OTSM[1]-TRIZ Problem Solving Process: Solutions and Their Classification.

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ABSTRACT

Described is the classification of the main types of solutions, which make the "Solution" Line in the process of problem solving within the framework of the OTSM-TRIZ (1, 2, 3, 4) approach.

The Mile Stones system was developed for educational proposes, but it is also helpful for avoiding some misunderstanding between members of a problem-solving team as well as between an OTSM-TRIZ coach and his customer.

This work only deals with one line of analysis of a problem situation - that of building a solution that is used in practice here and now – in specific conditions. All other lines of analysis and the technologies of obtaining different types of solutions used within the OTSM-TRIZ approach are omitted with a view to focus attention only on the suggested classification of various types of solution. For the same purpose, omitted or considered briefly are the mechanism of obtaining and specifying the requirements for solutions and the rules of evaluating different types solutions.

[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 had to be explained. That is why this comment appears here.

Initial requirements for the Solution Line

These are the requirements for the Solution Line which are in our opinion the most important ones in terms of the OTSM-TRIZ problem solving process:

- The Line must be coordinated with the entire complex of lines of analysis of a problem situation and synthesis of solution on the basis of the OTSM-TRIZ approach and within the framework of models of Classical TRIZ proposed by Altshuller (5), in order to increase the efficiency of work on a problem of the entire approach as a whole.
- The Line must not depend of the used tools of problem analyzing and solving, in order to provide flexibility of its use for various tools of problem solving.
- The Line must not depend on those areas of knowledge to which the problem pertains, in order to be universal and subject-independent.
- The Line must be simple and understandable to experts in this problem who have insufficient knowledge of modern problem solving technologies, in order to use a team of experts-specialists in a narrow field and to provide work in one concept language.

Line of Solution: General description

Let us start from what a problem-solving process ends with within according to OTSM-TRIZ.

Most specialists who encountered a problem situation have a strong conviction that the more solution concepts (ideas) are developed in the course of problem analysis, the better for the project. At the same time here and now – in specific conditions – one solution is being used. We consider this solution, embodied here and now - specific material objects; specific actions performed by people or a method and theory that are being used in practice – a final goal of problem-solving and call it **Implemented Solution**

This means that in order to solve a problem - to find a solution idea and to embody it in a specific form suitable for practical use – it is enough to develop one solution that would satisfy all necessary requirements.

An exteriorly obvious idea is often seen as a novelty even in the environment of professional problem solvers. At the same time, those who regularly deal with problem analysis and problem solving know that while analyzing, one often comes across multiple solution ideas. Those ideas are often indistinct, are not filled with specific knowledge. Often and often those ideas have numerous disadvantages, having at the same time something positive in the context of solving a specific problem. Such ideas, described in the form of a set of their positive and negative properties within the framework of OTMS-TRIZ, are called **Partial Concept Solution (PCS).**

Nevertheless, in the course of the work on a problem, these **Partial Concept Solutions** gradually concretize, integrate with one another forming a more concrete outline of a further Implemented Solution. This kind of solutions, forming a system of Partial Concept Solutions, is called **Converged Concept Solution**. (CCS) (6, 7)

The difference between **Converged Concept Solution** and **Partial Concept Solution** consists in that:

- **Converged Concept Solutions** are more concrete and are close to reality unlike very indistinct **Partial Concept Solutions,** which are rather fragments of fairytales than solutions to be used in real life.

- **Converged Concept Solutions** are created in such a way that positive properties of different PCS are summed up and multiplied producing a synergetic effect, while the negative properties of the same PCS decrease and eliminate one another.

- **Converged Concept Solutions** are now evaluated not only by their positive properties, but also by the disadvantages inherent in them and by the negative effects they may cause when realized. To reveal these negative, undesirable effects, mental experiments and computer and full-scale simulation of individual CCS are carried out.

- **Converged Concept Solution** includes **Partial Concept Solutions** as constituent elements. Moreover, other CCS may figure in the capacity of CCS elements.

As a result of CCS integration with one another and with PCS, there appear CCS which may have undesirable properties and effects, but the summary level of their negative, undesirable properties and effects is much lower than the produced positive properties and effects. Such solutions look quite acceptable. This testifies to the fact that we have obtained a new type of solution, which we call **Final Concept Solution (FCS).**

The distinctive features of **Final Concept Solution** as compared with **Converged Concept Solution** are:

- First of all it is the fact that the desirable integral – positive - effect considerably exceeds the negative - undesirable – effect, which is so small that in some specific conditions of a specific situation it is quite possible to reconcile oneself to it.

- While there may be dozens of PCS and ICS, the number of FCS rarely exceeds 5 or 6 (it may amount to 10-20 together with variants.).

