element and all of its Anti-Elements.

Group 4 – The Resource Model

- ability to find and use Resources necessary for problem solving on the basis of the Main Model and the Full Scheme Model; ability to combine resources with Elements of Supersystem and their derivatives; the use of Internal Resources (those of Subsystems) and their derivatives, the use of Modification of any Resources in time: not only their condition in the present, but also in the past and the future;

[2] Here we include all possible alternatives of time in both the past and the future. We may see the Present as the cross point of a number of lines which can be drawn from the past to the future with a different degree of probability.

- ability to find resources necessary for the Problem Situation Solution beyond the possibilities of the described situation (including the use of the Main Model and the Full Scheme Model)

Group 5 – The Ideality Model

- ability to compose an ideal model of Elements using different levels of Ideality and the Systemshape Feature;
- ability to formulate a particular Ideal Final Result (IFR) for a particular Contradiction;
- ability to see the difference between Contradiction and Ideal Final Result;
- ability to compose an ideal model of the Problem Solution using different levels of Ideality.

Group 6 – The Contradiction Model

- ability to see Contradiction as a barrier on the way from Resources of Initial Problem Situation to Ideal Final Solution;
- ability to recognise Contradiction as the Underlying Cause of all problems;
- ability to see Contradictions and employ them;
- ability to intensify Contradiction in order to reduce the Solution Search Space;
- ability to recognise various types of Contradictions in Problem Situation;
- ability to see, perceive and employ opposites (their combination and interplay)
- ability to see undesirable negative consequences of positive desirable results and vice versa: ability to see desirable positive consequences of negative undesirable results;
- ability to see a System of Contradictions using the Full Scheme Model.

Group 7 – The Problem Situation Model

- ability to recognise the Underlying Cause of the Problem;
- ability to analyze any Problem Situation taking into account its Specific Conditions and variants of their evolution;
- ability to see the whole Hierarchy of Problems behind a given problem in accordance with the Full Scheme Model;
- ability to analyze the Problem Situation in the same way as any other element of the world;
- ability to choose (using the Full Scheme Model) from the System of Problems exactly that problem (and at that moment of time) the solution to which will produce the best effect at a given stage of evolution;

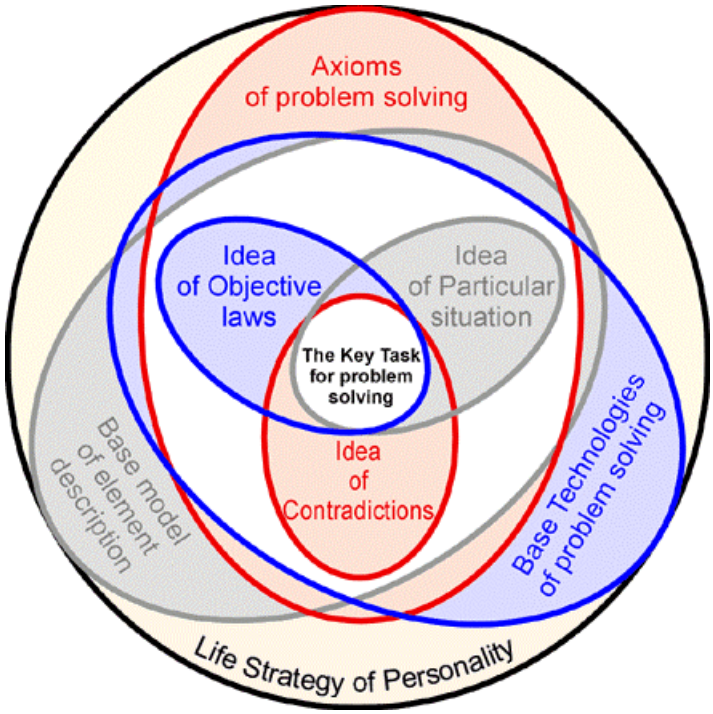
- Group 8 – The Problem Solution Model
- ability to differentiate between the estimation of Partial and Final Solutions3;
- ability to use common sense and the OTSM-TRIZ tools in order to reduce the Solution Search Space during the process of problem solving;
- ability to extract Key Elements of Problem Situations –elements which cause the largest number of undesirable effects and contradictions;
- ability to estimate and take account of the Processes Predetermination Degree in the past and the future;
- ability to find Partial Solutions to a Problem and transform them to a Complex Solution adequate for a current specific situation;
- ability to admit the need to solve a completely different problem hidden under the mask of a given situation. Being ready to refuse from solving a given problem if it is forced by external circumstances.

[3] In the former case it is important to get at least a bit of positive result (without paying attention to negative consequences). In the latter case it is necessary to pay more attention to negative results, tipping the balance between positive and negative consequences.

