Revision of Classical TRIZ Assumptions

Introduction

In reviewing the history of TRIZ, we should keep in mind that the creation of a new science and the introduction of a new and significant paradigm represent a revolutionary process that differs greatly from the normal process of scientific development[1], especially in the political climate of the former Soviet Union. The government institutions most influential in this area – the Academy of Sciences, which controls all developments in science, and the Inventors Society, which controls the work of inventors and the inventive process – were very negative regarding TRIZ. Numerous attempts to "stop" TRIZ, including the official banning of seminars, prohibiting the publication of books and articles, screening or even withholding private correspondence, and listening in on telephone conversations, etc. were undertaken. At the same time, many of Genrich Altshuller's works were simply stolen, modified slightly, and then published under different names without referring to the true author.

On the other hand, the absence of a market economy and, therefore, of a practical way to capitalize on TRIZ led to the situation where TRIZ attracted many enthusiasts. At times, these were people with certain peculiarities, who, for various reasons, could not find their niche in the sciences that were officially recognized by the totalitarian regime.

Under these conditions, the only reason that TRIZ survived and continued to grow was that the structure developed by Altshuller included a rigid system of basic assumptions and a transparent system for TRIZ development, which enabled TRIZ to be built as a unified "organism." This system was never depicted in any written document, rather, it was the accepted practice. Further, the acceptance of this system was mandatory to become a member of the TRIZ society.

Organizationally, the TRIZ society was more like a religious order, with the incumbent internal discipline, than a typical scientific fellowship:

- Anyone interested in TRIZ could easily become a member of the society by writing a letter to Altshuller or by attending a seminar (usually free of charge).
- All members of the society had equal rights; no one enjoyed special privileges
- Everyone could apply the science as they saw fit, as long as they followed the main assumptions of TRIZ
- Altshuller managed all scientific developments and passed final judgement on what was good or bad for TRIZ
- Altshuller managed the scientific process by delivering keynote speeches at bi-annual TRIZ congresses, and through his personal correspondence. There were months when Altshuller's correspondence reached several hundred letters.
- Those who "violated" the rules could be punished by being pushed "behind the TRIZ door"; upon Altshuller's request, colleagues would stop all association with an individual. Although in reality this only happened a few times, the threat of being cut off from TRIZ was a serious one. For each individual involved in TRIZ, it was extremely important to be part of the TRIZ

[1] Thomas S. Kuhn. *The Structure of Scientific Revolutions* (University of Chicago Press, 1996).

community, and therefore such a threat was a very potent method of control and consolidation of the society.

There were also several main scientific assumptions that enabled effective TRIZ development:

- TRIZ is fundamentally different from the Trial-and-Error Method (TEM); TRIZ and TEM are incompatible
- TRIZ is a technical, rather than a psychological, science
- The main goal of TRIZ is to transform everyone into a creative individual
- The patent library is the basis for TRIZ development
- A contradiction is the core of an inventive problem; resolving the contradiction means solving the problem
- Increasing ideality is the direction in which the search for solution and system development are carried out
- High-level inventions are preferred over low-level inventions

All of the above should be credited with allowing Classical TRIZ to survive and advance under the extremely unfavorable conditions of a totalitarian society.

According to Dr. Kuhn, in the evolution of any science there comes a time when the scientific models, postulates, basic assumptions, etc. that were accepted and very helpful in the previous stage must be revised. Some old postulates are rejected and/or their use is restricted; new ones are introduced. This has happened quite often in the evolution of physics, chemistry, biology and other sciences.

Any paradigm change is a painful process, at times dividing an entire scientific community. However, human history has demonstrated that the need for revision is usually driven by the normal evolutionary process. Moreover, timely revisions are signs of a healthy process rather than the result of the ill will, ambitions, or ignorance of the "revisionists."

TRIZ is no different. For the past 15 years in the evolution of TRIZ, some drastic changes have taken place:

- TRIZ has moved into the free world
- New fields (business, advertising, pedagogy, etc.) have being explored
- New professional experience accrued in technical applications has been the driving force in the development of the theory

It is quite obvious that the time to revise the fundamentals of TRIZ is now, especially since some of them have never been fully articulated and instead have merely been accepted "by default." The following is the result of analysis and of multiple discussions with numerous TRIZ professionals. Each assumption accepted in Classical TRIZ is articulated, the problems associated with it are discussed, and a revised formula and directions for further development are offered.

