Ideal Team: Combined Use of TRIZ Tools for Building Successful Work Teams

Rubina N.V., Saint Petersburg, 2014

"There are no people who could regularly, one by one, solve problems of highest levels thanks to their knowledge, experience, and aptitude. If the problem costs 100,000 samples, no one can do it alone" (G.S. Altshuller, G.L. Filkovsky, 1975) [1].

1. Invention Team. Problem Statement

Inventive problem solving is one of the major stages in completing various projects (innovative, industrial, scientific, commercial, educational, etc.). Solving of inventive problems, especially of higher (3-5) levels, requires coordinated efforts of several specialists. By joint efforts, the project team has to analyze the inventive situation, synthesize ideas for inventive problem solving, and assess the obtained solutions.

The object of this research is to reveal the principles of formation, performance, and development of ***invention teams.***

General team building approaches and methods are known and used when forming an invention team, though such approaches are outside the scope of this research. Creative teams, for example, choirs or orchestras, which do not generate any landmark solutions, are also left out of consideration. An invention team is a team formed to solve inventive problems in various fields of human activities: science (for example, the Landau school), engineering (S.P. Korolev's group), art (the Beatles).

This research attempts to show how TRIZ can be applied to building and development of invention teams.

2. Invention Team Building Principles

TRIZ suggests a five-level system for assessing inventions according to the degree of their complexity and breakthrough [2]. First-level "inventions" are usually considered to be outside the scope of inventive activity. This research focuses primarily on those teams that solve problems of higher levels.

Invention teams must always be formed when the completion of a project requires solution to inventive problems in any field of human activities. As a rule, such teams are built formally, and their members may not feature the required components and development level of inventive thinking.

TRIZ methods are a compilation of the best inventive practices. Three stages of inventive problem solving have been singled out as a result of analysis of several ARIZ modifications: ANALYSIS, SYNTHESIS, and ASSESSMENT (Fig.1). At the Analysis stage, the structure and elements of a system, its relationships and interactions are

Рис. 1. Модель процесса решения изобретательской задачи

revealed, and existing contradictions specified. The Synthesis stage consists of the building of an ideal system model, transforming of the initial system in line with the existing requirements, searching for analogs, and applying known system transformation techniques. At the Assessment stage, the obtained results are checked for possible negative effects, and the feasibility of extensive application of suggested solutions is verified [3]. Inventive problem solving demands that inventors mobilize various components of their thinking.

Selection of invention team members must be based on the complete model of inventive problem solving process. The team must include members with various types of inventive thinking: Analyst, Transformer and Reviewer; and led by Expert, i.e., a specialist possessing all the above-mentioned inventive thinking components developed to a high level.

Team Analyst must possess such thinking components that permit to pass from an inventive problem to a problem model and then generate an ideal solution model. The nature of Transformer's thinking must enable him to generate various solution ideas and pass from the solution model to an actual solution. The assessment and development of generated ideas is the stage of paramount importance for inventive problem solving; so, Reviewer's thinking peculiarities must ensure the success of this stage. Expert's role can be compared to that of a symphony orchestra conductor: he must be a talented musician possessing, at the same time, special skills for conducting an orchestra. To make the team successful, its Expert must feature a high and well-balanced level of Analysis, Synthesis, and Assessment, given that his/her Assessment level surpasses, to some extent, that of Reviewer's.

3. Invention Team Building Technology Based on Methods of Inventive Thinking Diagnosis

This research offers a methodology to diagnose inventive thinking and determine its type and level. Inventive thinking modeling and diagnosing are based on the analysis of some TRIZ tools: ARIZ, a structural diagram of inventive creativity, and a model of inventive problem solving. Three major components of inventive thinking have been identified: ANALYSIS, SYNTHESIS, and ASSESSMENT (Fig.2)

Рис. 2. Модель изобретательского мышления

The methodology of inventive thinking diagnosis permits to specify what thinking components are needed for successful application of various TRIZ tools. Thus, an ideal image of a specialist who is best suited for successful accomplishment of a specific project stage can be generated.

The analysis of diagnostic results made on a sample group of 500 individuals aged from 6 to 60 years with different occupation and education has enabled us to specify 12 major types of inventive thinking [4].

Based on the diagnostic results, we were able to identify what inventive thinking components of an individual are the most important for inventive problem solving. By comparing the data related to the three stages of inventive problem solving, we can determine, in most cases, which of the three major groups (Analyst, Transformer, Reviewer) an individual belongs to by his/her type of inventive thinking(Table 1).