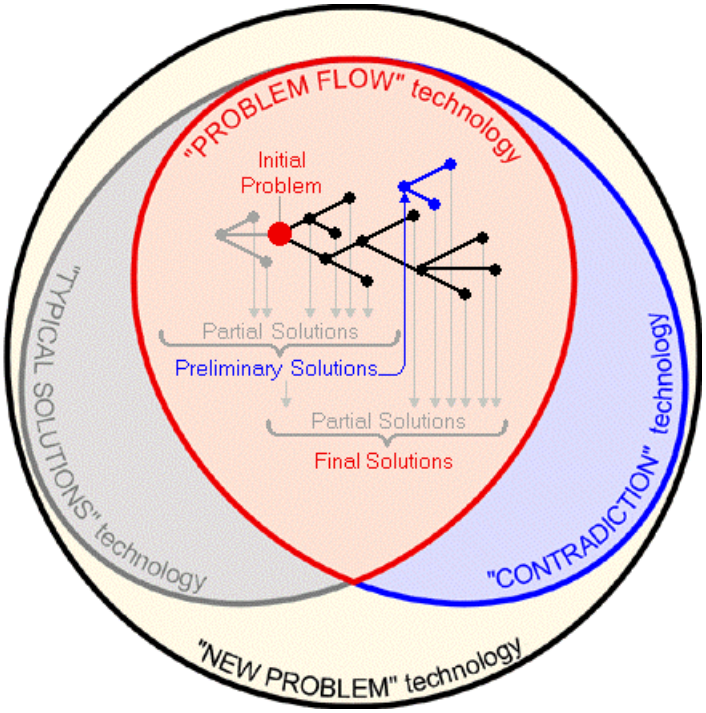
Group 9 – TRTL (The Theory of Creative Personality Development of G.Altshuller & I.Vertkin)

- having a new or unachieved ultimate Goal (or a System of Goals) which is worthy and valuable to the community;
- having a Program of Activities (or several programs) aimed at achieving the defined goal and controlling the process of its execution;
- Motivation and Concrete Results in carrying the heavy workload necessary to be in accord with a plan;
- ability to solve problems encountered on the way to the Goal;
- ability to defend one's own ideas, bear public unacknowledgement and incomprehension, ability "to stand punishment" and keep loyal to the Goal;
- Commensurability of Achievements (or their dimension) with the defined Goal.

Picture 1. Main Scheme of OTSM-TRIZ



Picture 2. Base technologies of problem solving



References:

1. N.Khomenko, Contradiction of problem description (Russian).
2. N.Khomenko, The key problem of problem solving (Russian).
3. N.Khomenko, Software "Invention Machine – ARIZ" and transformation of Physical Contradiction into solution of a problem (Russian).
4. N.Khomenko, System of Yes-No games as a TRIZ education technology (Russian).
5. N.Khomenko, The Net-Technology of TRIZ education as an alternative to the traditional linear technology of teaching (Russian).
6. N.Khomenko, The advantages of the Net-Technology of TRIZ education in teaching skills necessary for resolving a system of contradictions (Russian).
7. N.Khomenko, T.Sidorchuk, Situation type of Yes-No Game for an analysis of fairy tales by pre-school children (Russian).

Most of the articles were published in the proceedings of different conferences, however all of them are available on the Web site of the Minsk TRIZ Technologies Centre: http://www.trizminsk.org

* * *

About authors:

Nikolai Khomenko born in 1954
TRIZ Expert. 20 years experience.
Master of TRIZ (qualified by Genrich Altshuller). Master of Science in Engineering.
Professor of ENSAIS, Strasbourg, France and leader of educational project Jonathan Livingston (international team around the world)

TRIZ Education: 1980 Valery Tsourikov (140 hours); 1984-1986 Genrich Altshuller (1984 – 140 hours; 1985 – 80 hours; 1986 – 80 hours) OTSM-TRIZ research under Altshuller's supervision from 1983 to 1998.
TRIZ experience: 20 years experience in problem solving management (spaceship equipment, microelectronics, machine building, software development, research problem, management problem etc.). Large experience in TRIZ education around the world. Duration of training from 24 to 140 hours. Former students: engineers, researchers, professors and students of universities, children, pre-school teachers, managers and government consultants.
Area of scientific interests: More then 33 publications. Problem solving management of complicated system of contradictions. New TRIZ education technologies and their implementation into existing system of education since pre-school age.
E-mail: jl-project@usa.net
HTTP://www.trizminsk.org/lab

Alexander Sokol born in 1977
TRIZ-Expert. 11 years experience.
BA in English Philology (due in June, 2000)
TRIZ Education: 1989-1993 S. Kreinina & T. Kleimihina (300 hours); 1991 – Y.Murashkovky & S. Ivanov (80 hours); 1992 – Y.Murashkovsky & M.Rubin (80 hours); 1993 – I.Vikentyev (40 hours).
TRIZ Experience: 1993-1995 assistant teacher at Y.Murashkovsky's seminars for teachers of humanities. 1994-1997 introductory courses on TRIZ for various secondary school and college students. From 1996 elements of TRIZ started to be incorporated into a course of General English.
Area of scientific research: development of an integrated OTSM-TRIZ English Course.
E-mail: sokol@triz.riga.lv