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Advanced Multi-Screen Scheme of Powerful Thinking

Contents

EDITOR'S NOTE

We have not found a text dedicated specifically to the Advanced Multi-Screen Scheme of Powerful Thinking in the Nikolay Khomenko's archive. Meanwhile, this model is one of the OTSM-TRIZ basic models.

The multi-screen scheme actually sets reference points for the development of inventive thinking in terms of OTSM-TRIZ. The topical nature of this article is also determined by the fact that the educational process does not fully utilize the multi-screen scheme (system operator reflecting the hierarchy, time, and anti-system axes) introduced by TRIZ author G. S. Altshuller. The educators often apply trimmed-down versions of the system operator, missing en route its key functions.

Texts by Nikolay Khomenko and the printout of his recorded dialogue with Dmitry Kucheryavy on the advanced multi-screen scheme are used in this work (see the file list).

Edited by A. A. Nesterenko with the participation of I. K. Kaikov.

BACKGROUND

The "Element – Name of Feature – Value of Feature" (ENV) model served as the starting point in the creation of the Advanced Multi-Screen Scheme of Powerful Thinking (AMS). The contradiction scheme and the solution analysis fit well into this model, and thus an idea arose to reduce the rest of classical TRIZ tools to models matching the ENV model. The idea was to describe the system in a pseudo-mathematical model using the vector space each system of which is a vector in a multidimensional parametric space where each parameter is its axis. As the system evolves, the vector is correspondingly "rotating" within such space (see the 1988 Miass Conference report[1]).

This model was initially tied down to the problem solving process. When OTSM began its formation as a system in the early 1990s, I shared with G.S. Altshuller some assumptions concerning axes that, to my opinion, had to be introduced into the scheme of powerful thinking. In particular, I was speaking about the variability axis (about the need to introduce the STC operator[2] and watch how the system changes, i.e. track changes in the multi-screen scheme), and Altshuller responded that it was a long-standing idea. When writing his book *Creativity as an Exact Science*, Altshuller wanted to expand the multi-screen scheme through the addition of STC, but the resulting picture was rather complicated, and as he could not find adequate graphics, the idea was put aside. I pointed out other parameters, which he approved of, but graphic representation posed a problem. As there already existed a description prototype based on parameters, each having a corresponding list of values, the idea arose to describe axes in the similar manner.

[1] N.N. Khomenko. *On IM-A and Transition from PhC to its Solution.* / http ://www.trizminsk.org/e/2000131. htm

[2] STC – Operator of varying features (size, time of life or time of operation, and cost of the system) employed to overcome mental inertia in the problem definition and solving process. It was used in earlier ARIZ versions, in the creative imagination development course (editor's note).

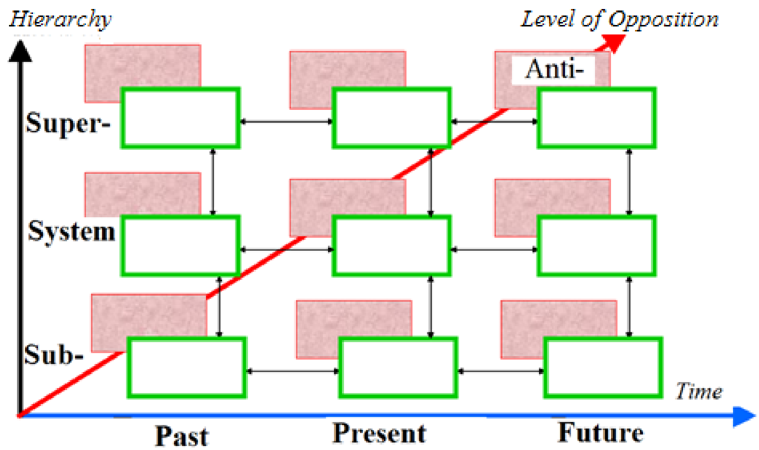

Fig.1. Classical multi-screen scheme by G.S. Altshuller. The diagram is from N. Khomenko's presentation.