Table 1. Major Types of Inventive Thinking and Levels of Their Development

Group \ Level	low	middle	high	highest
Analyst	A– 0-2.0 S– 0-1.0 As – 0-1.0	A – 2.1-3.0 S – 1.1-2.0 As – 1.1-1.5	A – 3.1-3.5 S – 2.1-2.5 As – 1.6-2.0	A – 3.5-5.0 S – 2.6-5.0 As – 2.1-5.0
Transformer	A – 0-1.5 S – 0-1.5 As – 0-1.0	A – 1.6-2.5 S – 1.6-2.5 As – 1.1-1.5	A – 2.6 -3.0 S – 2.6 -3.5 As – 1.6-2.0	A – 3.1-5.0 S – 3.6-5.0 As – 2,1-5,0
Reviewer	A – 0-1.5 S – 0-1.0 As – 0-1.5	A – 1.6-2.5 S – 1.1-2.0 As – 1.6-2.5	A – 2.6 -3.0 S – 2.1 -2.5 As – 2.6-3.5	A – 3.1-5.0 S – 2.6-5.0 As – 3.6-5.0

The methodology for determining the types of inventive thinking is described in Rubina's thesis work [3]. It is based on solving of inventive test problems with the entire solving process recorded. The analysis of the inventive problem solving protocol permits to specify the level, at which each inventive thinking component was used (Table 2, ITQS - Inventive Thinking Qualities System). An average score for each of the three inventive thinking components (Analysis, Synthesis, Assessment) is calculated based on the above levels. The average scores are further compared with the data in Table 1. For example, if a diagnosed specialist shows of inventive thinking skills on the following score levels: Analysis - 2.8, Synthesis - 3.1, Assessment - 1.8 - it corresponds to the inventive thinking of a high level Transformer in Table 1.

To ensure success of an invention team (especially at initial stages of TRIZ training), it is important to select team members so that poor and strong sides of their thinking complement and compensate each other.

<u>The invention team building technology must include:</u>

1. Determination of the type and level of inventive thinking for each specific specialist on the basis of inventive thinking diagnosis.
2. Selection of such Analyst, Transformer, and Reviewer, whose levels of inventive thinking component development can be harmonized among themselves.
3. Selection of Expert: he/she must feature a high and well-balanced level of development of Analysis, Synthesis, and Assessment skills, given his/her Assessment level surpasses that of team's Reviewer.
4. Building of an invention team with the number of members exceeding the above mentioned number of roles (over four). A possible option can envision a team with several (2-3) specialists of the same type of inventive thinking. In this case Expert/Organizer may be selected from the team members.
5. Invention team cohesion: in the process of invention team activity, the roles of Analyst, Transformer, and Reviewer get mainstreamed on their own and, which is more

important, required relations get established between the Expert/Organizer and the rest of the team.

6. Development of commanding roles. If one of the team members shows insufficient level of inventive thinking component development in the process of team building, he/she may undergo a special training program.

The implementation of the proposed technology can be illustrated by possible building of working teams from WS[1]-2011 students below:

1. *Determination of Inventive Thinking Type and Level*

The types of WS-2011 students' inventive thinking and development levels of their specific properties have been identified by diagnosing.

