

# **Introduction to TRIZ**

## **(Theory of Inventive Problem Solving):**

### **A Technological Philosophy for Creative Problem Solving**

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#### **Contents:**

- [1. Introduction](#)
- [2. Overview of TRIZ' recognition of technology](#)
- [3. Overview of TRIZ' methodology for problem solving](#)
- [4. Tasks for Studying and Penetrating TRIZ](#)
- [5. Essence of TRIZ](#)
- [6. An Easy Procedure for Problem Solving: USIT](#)
- [7. Conclusion](#)

References:

[Editor's Note \(Toru Nakagawa, Nov. 16, 2001\)](#)

#### **Abstract:**

TRIZ is a technological philosophy born in the former USSR and is a methodology for creative problem solving. TRIZ has extracted principles of invention from analysis of a huge body of patent bases, has revealed laws of evolution of technical systems, and has established general procedures for problem solving, especially for solving contradictions. The key to penetration of TRIZ into industries is its simplification. The present paper expresses the essence of TRIZ concisely, and introduces USIT as an easier procedure for creative problem solving containing such TRIZ' essence.

#### **1. Introduction**

The present paper introduces **TRIZ**, which was developed in the former USSR on a grassroots basis, has become known to the West after the end of the Cold War, and is currently attracting much interests in industries and in academia. "TRIZ" is the English spelling of the Russian abbreviation representing "**Theory of Inventive Problem Solving**", and is pronounced just like "trees" in English.

In 1946 in the former USSR, a young patent adviser in a Navy Office, **G. S. Altshuller** of age 20, recognized that among a huge number of patents there appeared similar ideas and analogous solutions in different areas, in different eras, and for different problems. And

he realized that even "original" and "creative" inventions naturally had common patterns. Thus he thought that if we should extract the patterns of inventions from good patents and study them, every one could become an inventor. Such a study could help people become less dependent on trial-and-errors and incidental enlightenment.

He sent a proposal of his ideas to Stalin, and, as the result, was deemed being against the regime and was sent to a GULAG for five years. Later on, in spite of similar continuous suppression by the authorities, he studied the patent databases, extracted principles of invention, and developed in a bottom-up, step-by-step manner a new view of technology and a methodology for solving technological problems. From 1970 to 1974 he was allowed to teach at a public institute every Sunday for training students, but during all other eras he had to conduct his research and training activities with his private grassroots organization.

He analyzed a huge number of patents and extracted "Principles of Invention" (i.e., essence of ideas in inventions), and devised procedural methods to think of such inventions (he called them "Algorithm of Inventive Problem Solving"), and further tested their usefulness by applying them to different problems. Such research was done all manually and experientially with his associates.

In 1990, associates and followers of Altshuller were teaching TRIZ in about 200 TRIZ schools (they were sometimes official laboratories/courses, whereas sometimes private groups) to about seven thousand students all over the former USSR.

As the results of the decay of the former USSR and the subsequent end of the Cold War, a large number of TRIZ specialists have emigrated to **USA and Europe** and brought TRIZ to the Western countries. Especially in USA, such Russian TRIZ specialists have developed PC software tools of TRIZ knowledge bases, and have conducted seminars and consulting to penetrate TRIZ to industries.

**In Japan**, TRIZ was first introduced in 1996 by Nikkei Mechanical Journal and has attracted much attention from industries, especially in manufacturing, and has been tried for application.

Activities of introducing TRIZ in Japan in its initial stage, however, had drawbacks in the following points: (a) The catch copy of "Super-inventive techniques" generated some skepticism and misunderstandings. (b) Information of TRIZ was mostly based on textbooks of 1970s and did not contain enough up-to-date information due to the language barriers. (c) Software tools of TRIZ were good as a knowledge base, but could not smoothly guide the thinking process in problem solving.

The present paper gives an introductory overview of TRIZ with the principal intention of overcoming the above mentioned drawbacks. For more detail, readers are referred to the WWW site "TRIZ Home Page in Japan" [1], for which the present author serves as the Editor.

## 2. Overview of TRIZ' recognition of technology

As described above, on the basis of the analysis of a huge number of patents, TRIZ has established new views of the whole system of technology as follows:

(1) **Technology oriented:** Oriented neither towards abstractness of academic science/technology nor towards concreteness of industrial technologies, but oriented towards both abstractness and concreteness as a new approach to technology. This has created a new stance for abstractness necessary for industry.