First, there was a set of individual axes, but as their number increased, ideas were formed to group the axes to be agreed on by the colleagues (real-imaginary, static-dynamic, conservative-variable). http://otsm-triz.org/sites/default/files/pictures/ms-ru.png

A set of axes for a multi-screen scheme represented by two groups, the real and the fantastic (imaginary), was determined by 2011.

Functions of the Advanced Multi-Screen Scheme of Powerful Thinking

The classical multi-screen scheme is required in:

- Analysis of resources available within the system;
- Analysis of problems arising in the system and their link to sub-system, super-system, etc.;
- It helps to avoid the limits of 5+/-2 [3];
- It gives the view of the problem not in isolation, but in interrelation [with other problems].

The advanced multi-screen scheme is a set of parameters, which we must specify, and qualities and features necessary for problem solving.

The AMS function is the problem analysis and solving. It is required to describe and solve problems. This is *a model for describing models*. Similarly to the powerful thinking space, it can be defined as a metamodel in which a model is built.

The following image can be considered: we have plasticine to shape the description of a problem. Out of the description, we then shape a problem model, then a "perception model", and finally a solution model. In this case, AMS is the "plasticine". OTSM technologies are the tools to change the shape of such "plasticine", which needs treatment to produce the solution.

[3] According to a known rule derived by American psychologist G. Miller (7 +/-2), human short-term memory cannot remember and repeat more than 7 plus or minus 2 elements. When mentioning this rule, Nikolay always said that 7 +/-2 pertained to PRIME elements. However, we typically deal with elements that are more complex. Based on his personal experience, he thus applied the 5+/-2 rule (note by I. Kaikov).

Any thinking activity should be carried out taking into account the location of the initial problem model in the powerful thinking space. Any change along one of the axes changes the entire situation in the powerful thinking space. The ability to track such changes and employ them in work is of extreme importance.

Development of thinking in line with the scheme of powerful thinking forms the primary goal of OTSM-TRIZ.

STRUCTURE OF THE ADVANCED MULTI-SCREEN SCHEME OF POWERFUL THINKING

Axes of the Powerful Thinking Space Scheme: General Characteristic[4]

The powerful thinking space can be conventionally described in the form of axes similar to those describing Euclidean space: height, length, and width.

Each axis of the scheme of powerful thinking:

1. Can be considered as a range of values of a feature the name of which corresponds to that of the axis.

Along the anti-system axis, we can thus consider the values of the feature: system – "less than a system" – non-system – anti-system.

2. May represent a family of related axes.

For example, we can simultaneously analyze the process along several time axes having different scale: seconds, days, millennia. This provides for tracking of short-, medium-, and long-term changes in the selected elements.

3. Contains an element of uncertainty.

Determining a required value on an axis or selecting one of the axes from a family is impossible without taking into account the relation to other axes. The same happens when we are making a soup and cannot decide how much salt is needed if we do not know what ingredients are used, how much water is added into the pot, etc. For the time being, this is a specific art. Each cook has his/her own way, not always realizing the reasons for the action performed.

Two subspaces can conventionally be identified in the powerful thinking space, which penetrate each other similarly to waves from different radio stations penetrating the environment:

- subspace of the real world and
- subspace of the imaginary.

[4] Development of thinking in line with the scheme of powerful thinking forms the primary goal of the General Theory of Powerful Thinking (OTSM-TRIZ).