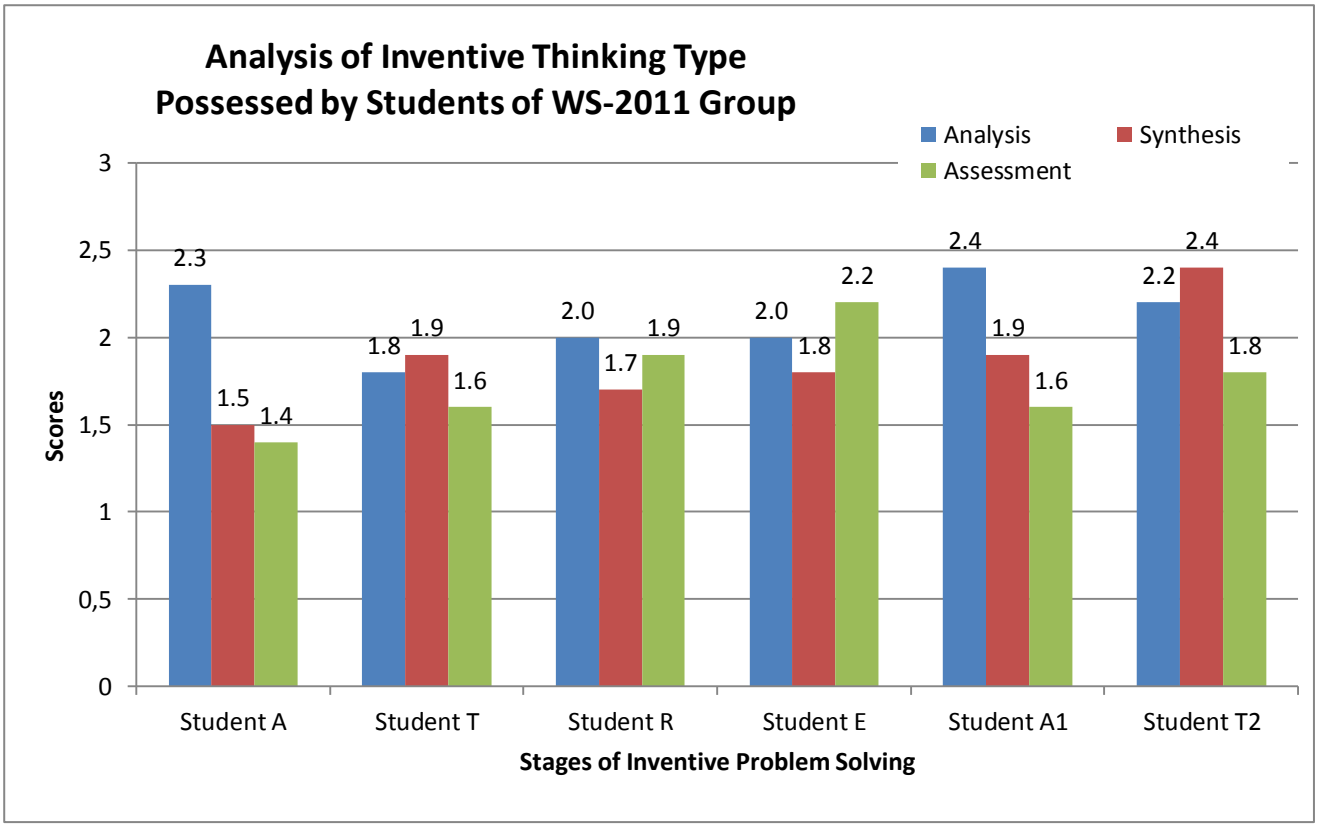

Fig. 3. Selection of Analyst, Transformer, Reviewer, and Expert.

Student A = mid-level Analyst; Student T = mid-level Transformer; Student R = mid-level Reviewer; Student E = mid-level Reviewer; Student A1 = mid-level Analyst; Student T2 = mid-level Transformer.

2. *Selection of Analyst, Transformer and Reviewer for Team Work*

Team 1

Student A = Analyst (Analysis level 2.3) + Student T = Transformer (Synthesis level 1.9) + Student R = Reviewer (Assessment level 2.2) can be combined into Team 1. Their inventive

[1] WS-2011 - The Winter School at St.Petersburg State University composed of students from various universities and colleges, with the diagnosis performed both prior to and after TRIZ studies.

thinking types and levels will permit to coordinate their efforts in inventive problem solving (Fig.3).

Team 2

Student A1 = Analyst (Analysis level 2.4) + Student T2 = Transformer (Synthesis level 2.4) + Student E = Reviewer (Assessment level 2.2) can be combined into Team 2. On the whole, the levels of inventive thinking in Team 1 and Team 2 range within mid-level. The level of Team 2 is slightly higher, but it has no candidate for Expert/Organizer.

3. Selection of Expert/Organizer

Team 1

Student E has a slightly higher level of inventive thinking than the rest of the team and can act as Expert-Organizer in the team. What is important is that Student E's reviewing level is higher than that of Reviewer in this team (Fig.3).

Team 2

None of the above students has the type and level of inventive thinking that could allow him/her to take the role of Expert/Organizer in Team 2.

4. Building a team from a number of specialists exceeding the number of listed roles

Team 1+

The number of team members should not always be equal to the number of needed roles. Several specialists with just about the same type of thinking can be selected as a result of diagnosis. In this case, Students A and A1 can complement each other at the Analysis stage (a slightly higher level of Synthesis possessed by Student A1 will permit to find good ideas for ideal system model). Students T and T2 can work together at the stage of Synthesis (the fact that Student T2 has a slightly higher level of Analysis is important for the transition from a problem model to solution model). Students E and R are reviewers according to their inventive thinking type, but Student E has the level of Assessment higher, and can be regarded as potential Expert/Organizer (Fig.3).