- Description of **Final Concept Solution** is more specific and concrete than PCS and ICS. It is concrete to such an extent that it is possible to pass to the selection of necessary materials and components and to start development and manufacture of prototypes.

All so far described processes occur in the heads of problem solvers. The obtained ideas are checked with the aid of mental experiments, tracing and sketching, and computer simulation. Sometimes, in order to check some PCS and ICS, full-scale experiments are carried out before selecting or rejecting the obtained ideas for manufacturing a prototype or experimentally checking its efficiency. The selected **Final Concept Solutions** embodied in a prototype and tested experimentally with a positive mark are called **Prototyped Solution**.

After passing to work on **Prototyped Solution**, the situation changes basically. So far, we have dealt mainly with mental simulation and mental experiments. Now a full-scale experiment with physically existing models is of first importance. At this stage, a transition to idea realization, to its embodiment in specific forms starts: mechanisms, constructions for engineering systems; organization, groups of people, organizing various events, law provision of various formalities, etc. are for problems from the business sphere.

Though at this stage we are dealing mostly with material embodiment of ideas, we, nevertheless, encounter some problems, the solution of which requires metal experiments, analysis and generation of additional concept solutions. In other words, we need the same mechanism of problem solving which helped us obtain concept solutions accepted for prototyping.

After the tests have been carried out, the problems have been solved and a decision to pass from a prototype to implementation stage has been taken, we face once again the situation, when it is

necessary to solve the arising problems. And we can use once again the mechanism of obtaining a concept solution, which we used in order to obtain solutions suitable for prototyping. In a general case, prototyping of some additional conceptual ideas may be needed.

Thus we can describe in a general form the process of work on a problem from an initial situation till a solution introduced in practice. It will comprise three stages:

- Mental simulation of a problem situation in order to obtain a concept solution.
- Full-scale simulation or experimental check of concept solutions obtained at the stage of mental simulation in order to obtain a well-tested material prototype of the concept solution.
- Implementation of a finalized prototype and its wide use in real life situation for which it is designed.

This is just one of the most general schemes of OTSM-TRIZ presenting different approaches to the process of transformation of **Initial Problem Situation Description** to a concrete production of **Implemented Solution** (material or non-material) or actions in accordance with some plan.

We call this scheme **Line of Solution:**

- **Initial Problem Situation Description, -** without an acceptable solution.
- **Concept Solution, -** description of a solution, accepted for prototyping or implementation.
- **Prototyped Solution, -** tested prototype accepted for implementation.
- **Implemented Solution, -** Desirable result performed and accepted.

Initial Problem Situation Description is usually indistinct. It is not always clear what are the aims and what means are allowed to use. There is only a description of some disadvantage – some **Undesirable Effect,** of something to be eliminated or changed.

Implemented Solution is a specific product that eliminates the initial problem situation. This problem may be of various kinds:

- Material, for instance, some electronic devices, mechanical machines or buildings.
- Nonmaterial, for instance, theories and methods, some feelings of a spectator examining a picture or other work of art.
- Actions already performed in accordance with a certain plan in order to achieve some aim or actions, which achieved that aim.
- Combination of the above-mentioned products.

OTSM-TRIZ approach is aimed at providing a transfer from **Initial Problem Situation Description** to **Concept Solution.** This is the main designation of this approach and its niche in the problem solving process. At the same time, since certain problems occur often enough both in passing to **Prototyped Solution** and in passing to **Implemented Solution**, one can say that the OTSM-TRIZ approach is applicable to all stages of problem solving – from **Initial Problem Situation Description** to **Implemented Solution**. Just like mathematics is used for estimating and evaluating concepts, for calculations necessary for creating a prototype, and for calculations needed in transfer from a

prototype to **Implemented Solution**. Just as in case with mathematics, the OTSM-TRIZ approach may be used in all sorts of specific problems arising due to some undesirable phenomenon.

Classification of the main types of solutions used within the framework of OTSM-TRIZ approach to the problem situation analysis.

1. **Initial Problem Situation Description -** description of something undesirable without an acceptable solution how to eliminate it.

2. **Concept Solution -** description of a solution accepted for prototyping or implementation.

   2.1. **Partial Concepts Solution –** appears as a result of the analysis stage of a problem solving process.

   2.2. **Converged Concept Solution -** appears as a result of the synthesis stage of a problem solving process

   2.3. **Final Concept Solution** or just **Concept Solution – Converged Solution** that passed test of mental experiments or computer simulation and was accepted for prototyping or implementation.

3. **Prototyped Solution -** tested prototype accepted for implementation.

4. **Implemented Solution -** result of problem solving that is performed and accepted.

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