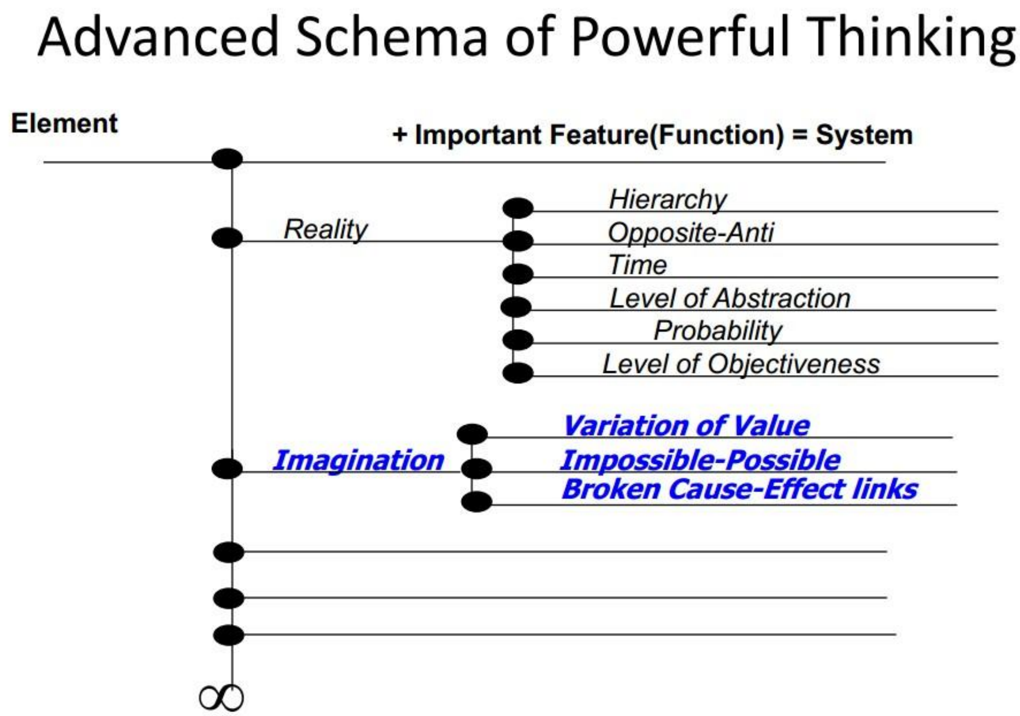

Fig. 2. Advanced Multi-Screen Scheme. The diagram is from N. Khomenko's presentation.

Subspace of the Real[5]

- Hierarchy axis (super-system – sub-system) – the ability to see an element (system) in a selected hierarchy of elements of the world (systems).
- Anti-system axis (system – anti-system) – the ability to see, perceive, and use the opposites (their combinations and interactions).
- Time axis (the past – the future) – the ability to see an element (system) in time, see how the past could have predetermined the present ("now") and how "now" can predetermine the future[6].

- Abstraction axis (specific – abstract) – the ability to describe elements (systems) at different levels of abstraction.
- Probability axis (inevitability – randomness) – the ability to evaluate and take account of the process predetermination degree in the past and the future.
- Objectivity axis (objective – subjective) – the ability to navigate in the space of objective and subjective factors, to see such factors and distinguish between them.

[5] Framed are the axes present in the classical multi-screen scheme by G.S. Altshuller (editor's note).

[6] Including all possible alternatives of time in both the past and the future. NOW can be considered as the cross-point for a number of lines that can be drawn from the past to the future at different levels of probability.

Subspace of the Imaginary

- Axis of variability of features (current value of a selected feature – degree and direction of deviation from the current value) – the ability to vary the values of features of an object on a large scale and track changes in the scheme of powerful thinking; the ability to track the resulting qualitative changes in other features, changes leading to qualitative leaps throughout the powerful thinking space.
- Possibility axis (possible, real – fantastic, unreal) – the ability to employ the impossible, the inadmissible, the fantastic; the ability to think beyond the possible and the real.
- Cause and effect axis (rational – irrational) – the ability to employ models that break the cause and effect relationships among phenomena.

The ability to realize which thinking subspace we are in at a given stage of analysis or reflection is one of the major skills that require constant development and improvement, particularly for preschool and primary school children.

One of the problems associated with the development of imagination (particularly that of children) is the absence of distinction between the imaginary and the real world, the absence of sound assessment of real situations.

For example, a child seriously suggests using the jet action of air ejecting from an unplugged inflatable swim ring as an additional drive to overcome the river flow. It is amusing in a cartoon plot, but in reality, the child can easily die.

Description of Axes in the Space of the Real

Hierarchy Axis (Super-System – Sub-System)

The axis forms the ability to see an element (system) in a selected hierarchy of elements of the world (systems).

[It is represented in the Altshuller's multi-screen scheme (Fig.1) by the vertical axis OY].

Each lower level in the hierarchical structure of an object represents parts of the systems of an upper level (if the function of the system is indicated) or elements of sets (if the function is not indicated). The values of such feature include parts (sub-systems) of the element, as well as elements incorporating such element.