5. Invention Team Cohesion

Team 1

In the process of work and inventive problem solving, the roles in this team can be distributed as follows: Expert/Organizer = Student E; Analyst = Student A; Transformer = Student T; Reviewer = Student R.

Team 2

This team may include Student A1 (Analyst), Student T2 (Transformer) and Student E (Reviewer). The functioning of this team will be hindered by the absence of Expert/Organizer with the level of inventive thinking surpassing that of other team members. Attention should be paid that a situation with three leaders may occur in this case. Such a situation can lead either to a significant rivalry within the team, or to the formation of three new invention teams.

Team 1+

All these students can be integrated into a single invention team. This team can be especially successful if its members represent different professions (for example, biologist, chemist, programmer, manager, etc.)

6. Commanding Role Development

A combined application of various TRIZ tools (controlled imagination development methods, system operator, ARIZ, function analysis, Su-field analysis, system evolution trends) makes it possible to form individual components of inventive thinking and, partially, compensate for thinking limitations of each specialist. Table 2 shows the Inventive Thinking Qualities System (ITQS), as well as TRIZ methods for forming each inventive thinking component.

The invention team building technology provides for an option when one or more specialists feature an insufficient level of development of Analysis, Synthesis or Assessment. In this case we suggest that a special training program to adjust the level of inventive thinking be developed.

For this purpose, ITQS and a matching TRIZ tools application system can be used (Table 2). ITQS was developed by G.S. Altshuller on the basis of inventive thinking model and inventive creativity structural diagram. This system comprises deals with inventive thinking components and development levels of each component (from 0 through 5).

Each thinking component features a specific transition to the next level. Mobilization of all thinking qualities has a paramount importance for successful problem solving. When forming the inventive thinking components, the problems must be gradually complicated to the degree when a successful solving demands a high level mobilization of all inventive thinking qualities.

Let us take the diagnostic results for students of WS-2011 group as an example (Fig.3). The diagnosis revealed different types of inventive thinking, which served as the basis for combining those students into teams.

Our analysis showed that **Team 2** may experience problems related to team management control. Student E (Reviewer by the inventive thinking type) could act as Expert/Organizer, but his Analysis and Synthesis levels are lower than those of the other Team 2 members. We have to develop a training program that could help develop the missing qualities of thinking. Table 2 offers us the TRIZ methods that permit to train the Analysis and Synthesis components of thinking and raise them to level 2-3. Student E could be offered a training program that includes training in:

- integrated use of System Operator (4-6 hours);
- generation of fantastic ideas through step design, STS (Size-Time-Speed), MFOM (Method of Focal Objects), and Morphological analysis (4-6 hours);
- system modeling using Goldfish method, SLP (Smart Little People), Su-field analysis (6-8 hours);
- study of system evolution trends ("patent well") - 2-4 hours.

Team 1 is composed of students whose inventive thinking types and levels are harmonized. However, the diagnostic results show that Student A possesses a lower Synthesis and Assessment level compared to the other team members. Such peculiarities of thinking may lower the Analysis quality and complicate the transition to the following stages of problem solving. To enhance Team 1, the training program for Student A should include training tasks in:

- integrated use of system operator (4-6 hours);
- generation of fantastic ideas through phantogram method, system modeling using IFR (Ideal Final Result), STS, and SLP (8-10 hours);
- formulating contradictions and applying procedures for their resolving; mobilizing resources (4-6 hours).

Such a training program will raise the level of Synthesis and Assessment, and enable Student A to analyze not only the inventive situation at hand, but also the proposals and ideas generated by other team members.