1. TRIZ and the Trial-and-Error Method (TEM)

"TRIZ is 'exclusive'; it is necessary to fight TEM; TRIZ cannot cooperate with methods based on TEM."

Associated problems: When a new science or method emerges in an area already occupied by others, differentiation is the key to survival and initial growth. However, aggressive differentiation destroys bridges with potential allies. Once the newcomer gains strength and finds its niche, rigid boundaries are no longer required.

An example involving Freudian psychoanalysis: In the beginning, when Freud was fighting for his work to be recognized, he was very firm in his contention that behavior is based on sexuality. In the 1930s, when psychoanalysis was widely accepted, he almost completely abandoned the very mention of this phenomenon.

The confrontation with TEM was definitely vital for the survival of TRIZ in the beginning of its evolution. Later it turned into an obsolete tradition, hindering the integration of TRIZ into other sciences and typical practices.

Revision: TRIZ should be one of the elements in the general system of sciences. It should be able to cooperate with other sciences. Of special importance for TRIZ is that it cooperate with other systems and methodologies that have the same goal, yet are not based on TRIZ. Earlier, TRIZ entered into such a relationship with classical Value Engineering (VE). Recently, cooperation with methods such as QFD, optimization methods, decision-making methods and tools, robust design, etc. is in progress. This is a "two-way street" – i.e., some elements of TRIZ find their way into other methods and theories. This process, rather elemental today, is inevitable.

Directions for further development: Purposely organize and perform the process of integrating TRIZ with potentially related methods.

2. TRIZ and personal creativity

"The main goal of TRIZ is to help everyone become a creative individual, provide everyone with the possibility of participating in the creative process, and to instill in everyone the desire to create."

Associated problems: Unfortunately, in real life the same people whom we are trying to satisfy offer very strong resistance to this process. Quite often people do not want to change their way of thinking at all. All they want is an instrument for problem solving or, better yet, something to help them find a ready-made solution they can use.

Revision: Creative education should be complemented by simple, effective tools and databases, which can help users achieve results without a lengthy learning process. Furthermore, these simple tools and databases can become a lure into the creative process.

Directions for further development: Develop TRIZ-based tools, preferably software tools, which can be used with little, if any, TRIZ education.

3. Technological TRIZ

"The development of technological TRIZ is mostly complete; now we need to concentrate on developing methods for raising creative individuals."

Associated problems: In the mid-1980s, Altshuller offered this assumption, based on the development and testing of two outstanding problem-solving tools: ARIZ-85B and the system of 76 Standard Solutions. With the aid of these tools, the participants of TRIZ seminars of varying length (from 60 to 200 hours) could successfully solve the majority of training problems. With real-life problems, however, the rate of success was considerably lower. For example, ARIZ could not be used to address small system improvements or typical problems faced during the Value Engineering process. Like all other TRIZ tools, ARIZ required considerable education in TRIZ, to enable the user to pre-formulate his/her problem in terms that would support the application of these tools.

Also, attempts to computerize TRIZ showed that, with some exceptions, Classical TRIZ could not be computerized as it stood, which was a clear indication that the system logic was insufficiently developed.

Revision: ARIZ is focused primarily on concept development and assumes that the problem-at-hand is the correct problem one should be working with. However, the real inventive process always requires additional steps that help one understand and formulate (sometimes reformulate) the problem before attempting to solve it. Also, this process should allow one to work with any problem in any statement without special pre-formulation.

Directions for further development: Develop processes that include all necessary problem-solving steps, and develop integrated tools able to support all steps.

4. TRIZ and levels of invention

"Mankind needs inventions. Inventive solutions are preferable to non-inventive ones; high-level inventions are preferable to low-level inventions. The main mission of TRIZ is to enable inventions of the highest possible level."

Associated problems*:* Practical applications have completely repudiated these statements. Clients have no need for inventions; they merely want to eliminate their problem in a simple and inexpensive way. The higher the level of invention, the more difficult and expensive the implementation, since the system must be subjected to drastic changes.

Revision: If acceptable results are attainable without an invention, then the invention is not required. If acceptable results are attainable by a low-level invention, then a high-level invention is unnecessary.

For example, if a mechanical problem can be solved by introducing an unusually-shaped lever, this solution is preferable to looking for ideas that call for the application of magnetic liquids, shape-memory materials, or some other complex physical, chemical or other effect.