Defining a system per se is defining a reference point. This point may be of any kind: a capillary, a small portion of the wall, an even smaller portion of the wall, a molecule.

Time Axis (the Past – the Future)

The axis forms the ability to see the system in time. [It is represented in the classical multi-screen scheme by the horizontal axis OX].

Time also has its sub-systems, and one can speak about different times:

- about the time of life of a particular system, for example, about the life cycle of a particular car, from its manufacture to its use;
- about the technological cycle of operation of a system;
- about the time in history (what a cart – predecessor of cars – was like, what a car is today and what it will become in the future).

Therefore, the time axis is not a single axis but is represented by a subspace of time axes. This constitutes the fractality of the multi-screen scheme.

Anti-System Axis (System – Anti-System)

The axis forms the ability to see, perceive, and use the opposites (their combinations and interactions).

The values of a parameter along this axis include system, “less than a system”, non-system, anti-system.

How can an anti-system be defined? There are options.

1. According to its function. An anti-system is a system having an opposite function.

2. According to the principle of operation, when the same function, the same result is achieved by an opposite action. For example, we need a black line against a white background. One can take a black paint and a white notebook and draw the line, or take a white paper, coat it with a black layer, cut off the black and leave only the white layer, i.e. delete instead of drawing.

3. Within the scope of a parametric space, an anti-system can be considered as something having at least one different parameter. When defining an anti-system through action and function, we should understand that these are parameters as well. In fact, any object that changes a parameter of a system, for example, its function, can serve as an anti-system. For example, a flat tire may become an anti-system for a car. A sub-system of the main system may thus become an anti-system with respect to the system.

When an anti-system is compared to a “harmful machine”[7], the latter is one of the classes of anti-systems.

On the other hand, a question arises: What do opposite values mean? Are 300 degrees Celsius and 1,000 degrees Celsius the opposites?

Anti-systems are defined in OTSM as systems that “challenge” our system, for example, systems-competitors or systems designed to render our system inoperative.

What does controlled thinking mean? It is the ability to use anti-systems. If we want to drive fast, we should make an anti-system to reduce the speed. If we want to turn left, we should turn right as well, and so on. A system cannot be controlled if it operates only in one direction. There should always be the opposite. Therefore, when designing a high-speed car one should think about its brakes; when designing a takeoff system for an airplane we should consider the way it would land.

A question remains about the ways to construct an anti-sub-system and an anti-super-system.

Let us take a car as an example. Its engine is a sub-system and movement is its function. An anti-system based on the function should stop the car, for example, by freezing the engine. However, there are many ways to stop the car, so there may be many anti-systems.

Let us consider an anti-system for a super-system. A super-system of a car is the road and its function is to facilitate the movement, creating conditions for the operation of the wheels. Consequently, the anti-system of the road includes everything that changes the properties of the road, making it impossible for the wheels to move.

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[7] The concept of a “harmful machine” (a complete technical system formed within TS without intentional participation of a man and generating a harmful product) was introduced by N. Khomenko during his work in Korea. This model often makes problem solving easier. According to the Law of System Completeness, the “harmful machine” can be destroyed by removing or rendering any of its elements inoperative (editor’s note).

Abstraction Axis (Abstract – Specific)

The axis provides system description at different levels of abstraction.

Abstraction is determined by the number of parameters taken into account in model building. The more specific the object we describe, the larger the number of parameters we specify. The higher we ascend the ladder of abstraction, the fewer parameters are responsible for the model. The abstraction axis allows varying the number of parameters taken into account.

There is no point in discussing abstract models that do not take any account of specifics of a particular situation.

Probability Axis (Inevitable – Random)

The axis forms the ability to evaluate and take account of the process predetermination degree in the past and the future.

Elementary definition of probability is a value that demonstrates how many events from a number of events are likely to occur. When there are many interrelated events, probability is conditional (probability of a specific event given that another event will also occur).

Probability should be taken into account in forecasting, in solution assessment, in out attempts to see the past. We model the past as well: when detectives investigate crimes or historians restore the course of events, they also take account of the probability of events.