(2) **Laws and trends of evolution of technical systems:** Established from the analysis of history of evolution of technical systems. The law of evolution of technical systems towards the increase of ideality was revealed, where the ideality is defined qualitatively by "principal function / (mass + size + energy)".

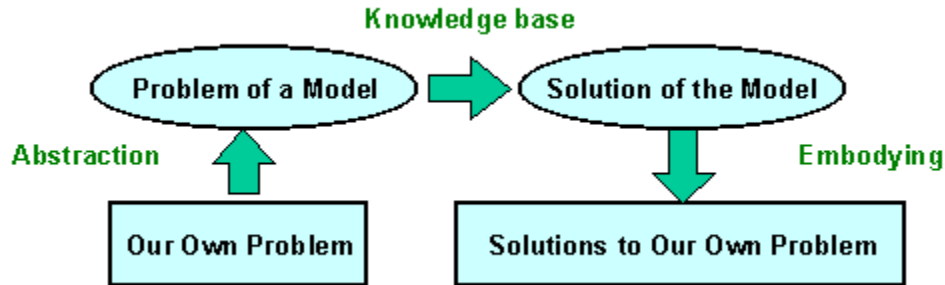
(3) **A hierarchical search system from target functions to technical means:** Science and technology usually state their findings in the scheme of "experimental conditions ==> (natural laws) ==> resultant effects". On the other hand, technology applications want to find appropriate means for realizing the target functions. Since this requirement has the direction opposite to the statements of laws in science and technology, the search is often very difficult. TRIZ has developed a hierarchical representation system for the technological functional targets, analyzed and accumulated known means for realizing such functional targets, and thus established a knowledge base stated in the format of "target function ==> technological means".

(4) **"Principles of Invention":** 40 principles of invention were established. They include 40 principles, such as "division", "separation", "local properties", etc., and many of the principles have two, three sub-principles. Multiple examples of application for each principle are also accumulated for illustration.

## 3. Overview of TRIZ' methodology for problem solving

The original purpose of TRIZ development was to establish a methodology for creative problem solving. On the basis of the recognition of technology stated above, TRIZ has succeeded in establishing a new system of methodology which has much exceeded the level of "know-how to invent".

(5) The **basic model for problem solving in TRIZ** is illustrated in the following figure.



Trying to solve our own problems individually and concretely is rather difficult and often guides us to trial-and-errors. Thus, it is advised to utilize a collection of models (or templates) of problem solving, which were studied and accumulated beforehand. We first try to make our problem abstract into the problem in an appropriate model. Then the known solutions of the model are applied to our case to find some appropriate concrete solutions to our own problem.

(6) TRIZ has established a form of representing the essence of problems, i.e., **technical contradictions**, and provided a table of useful hints to solutions. Technical contradictions are the cases where if we try to improve an aspect (or a parameter) of the system, some other aspect becomes intolerably worse. In order to represent the situations of technical contradictions, TRIZ has selected 39 parameters of systems and has provided a problem matrix of size 39 x 39. Then, by surveying a huge number of patents, each patent was analyzed to find which type (among 39 x 39) of technical contradiction it treated and which principle of invention (among 40) it used in its solution. Accumulation of this analysis has revealed which principles were most used in each of the 39 x 39 types of problems. The top 4 principles in each type of problem were recorded in a tabular form of 39 x 39 elements; the resultant table is called "**Altshuller's Contradiction Matrix**". This is an incredible research achievement established in TRIZ.

For using this matrix, one has to think of which matrix element his/her problem should be assigned to and then has to consider about the four principles of inventions suggested by the matrix as the hints, so as to realize them into a solution to his/her own problem. For using these hints, capability of flexible thinking is needed.

(7) TRIZ has defined the concept of "**Physical Contradictions**" and revealed the "**Separation Principles**" to solve such contradictions. Physical Contradictions are the cases where two mutually-opposite requirements to one aspect of a technical system need to be fulfilled at the same time. The situations like this are contradictory and absolutely impossible to solve, in our ordinary sense. On the contrary, however,

TRIZ advises to reformulate the problems into the form of Physical Contradictions and then has demonstrated that they can readily be solved with "Separation Principles". By closer analysis of the apparently-opposite, simultaneous requirements, those requirements may be found separable in time, in space, or in some other conditions. Then under such separate conditions, the system may simply satisfy the opposite conditions separately. This method is called Separation Principles.

(8) TRIZ has developed a problem-solving procedure where we first analyze the problems to formulate a Technical Contradiction, then reformulate it with several steps into a Physical Contradiction, and finally solve it with Separation Principles. This procedure is called **ARIZ** (Algorithm of Inventive Problem Solving).