Table 2. ITQS and Methods of Inventive Thinking Properties Improvement

Levels / Components	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
ANALYSIS Components						
A. Component Analysis	Unable to single out system elements	Capable of singling out elements, though in a systemless manner	Capable of arranging system elements into chains by decreasing ranks	Capable of singling out elements of similar properties	Capable of singling out elements needed for performing a certain function	Capable of separating functions from their carriers
Tools		System Operator (SO). Understanding a system as a whole that comprises parts (subsystems). Morphological analysis. Synectics	SO. Subsystems also consist of sub/subsystems and so forth. STS	SO. Subsystems may be similar or different by their properties; subsystems of various systems may be identical or differ by their properties. MFO. STS	SO. Different systems may be used to perform different functions. MFO	SO. A system can be regarded as a combination of properties and functions. Phantogram is a technique for separating a function from an object. SLP
B. Transition to Supersystem	Unable to integrate elements into a system and/or supersystem	Capable of integrating using external features only	Capable of arranging elements into chains by increasing ranks	Capable of integrating elements on the basis of common properties	Capable of integrating elements on the basis of common functions	Capable of realizing various functions on various resource basis.
Tools		SO. Understanding a system as a whole that comprises parts; understanding a supersystem as an integration of systems. Synectics. STS	SO. Supersystems can have different ranks. Step design. STS	SO. Systems can be integrated into various supersystems on the basis of common features. Step design. Phantogram method: Integration techniques	SO. Systems can be integrated into various supersystems on the basis of common features. Step design. Phantogram method: change the supersystem	SO. Complex use. Method of Robinson Crusoe. Step design
C. Identification of Relations	Unable to identify relations and	Capable of identifying single-link relations and interactions	Capable of selecting the relations and interactions needed for problem	Capable of modifying existing relations and interactions	Capable of introducing new relations and	Capable of investigating relations and interactions non-

and Interactions	interactions		solving		interactions	characteristic for the given system
Tools		SO. System elements are interlinked; systems are interlinked within a supersystem. Morphological analysis. Method of fantastic subtraction. MFO. Viewpoint. Synectics. STS	SO. Systems and supersystems feature a lot of various links. SLP. Morphological analysis. MFO. STS	SO. Complex use. Phantogram: a conjunction-disjunction technique. Binomial of fantasy. SLP. MFO	SO. Complex use. Phantogram: a conjunction-disjunction technique. Method of fantastic subtraction. Binomial of fantasy. SLP	SO. Complex use. MFO. Binomial of fantasy. Method of fantastic subtraction. SLP
D. Change of systems over time	Unable to imagine system's past and future	Capable of imagining what was a given system over a short period of time and what it can become	Capable of imagining how the system emerged and how long it can exist (ontogenesis)	Capable of imagining how the first such system emerged and forecasting how such systems can evolve	Capable of imagining what were similar systems in the past and forecasting the evolution of such systems in future (phylogenesis)	Capable of imagining how the function of a given system was performed in the past and forecasting how it will be performed in future (system phylogenesis)
Tools		SO. Systems change over time. Methods of composing proverbs. Storyboarding. Propp's cards. Method of composing fairy tales by G.S. Altshuller. STS	SO. The life of a given system can be traced since its emergence and compared to the duration of lives of similar systems. Phantogram: system-change-over-time technique. Storyboarding. STS	PaleoTRIZ ("patent well"). SO. Systems' future can be forecast with their evolution trends taken into consideration	SO. Entire system classes evolve naturally	SO. Similar functions can be performed by different systems; function carriers change naturally
E. Sensitivity to contradictions	Unable to identify a conflict in the	Capable of identifying contradictory requirements in the	Capable of identifying system elements related to contradictory	Capable of identifying contradicting properties of the	Capable of identifying contradicting functions	Capable of aggravating the state of conflicting elements

	proposed problem	system	requirements	system		
Tools		ARIZ. Understanding contradiction as contradicting requirements made to the system. Goldfish method. Method of composing fairy tales by G.S. Altshuller. STS	SO. As a rule, a certain part of a system is needed to implement a specific requirement. Goldfish method. SLP. Phantogram method. ARIZ: formulating the contradiction of requirements	SO. Certain parts of a system must possess needed properties to implement specific requirements. SLP. Phantogram method. ARIZ: formulating the contradiction of properties	SO. A system must possess a set of properties to implement specific functions. SLP. IFR	ARIZ. IFR
F. Ideal modeling	Unable to change an image mentally	Capable of changing the properties of a given system mentally	Capable of choosing a property changing technique	Capable of changing a system in a conflict zone	Capable of changing a system in conformity with required properties and functions	Capable of fully changing a system in conformity with its ideal image
Tools		MFO. Phantogram method (changing of system properties using fantasizing techniques). SLP. Synectics	SLP. Phantogram method. Su-fields.	SLP. IFR. Su-fields	SLP. IFR. Contradiction resolving techniques	IFR. Contradiction resolving techniques. Usage of effects. Su-fields
SYNTHESIS Components						
H. Use of resources	Unable to use resources	Capable of using intrasystem resources set by problem statement	Capable of using resources not included into the system specified in the problem	Capable of object-oriented selection of resources for problem solving	Capable of deriving resources from all those available	Capable of using resources previously unknown for a given problem
Tools		Morphological analysis. Method of Robinson Crusoe. STS	SO. Complex use. Method of Robinson Crusoe. STS	SO. Complex use. Phantogram method. ARIZ: mobilization of substance-field resources	SO. Complex use. ARIZ: mobilization of substance-field resources. Use of effects	Use of effects
I. Use of analogs	Unable to use analogs	Capable of using analogs and making comparisons	Capable of selecting an analog corresponding to	Capable of changing solutions in	Capable of drawing analogs to IFR	Capable of finding new principles for drawing