An event model differs from an object (for example, locomotive) model by always assuming the probability of some events. Therefore, the probability of an event is important, or else we might “get lost in fantasies”.

The following example explains why introducing the probability axis to AMS became necessary. Let us assume that a customer states that a solution does not work under a particular condition (for example, when the ambient temperature exceeds thirty degrees). We should decide whether the temperature increase up to thirty degrees is inevitability or randomness. If it is randomness, then what is its probability of occurring? If we are told that a particular proposal is poor because it might fail in a specific case, we should analyze how often such case occurs and whether the event is important enough to be taken into account. Action is certainly required if the event occurs continuously, but if the chance is a million to one the event might be disregarded.

Objectivity Axis (Objective – Subjective)

Objectivity is a feature that determines the degree of dependence of statements or values of other features on a person describing the element. The objectivity axis provides for the ability to navigate in the space of objective and subjective factors and to distinguish between them.

Specific practice in evaluating this factor is lacking; there is only understanding of the importance of its evaluation.

The description of an object in a sub-space of the real is in any case combined of opinions of some persons. Such opinions may be based on objective factors as well as on personal emotions and subjective liking.

When describing a problem from different standpoints, we seem to expand the area of search, but in reality, we form such intersection of a number of standpoints that substantially narrows the search field.

Examples can be given when the customer's experts had predicted the operation of a system under particular conditions, and then their physical explanation of the process turned out to be incorrect. It is difficult to determine the extent to which the provided information is objective or subjective or whether it corresponds to modern understanding of objective laws and approaches such laws.

In one's own work, it is necessary to assess the objectivity or subjectivity of our perceiving the obtained result. Does the information we have meet objective requirements, or do we have only our personal emotions? Consequently, we should make corrections: if we deal with our personal emotions, it might be wise to put them aside and get back to the problem a little later.

Each person upholds his/her problems, often trying to conceal the attempt to solve undeclarable problems and achieve hidden goals. After having discussions and reaching consensus, we may arrive at something different from individual judgments, like averaging and synthesis of different standpoints.

To assess the objectivity of opinions expressed by discussers is a very nontrivial task. Nobody can be absolutely objective, but we should strive for objectivity.

Description of Axes in the Space of the Imaginary

Variability Axis (Current Value of a Selected Feature – Degree of Deviation from the Current Value)

This axis provides for the ability to vary the values of features of an object on a large scale and track changes in the scheme of powerful thinking.

The STC (size, time, cost) operator was initially applied to change parameters during the problem analysis process. Then TRIZ developers attempted to go beyond such parameters, and the operation of the resulting model turned out to be satisfactory. For example, if a system has a pressure parameter, it is worth analyzing the result of reducing this parameter to the minimum or, vice-versa, of increasing it infinitely. The STC operator thus became a scaling operator: a feature of the object is selected and its changes along the axis (from zero to infinity) are considered.

However, some parameters cannot be varied along a line. Variability in the broad sense presupposes selecting and changing a feature of the object. At the same time, changes in the entire multi-screen scheme caused by changes in a single parameter should be analyzed.

In fact, the variability axis forms the ability to experiment mentally. This does not mean the need to go beyond the range of typical values when varying the values of the features. When we apply the technique of exaggeration, intensification, and reduction to absurdity, we should shift down to zero and even to anti-values of the feature in order to eliminate mental inertia, but in other cases of using mental experiments to explore, there is no need to go beyond the limits…

Possibility Axis (Possible, Real – Fantastic, Unreal)

The axis forms the ability to employ the impossible, the inadmissible, the fantastic.

Here we speak about the impossibility within the framework of opinions of particular persons or public opinion.

Specialists regarded transoceanic transmission of a radio signal as impossible because the signal would go straight into space. However, Marconi did not believe them and rediscovered the ionosphere that reflected the signal, which reached Newfoundland from Europe. We should admit the impossible when working on a problem. V. Gerasimov even called his method as “To Admit the Inadmissible”.

The impossibility does not mean low probability or cause and effect relationships. It is what people reject and do not even want to think about.