Based on the above, it is preferable to secure as good a solution as possible by applying simple approaches, and leave off advocating high-level solutions. We need simple methodologies, which are compatible with TRIZ, to solve simple problems.

***Directions for further development**:* Develop a methodology, based on TRIZ, which will aid in the finding of low-level solutions.

5. TRIZ and patent libraries

"TRIZ was created, and continues to evolve, based on analyses of patent libraries. This assures rapid development, since technology is the only source of well-organized data on evolution."

Associated problems: In the beginning, the patent library provided for the fast and effective development of TRIZ by helping to identify general patterns and principles of problem solving. However, this approach has the following limitations:

- Inventions fill the patent library non-uniformly and occasionally (the result of using TEM). In some areas, the patent library is limited[2].
- Patents do not contain information indicating whether the invention was actually created and implemented. Many inventions are patented to conceal an individual or company's real direction of development.

Revision: For in-depth analysis the history of technology should be taken into consideration, as it provides proven information of implemented inventions, especially those introduced to a large market. Moreover, today TRIZ knowledge about patterns and lines of technological evolution may be used to validate an invention, define how it can move the system along its evolutionary path, and thus estimate its value for the purpose of making a decision about patenting.

Directions for further development: Develop TRIZ based on the existing TRIZ tools and approaches rather than on the patent library. Use TRIZ to enhance the structure of the patent library.

6. Patterns of technological evolution and markets

"Development is guided exclusively by the patterns of evolution of technological systems. Do as the patterns dictate – you can't go wrong."

***Associated problems**:* This assumption is largely the product of totalitarian mentality, as well as a misunderstanding of the role of markets.

***Revision**:* Two closely interacting yet entirely different processes guide the evolution:

- The constant generation of new ideas, concepts, products and services
- The selection of the best products and services for development and mass production by the market

[2] Igor Vikentiev proved that the patent library is limited and incomplete with regard to inventions utilizing geometrical effects.

Directions for further development*:* Introduce elements of the market approach into TRIZ, discover patterns and lines of evolution of markets, develop a methodology for analyzing and solving sales and marketing problems.

7. Patterns of evolution and high-level inventions

"New patterns of technological evolution must be discovered based exclusively on high-level inventions."

Associated problems*:* It is still quite difficult to precisely determine the level of an invention. Intuitively, we imply that high-level solutions are more elegant, non-obvious, and often achieved through the use of various effects. Also, these solutions suggest drastic change(s) to the system. But still, it is rather subjective. The biggest trap is the notion of "non-obviousness." Obvious solutions in one field are not at all obvious in another field. Moreover, the label "non-obvious" assigns a level of invention that is only temporary. Some "non-obvious" solutions of the past, such as the use of bolts as fasteners 500 years ago, are widespread and trivial today. It is possible that current high-level solutions will become obvious and trivial with the advent of TRIZ education.

Revision*:* Patterns must work for developing both new and nearly exhausted systems, and thus should be based on solutions and discoveries that are representative of a system's development at different stages of evolution, regardless of the appraisal of the level of solution. Further, the important point is whether or not a solution is utilized for system development and how often it is utilized. The patterns should include lines and steps which, though they might appear trite, aid the system development at one or another stage of evolution.

Directions for further development*:* Use several different approaches to:

- Develop Operators (principles, standards, etc.); for the one-time purpose of modifying a system to obtain a solution, a patent search oriented toward high-level solutions is a suitable approach.
- Reveal patterns and lines of evolution; for this we need to study the history of the systems of mass-produced products, where individual features are masked by statistical plurality.
- Develop methods for the historical analysis of the evolution of technological or other systems to discover patterns and lines of evolution.

8. TRIZ and contradictions

"TRIZ should focus on revealing and resolving contradictions; therefore, ARIZ is the primary tool."

Associated problems: Working with numerous real-life problems has shown that in many situations a problem can be solved without articulating a contradiction. For example, eliminating a specific shortcoming, achieving general improvement of a system, redesigning a system or assembly, etc. can be done through utilization of the Standard Solutions or Operators for system transformation, and even with the patterns of evolution, rather than with ARIZ.