(9) A functional analysis method, named "**Substance-Field Analysis**" has been developed. And then useful solutions for various cases of the Substance-Field Model have been accumulated and concentrated into "**76 Inventive Standard Solutions**."

#### **4. Tasks for Studying and Penetrating TRIZ**

As is described so far, TRIZ has developed a huge body of knowledge in the aspects of new recognition of technology and new methodology of problem solving. Such knowledge is written in textbooks, handbooks, and software tools. Since the contents of the knowledge are rich and advanced, promoters and enthusiasts of TRIZ believed that TRIZ would give a big impact onto technological innovations.

However, the penetration of TRIZ in USA and other industrial countries in 1990s was rather slow. This is not because TRIZ was poor but, on the contrary, because it was so voluminous and advanced, according to the present author's understanding.

The new views and methodology summarized in Sections 2 and 3 form so huge knowledge bases that it takes much efforts and time for a learner to understand and master them. If a learner wants to use TRIZ knowledge without mastering them by heart, he/she would need to make them referable at hand at any time; this means the needs of special equipment and software, and yet they would be tedious and difficult to use in real applications.

In the former USSR, students and engineers voluntarily came to study TRIZ at two-year courses at a level of graduate-school education. This was the source of the TRIZ experts in ex-USSR. In the western industrial countries including Japan, engineers in companies do not have enough time for such education. They want, if possible, to master the basics of TRIZ in, say, 3 days at a seminar so as to be able to apply it to their own problems.

Considering the current situations, it is necessary for the TRIZ promoters to clarify what must be taught/learned as the essence of TRIZ and how simple way TRIZ can be used in real applications. This must be the key to smoother and wider penetration of TRIZ.

## 5. Essence of TRIZ

Thus, it is necessary for us to extract the essence of TRIZ from a large number of TRIZ principles and methods. For doing so, we have to understand TRIZ not at the level of knowledge bases but more deeply at the level of its philosophy.

The present author obtained such understanding recently through his translation work of Yuri Salamatov's TRIZ textbook [2]. At the international conference of TRIZCON2001 in March 2001, the present author showed a slide describing "Essence of TRIZ in 50 Words". It is written as:

Essence of TRIZ:

Recognition that  
technical systems evolve  
towards the increase of ideality  
by overcoming contradictions  
mostly with minimal introduction of resources.

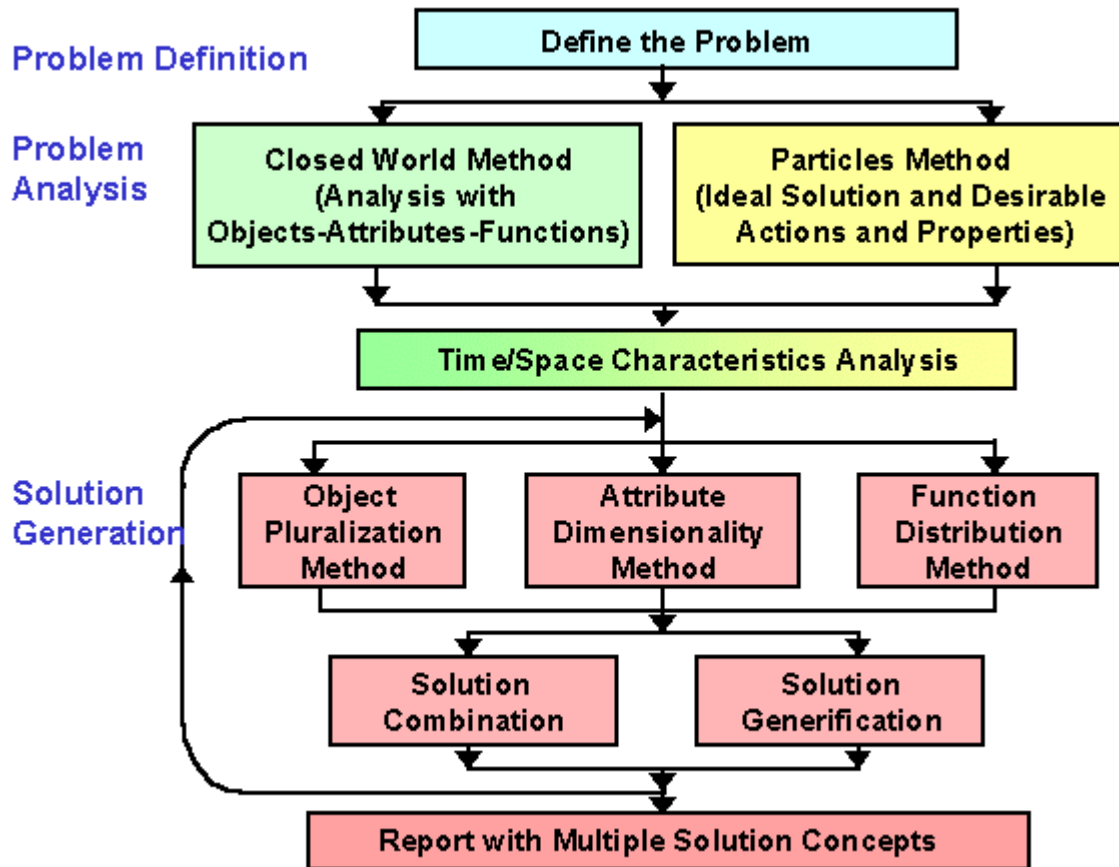
Thus, for creative problem solving,  
TRIZ provides a dialectic way of thinking,  
i.e.,  
to understand the problem as a system,  
to make an image of the ideal solution first, and  
to solve contradictions.