Possibilities and probabilities had to be introduced into the advanced part of the thinking operator because there are things we should imagine, forget about the possible and the impossible, build a tale, and then make it come true using special technologies. When we begin to design a situation, it is closed to the parameter of the impossible: for us, everything is possible. After analyzing the situation, we can answer the question of why it actually is impossible and how we can reduce the impossibility degree, i.e. decide on changes in the system that would make the situation possible. The impossible can be fought against with the help of the "Golden Fish"[8] or the "Swordfish"[9] operator.

Auguste Piccard was asked in his days, "Are you crazy, how can you submerge to the sea bottom, you will be crushed there?" However, step by step Auguste Piccard found a way. "I will not be crushed," he said, "if I submerge in a metal sphere." - "So you take a metal sphere and it will sink! And you won't be able to ascend." - "Why should it sink? I will tie up a float and will be drifting. I will ascend when necessary." - "How can you make a float? It will be crushed at such depth." - "Why?" – "Because it must be hollow…The Mariana Trench is enormous, the float will be crushed, squashed, and that's it." - "Well, then I will fill it with some liquid that cannot be crushed and is lighter than water." He thus moved ahead in stages. Fantastic-real, fantastic-real. The golden fish method… Could the old man come to the sea? Yes! Could he cast a net? Yes! Could he catch a golden fish?

The same actually happens with elementary contradictions. There are a macro- and a micro-level and system transition. For example, the entire system possesses feature A, while its parts possess feature non-A. It is similar to the problem with a capillary, where the entire system is cold while its parts are hot[10].

Cause and Effect Axis (Rational – Irrational)

The axis provides for the ability to employ models that break the cause and effect relationships among phenomena.

The axis is based on G.S. Altshuller's list of errors typical for working on a problem situation. The TRIZ author pointed out that a person was often incapable of accepting the idea of a solution if the ways for obtaining such solution were not clear, i.e. when the entire logical chain of cause and effect relationships could not be traced.

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[8] The "Golden Fish" operator (G.S. Altshuller) consists in transforming a fantastic situation into a real one by gradually separating the fantastic part. The situation is divided into a real part R1 and a fantastic part F1. The fantastic part is further divided into real R2 and fantastic F2, and so on, until a component is left which a real solution can be found for. The operator is described, for example, in the book *Inspiration by Order* by A.B. Selyutsky and G.I. Slugin, in chapter "Creative Imagination Development Course" written by G.S. Altshuller, pp. 158-162 (editor's note).

[9] V.M. Gerasimov developed and described this operator in his article "To Admit the Inadmissible". "First, a problem is defined, a problem impeding the development of a system for a long time is brought into light. The tougher the problem, the better, there is no point in thinking small in this situation. Then we assume that the problem has been solved, and potential changes caused by implementation of the solution are analyzed… In the course of work, proposals are gradually accumulated. At first, they are consequences of the initial – hypothetical – solution, and then they are consequences of the consequences. After making several (or several dozen) steps in this way, it is possible not only to improve the system, but also influence the initial problem. It often becomes simpler or just vanishes, although all useful system changes accumulated during analysis remain…"(http://www.trizminsk.org/e/212004.htm)

[10] The author presumably refers to the problem of capillaries in the chamber of an inkjet printer described in the book by N.A. Shpakovsky *Analysis of Technical Information and Generation of New Ideas: Teaching Guide*, Moscow, FORUM, 2010, pp. 196-200.

For example, the most desirable result is often rejected in the "Tongs" model[11]. The result is described without analyzing the methods required to achieve it. We simply describe what we would like to obtain if we were magicians, without thinking about the particular ways to do it. After we imagine and realize what we need, we state the problem and solve it by revealing barriers that prevent us from obtaining the result.

Thus, breaking the cause and effect relationships makes it possible to omit several steps in the problem solving process and decide whether it is worth building the solution logics in this direction, and if the answer is affirmative to add the missing links[12].

RELATIONSHIP WITH OTHER OTSM TOOLS

The advanced multi-screen scheme is a part of the universal model (ENV model) for describing elements of our world, both material and nonmaterial. All elements of the world have their features. Each feature has several, minimum two, values. A feature with a single value cannot exist by definition. Therefore, the advanced multi-screen scheme serves within the framework of OTSM as a part of the model for describing elements through their features and values[13].