		with similar systems	existing contradiction (or method of its resolution)	conformity with the sought-for function		analogs
Tools		Propp's cards. Synectics. Viewpoint	ARIZ: stating of contradictions; contradiction resolving techniques. Synectics. Phantogram method	ARIZ: stating of contradictions; contradiction resolving techniques. Su-fields	ARIZ: stating of contradictions; contradiction resolving techniques. Su-fields	SO. Complex use. ARIZ
J. Flexibility (capability of generating a large number of various ideas)	Unable to generate solution ideas	Capable of using known solutions	Capable of using many known solutions	Capable of developing known solutions	Capable of generating new solutions	Capable of generating new solution principles
Tools		Brainstorming. Morphological analysis. Method of Robinson Crusoe. MFO. Synectics. STS	IFR. Contradiction resolving techniques. STS	Contradiction resolving techniques. Usage of effects. STS. Phantogram method	Contradiction resolving techniques. Usage of effects. Su-fields	SO Complex use ARIZ LTSE
K. Contradiction resolving techniques	Unable to use techniques	Capable of using techniques known for the given problem	Capable of using known combinations of techniques	Capable of using new combinations of techniques	Capable of using techniques previously unknown for the given problem	Capable of finding new techniques and effects
Tools		Phantogram method. Contradiction resolving techniques. STS	Contradiction resolving techniques. IFR. Su-fields. STS	Contradiction resolving techniques. IFR. Usage of effects. Su-fields. SLP	SO. Complex use. Contradiction resolving techniques. IFR. Usage of effects. Su-fields. SLP	SO. Complex use. ARIZ. LTSE
ASSESSMENT components						
L. Sensitivity to contradiction resolution	Unable to suggest solutions that resolve contradiction	Capable of suggesting solutions that partially resolve contradiction	Capable of selecting a solution with the weakest negative effects	Capable of resolving a main contradiction	Capable of finding a new solution	Capable of finding a solution laying foundation for a new principle
Tools		Method of composing	IFR. SLP. STS	IFR. ARIZ Part 7	SO. Complex use.	SO. Complex use.

		fairy tales by G.S. Altshuller. IFR. Brainstorming. Synectics. STS			ARIZ	ARIZ. LTSE
M. Criticality	Unable to assess obtained solutions	Capable of assessing by analogy to known solutions	Capable of selecting the most ideal solution	Capable of changing an obtained solution in conformity with the ideal one	Capable of assessing an obtained solution from the viewpoint of its applicability to other problems	Capable of finding a solution that lays foundation for a new principle
Tools		Brainstorming. MFO. Synectics. Viewpoint	IFR	IFR. ARIZ Part 7	ARIZ Part 8	SO Complex use ARIZ LTSE
N. Originality	Capable of finding stereotype solutions (corresponding to the inertia vector)	Capable of using a known solution	Capable of proposing several solutions	Capable of modifying known solutions	Capable of finding a new solution	Capable of finding a new solution principle
Tools		MFO. Brainstorming. Propp's cards. Synectics. STS	MFO. Brainstorming. Binomial of fantasy. STS	Phantogram method. Contradiction resolving techniques. STS	Contradiction resolving techniques. SLP. Mobilization of substance-field resources	Contradiction resolving techniques. SLP. Mobilization of substance-field resources. LTSE

4. Approaches to Successful Invention Team Building

4.1. Inventive problem solving is a major stage in various projects (innovative, industrial, scientific, educational, etc.). Invention teams that carry out such projects can be built in different ways:

A. The formal approach, when the invention team is built based on any formal attribute (for example, by affiliation to the same department). Such teams solve problems also formally. The only advantage of such an approach is its simplicity and formal equality of all team members;

B. The commanding approach, when all team members as well as the team leader are appointed from outside. Such an approach has all the disadvantages of the formal way. Besides, the members of such a team usually feel they are made to work under uncomfortable conditions of forced interaction and subordination;

C. The democratic approach, when all team members are combined into groups and select their leaders independently (based on personal sympathy usually). This approach, though seemingly simple and providing free distribution of specialists, usually reveals and aggravates the problem of mutual relations within the group. Very often the situation of rivalry and psychological incompatibility precludes a team from quickly organizing its work and brings forth problems unrelated to the task set for the team.