So, we should just understand the essence of TRIZ in this manner and master a problem solving procedure which implements such an essence.

## 6. An Easy Procedure for Problem Solving: USIT

Problem solving procedures in traditional TRIZ are very difficult as mentioned in Section 3. Simplification of TRIZ procedures was tried in 1980s in Israel, and then improved further into **USIT** ("Unified Structured Inventive Thinking") in 1995 by Ed Sickafus at Ford Motor Company. The present author learned USIT in 1999 and has been working for introducing it into Japan.

The whole USIT procedure can be shown by a simple flowchart as follows. The steps of USIT are easy to master under the direction of clearly-stated guidelines.



In order to apply USIT to real problems, it is advised that USIT expert(s) and the engineers involving in the problem system should form a joint task group to solve the problem together. Neither handbooks nor software tools are used in USIT procedure. With USIT, you will certainly be able to generate multiple conceptual solutions to real problems.

## 7. Conclusion

In conclusion, TRIZ is a new technological philosophy born in Russia. It has developed a rich collection of methods for solving technical problems creatively. If anybody once master them, he/she will obtain a great ability of innovation in technology, in industry, and in academia.

In order to master TRIZ, the following three points are advised:

- (a) To study the structure and philosophy of TRIZ with TRIZ textbooks,
- (b) To apply the USIT procedure for easier problem solving,
- (c) To fully utilize the TRIZ knowledge bases with handbooks and software tools.

TRIZ has been used for creative problem solving not only in technological fields but also in nontechnical fields, like services and businesses. It also has rich experiences (in Russia) in the field of creativity education. TRIZ is expected to give great impact on innovation in all these fields in Japan and in the World.

### **References:**

[1] Toru Nakagawa, editor: "TRIZ Home Page in Japan", WWW site (in English and in Japanese), URL: <http://www.osaka-gu.ac.jp/php/nakagawa/TRIZ/eTRIZ/>

[2] Yuri Salamatov: "TRIZ: The Right Solution at the Right Time", English edition, Insytec, The Netherlands, 1999; Japanese edition, Nikkei BP, 2000.

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### **Editor's Note (Toru Nakagawa, Nov. 16, 2001)**

This paper was presented at the Annual Symposium of Japan Creativity Society. Though the society has a history over 20 years, I joined it newly last summer and presented this paper for the first time. Since I did not know much about the members, I assumed in preparing this paper that most of them had little knowledge about TRIZ, i.e. typically "Just heard of it". The length of the paper was limited up to four printed pages in A4 size. Under these restrictions, I wrote this paper of "Introduction to TRIZ". This turned out to be a valuable opportunity, as you see here.

This WWW site "TRIZ Home Page in Japan" has posted a large number of articles for these three years and fortunately received many readers in Japan and over the world. On the basis of these accumulated documents, most of recent articles are written for people who knew TRIZ to some extent. Hence it has been a long-pended task for me to write an introductory article for new readers on the basis of my current understandings. It is my pleasure to post this paper as the introduction to TRIZ for novice readers under the permission of Japan Creativity Society.

### **Editor's Note (Toru Nakagawa, Jan. 7, 2002)**

This paper is now posted in English translation as the first article of Year 2002.