This model was required to interconnect different problem solving tools of TRIZ and provide them with unified interpretation, a common language for describing elements of the world independently of their domain, their material or nonmaterial character. Designed to ensure a common approach to problem solving, OTSM-TRIZ should be capable of using any elements independently of their nature, at the same time taking account of specifics resulting from the nature of each element.

All this was needed to overcome the driving contradiction of OTSM as of a universal problem solving technology: the rules of such technology should be universal and thus common so as to be independent of the subject domain. At the same time, the rules should form an extremely specific tool for obtaining specific solutions in a specific domain. Nobody needs general words and recommendations. Specific solutions for specific problem situations are required.

This contradiction is resolved by system transition: each rule is extremely general and thus universal. There are few rules of this type. However, when using them not separately but within a system we can obtain a specific solution in a specific domain at a specific point in time during the life of particular elements of out world[14].

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[11] Detailed information about the "Tongs" model may be found, for example, in the article by N. Khomenko, J. Cooke "Inventive Problem Solving Using the OTSM-TRIZ "Tongs" Model" / http://otsm- triz.com/content/tongs ru

[12] To our opinion, the "Swordfish" operator described in article "To Admit the Inadmissible" by V. Gerasimov (see reference above) demonstrates not only the use of the "possible-impossible" parameter, but also the work with broken cause and effect relationships (editor's note).

[13] Later versions include abbreviation ENV (element – names of features – values of features). Common and specific features are defined in the model. The specific features are defined depending on a specific problem. The general features in the ENV model represent axes of the advanced multi-screen scheme. Focusing on the general features necessary for analyzing any problem forms one of the differences between the ENV model and its analogues in the field of artificial intelligence (editor's note).

[14] In his note to this passage, the author points out the need to "improve or even rework it, to show the connections and complementarity among axioms, the ENV model, and the multi-screen scheme" (editor's note).

ON MULTI-SCREEN THINKING

How does powerful thinking differ from weak thinking? The weak thinking sees that a tomato is red, while the powerful thinking understands that the tomato can be of any color, which forms the effect of the volumetric nature of the feature, the ability to see the entire set of values, those that in principle can belong to such feature and those that are limited for a given object. The volume of a feature is a set, a range of possible values. A large set results in the volumetric nature of the feature.

One of the concepts that should be introduced into TRIZ is the concept of a set. It forms the ability to see different sets and extract necessary information. Such ability immediately affords great possibilities. The man learns how to see and understand a situation several steps ahead. The view becomes wider, as through a panoramic glass.

On the other hand, mentally looking at a situation through a frame or a keyhole is a very useful technique. The ability to simultaneously narrow and widen the field of view is thus required.

The multi-screen scheme is the Ideal Final Result of powerful thinking. It demonstrates how much knowledge a person needs and in what light he/she should see the problem in order to work efficiently.

When looking at the same model, we can interpret it differently, i.e. replace it with other models. The same is observed with the fact based on which a model is built. The same happens in the nonmaterial world of imaginary models and elements…

Any object can be described using unlimited models that often contradict each other, all of them being correct but effective in different ways in different applications. Thus, there is the issue of building the most effective model that can help in problem solving.

REFERENCES (ARCHIVE FILES)

Name	Archive File Name
Lecture 1 (a file of lectures delivered in Minsk presumably to students of an institution of higher education)	Lect
Fragments of the recorded seminar in Artek	ARTEKNA (cartridge 4)
MModule Book - Raw about Multi screen schema Training	MMMB OTSM ENV Multiscreen schema Raw00
April 9, 1999 Lecture on Contradictions Chuksin Shpakovsky	04_GoshaPetrNic_contradict
A Monologue for Sveta	Sveta2_tas_xhh.
Audio recording of a dialogue with D. Kucheryavy (archive of audio files)	ce020500 Strasb DAK to onAdvanced Multi Screen.zip

Letter to A.A. Nesterenko (summer, 2010)	Nesterenko 2007 Jan 29quest_features_NK
Working papers for “Basics of OTSM-TRIZ Technology for Problem Analysis” seminar	PA1RAZ1N
Notes on the System Operator, August, 2003	Khomenko 030731 multiscreen