D. The play approach (interviews included), when specialists are assigned to teams using game rules (ranging from the simplest methods to games with complicated rules, including solving trivial logical problems). Such approach to team building has a number of advantages. Firstly, the playing space eliminates psychological barriers, brings a positive attitude of mind into further activities of team members; the team leader wins his/her position thus gaining additional authority in the eyes of team members. Secondly, elements of express diagnosis can be introduced into the rules of the game played for distributing specialists among groups, thus building teams that will definitely include one specialist with critical thinking. Thirdly, when performing playing tasks team members become aware that their success depends on how coordinated their efforts are and establish future interactions within the team; at the same time each team member tests his/her skills and ability to perform a specific role. Invention teams for performing real innovation projects are built from specialists, who have the knowledge and skills needed for successful accomplishing of project tasks. However, specifics of the thinking style of specialists must be taken into consideration to ensure team's success in inventive problem solving.

E. The professional approach provides for team member selection based on professional tests that include inventive problem solving aimed at diagnosing specialists' inventive thinking. Based on the results of the diagnosis the peculiarities of specialist's inventive thinking are identified. Team members are selected so that specialists with analytical, synthetic, and critical thinking style are available for solving practical tasks.

It should be noted that different ways to build training groups or teams should be used keeping in mind the complexity level of training tasks, time needed for their accomplishment, and their significance for the training process. There is no need to elaborately build a team for doing short couple tasks, but team building approach based on a well-devised game is highly recommended, even if the time is short, to form a team for a long-term project.

4.2. Commanding roles according to R.M. Belbin. As the analysis of literature on organization and optimization of teamwork shows, any team is built around its leader (formal or informal). Sociological and psychological research reveals specific tasks that need to be solved to optimize the functioning of a team.

The works of R. Meredith Belbin, the creator of the theory and model of roles within a management team, attract a great interest in this connection [6]. They consider in detail the specifics of team building for performing commercial projects and dwell on psychological, social and other details. The following provisions of R.M. Belbin's theory are of paramount importance for our research:

> "a team is not a mob of people, holding various positions, but a union of individuals, with each individual playing a role understandable to others";
>
> "when a group turns into a team, it becomes more effective by producing synergism".

Among the roles described by R.M.Belbin, we are interested in "intellectual roles": Analyst/Strategist, Idea Generator, Specialist.

The activity within the team starts to produce a gradual effect upon the team members. Depending on the role of a specialist in different teams, he/she can display, in varying degrees, the components of his/her thinking needed to accomplish a stage of inventive problem solving.

Integrating good specialists in one group does not mean building an effective team. Human interactions always end in formation of social relations including such that turn a group into a team and such that destroy the team and block necessary links. While a team is built and evolves as a system of interactions between specialists, inventive problems of various nature emerge: social, psychological, technological, industrial, etc.

5. How To Find The Treasure? Two Teams On The Way To One Goal

The well-known story by R.L.Stevenson about treasure island [7] gives an unexpected example that illustrates different strategies for reaching the same goal.

We meet the members of the first team (let's call it *The Honest Squire*) at the very beginning of the narrative. Their characters are described with an utmost clarity. We take their side right away and forgive them their mistakes. According to R.L. Stevenson, one of the major characters of the story, Dr. Livesey, has all the features of a Professional: he can analyze a situation quickly, suggest an idea for its solution, and is able to allow for negative effects. Jim Hawkins is the youngest member of the team, but the flexibility and adaptivity of his thinking make him a good Transformer. Captain Alexander Smollett displays the qualities of a good Reviewer from the very beginning. The team lacks an Analyst. The main thing is that social and commanding roles do not coincide. Squire Trelawney undertakes the role of a Professional (a project leader);

though the level of his inventive thinking is significantly lower in comparison with other team members.

Such distribution of functions results in gross blunders made in the beginning of the expedition: crew recruitment was entrusted to an outsider; ship's equipment does not match the main goal of the project, and, which is more important, the crew hierarchy was arranged wrongly.

The second team (let's call it *The Gentlemen of Fortune*) is hidden from us in the beginning. R.L. Stevenson shows us the genuine properties of the team members later. In fact, only John Silver, the leader of pirates, is capable of analyzing a situation, make decisions, and forecast the consequences. The other members of this team (Israel Hands, Job Anderson, George Merry) are endowed with "practical cunning" to different extents. This gives a spectacular example of people randomly integrated into one work team. Each of them is capable of accomplishing his task (set sails, pull oars, cast anchor, shoot a musket), but none of them can steer a ship, let alone develop a strategy for solving the emerging problems.

- Selection of invention team members:

The Honest Squire: Transformer = Jim Hawkins; Reviewer = Captain Smollett; Professional = Dr. Livesey. Here, Dr. Livesey has to combine the roles of Analyst and Professional, because other team members are unable to perform neither of those roles.

The Gentlemen of Fortune: In fact, this group cannot be called an invention team, since there is only one member who has to analyze the situation, generate ideas, and assess them in one person. So, this team is composed of Professional and other members with a very low level of inventive thinking (their thinking type has no importance in this situation).

- Selection of Professional/Organizer:

Dr. Livesey shows himself as Professional/Organizer when making acquaintance with Captain Smollett (despite Squire Trelawney's objections, he makes it possible for Captain Smallett to express his concerns).

John Silver behaves himself very furtively, but soon it becomes clear that he is an actual leader of The Gentlemen of Fortune.

- Adjustment of team composition during inventive problem solving:

John Silver tries to win Jimmy Hawkings to his side (though he is guided by the intention to make Jimmy his hostage and use him as a source of information). Jimmy, however, fully displays his transforming properties in this situation and achieves an unexpected result (seizes "Hispaniola") using and successfully combining new resources. Besides, Jimmy finds a new member for The Honest Squire team in the person of Ben Gunn.

Changes have occurred in the whole Honest Squire team. Primarily, they relate to role assignment and hierarchy arrangement.

One can find a very curious point in the unexpected interaction of the two teams. Dr. Livesey holds negotiations with John Silver and, having passed him the map, uses his influence upon the pirates to control enemy actions.

The rivalry ends in the victory of The Honest Squire. Besides, all the members of this team acquired an invaluable experience, the experience of inventive problem solving. The level of inventive thinking of the team members has undoubtedly risen.

6. Conclusions

- ✓ TRIZ methods are applicable to ***invention team building***. In this case, various TRIZ methods should be coordinated.
- ✓ The following principle must be laid as the foundation of invention team building: the team must comprise Analyst, Transformer, and Reviewer, with Professional to coordinate their activities. The inventive thinking level of all team members must be harmonized, while Professional's inventive thinking level (especially his/her criticality level) must be higher than that of other team members.
- ✓ The inventive thinking diagnostic methodology based on TRIZ methods can be used to select members of invention team.
- ✓ When a project is started, each team member begins to acts in conformity with his/her team role. The role of each team member bears upon him/her and depends on the qualitative composition of the invention team.
- ✓ If the team selection process reveals that some inventive thinking component is developed insufficiently, an adequate training using an IFQS-based program may be recommended.
- ✓ The research of team building problems using a complex of TRIZ methods has just begun. Its first results described in this article outline the major directions for further investigation.

7. Bibliography

1. G.S.Altshuller, G.L. Filkovsky. Sovremennoe sostoyanie teorii resheniya izobretatelskikh zadach (State-Of -The-Art Theory of Inventive Problem Solving), 1975. http://www.altshuller.ru/triz/triz2.asp

2. G.S. Altshuller. Algoritm izobreteniya (Invention Algorithm). – Moscow: "Moskovsky rabochii", 1973.

3. N.V.Rubina. Diagnostika razvitiya isobretatelskogo myshleniya na osnove metodov TRIZ. (Diagnosing Inventive Thinking Development Based on TRIZ Methods). Master of TRIZ dissertation thesis, Saint Petersburg, 2013.

http://www.triz-summit.ru/file.php/id/f5780/name/РубинаНВ-диагностика-11-07-2013.pdf

4. N.V.Rubina Struktura izobretatelskogo myshleniya. (Structure of Inventive Thinking). Saint Petersburg, 2013 http://www.triz-summit.ru/file.php/id/f5684/name/РубинаНВ-Структура-ИМ-17-06.pdf

5. N.V.Rubina. Sistema kachestv izobretatelskogo myshleniya (Inventive Thinking Qualities System). Saint Petersburg, 2009. http://www.temm.ru/ru/section.php?docId=4454

6. R.M. Belbin. Komandy menedgerov: kak ob'yasnit ikh uspech ili neudachu. (Management Teams: Why They Succeed or Fail.) "Mann, Ivanov, and Ferber" Publishing House.

7. R.L. Stevenson. Ostrov sokrovishch. (Treasure Island) Petrozavodsk, "Karelia", 1985.