Research has provided data that enables inventive problems to be divided into two different, yet mutually complimentary, classes:

- During the first stage of evolution, in the presence of abundant resources, development follows patterns of evolution and slows down due to the lack of knowledge about the patterns. For example, a problem might be solved by introducing a hinge. Nothing stands in the way of introducing such a hinge, and its introduction does not conflict with anything else. Or, the problem might be solved by exploiting an existing resource, and introducing the solution is not hindered by anything other than slow wit. These problems do not contain contradictions, in principal. Classical TRIZ solves this type of problem through the application of Substance-Field analysis, by completing and/or destroying Substance-Field Models. Thus, it is no accident that numerous attempts to connect Substance-Field analysis and contradictions have failed.
- System development is accompanied by depletion of resources. An increase in the requirements of the system as a whole leads to competition for limited resources between various functions (elements) of the system.

  Example: An aircraft should be able to achieve long range at high speed. However, an increase in the speed leads to an increase in the consumption of resources – fuel – which in turn leads to a decrease in range.

Revision:
At some point a compromise is a viable approach; then a contradiction must be resolved, often by utilizing hidden resources.

To be able to evolve systems on their early stage of evolution, we should have knowledge about the “correct” ways of evolution, such as detailed lines of evolution along the patterns (a “cookbook”). This knowledge might prompt an idea of what is missing and what should be added. According to our experience, these problems comprise about 75% of the total real-life problems.

Problems that contain contradictions emerge infrequently, and in the following cases:

- In the presence of an obvious harmful effect. Usually these are typical industrial problems that emerge when otherwise useful equipment causes harmful effect that must be eliminated with minimal cost.
- When required cost reduction may lead to a decline in quality.
- When a solution that is offered in accordance with a pattern of evolution can not, for some reason, be implemented, i.e., the solution leads to a secondary problem.

Directions for further development[3]:

- Develop a “cook book” for solving problems without contradictions
- Develop simple methods for solving problems with contradictions.

[3] Both directions have been implemented in the process of developing the Ideation TRIZSoft™ family of tools.

9. Universal TRIZ tools

"Most problems are best solved by applying universal TRIZ tools such as ARIZ and Substance-Field analysis."

Associated problems*:* This assumption is closely connected to assumption #2 – which focuses on the development of a creative individual. It is best for the TRIZ practitioner (professional) to be intimately familiar with one or several universal tools, allowing him/her to solve problems in different fields. However, such proficiency requires in-depth, lengthy studies and constant utilization.

Revision*:* Those who work in narrow fields and are repeatedly tasked with solving problems (which is the majority of engineers), should benefit from the application of specific creative tools, which are tailored specifically to their field of activity.

Directions for further development*:*

- Continue developing and enhancing the universal tools, especially in the direction of reducing the time required to master them
- Develop highly specialized tools, mainly software tools, for specific types of tasks and problems

10. Focusing on the ideal solution

"While solving a problem we should find the single best solution that is as close as possible to the ideal solution."

Associated problems: The ideal solution is usually obtained through the utilization of resources. Different systems may have different resources, therefore, a solution that is ideal for one system might be not be ideal for another. In other words, ideality might be local rather than global. Aiming at theoretical ideality might be misleading, detracting from the solution that is simple and based on the availability of local resources. Unfortunately, very often the appropriate resources are revealed only after an idea is found.

Revision: Consider "local" ideality in addition to theoretical or global ideality. Look for a wide range of potential solutions and then screen them to select the one that is most suitable. (Look for an exhaustive set of potential solutions.)

Directions for further development: Develop a methodology that will enable an exhaustive set of solutions to be found.

11. TRIZ and psychology

"The TRIZ methodology is the most important factor in the inventive problem-solving process. Psychological issues, such as overcoming psychological inertia, are auxiliary; the problem-solving process is not (or only slightly) dependent on psychology."

Associated problems: Although this assumption was quite effective in the initial stages of TRIZ development, it has since become a hindrance. It became clear that students do not easily comprehend a methodology that was created with no consideration of psychology. This proved to be especially true in the process of computerizing TRIZ.

Revision: Presently, the methodology has advanced without concurrent advances in the psychology of the process and, as a result, it lacks completeness. While solving real-life problems, TRIZ specialists observed that logical analysis (ideality, recognition of contradictions, etc.), suggestions of Operators, examples used to trigger analogies, and other data serve as a means of “charging” the subconscious mind with pertinent data for the creative process. In itself, the creative process is a “discharge,” which depends on many variables, but most of all on the contents of the data residing in the subconscious mind.

Directions for future development: At present, we need to intensify our efforts in the “psychology + TRIZ” area, and do so in close collaboration with psychologists.

12. TRIZ and mentality

“TRIZ was based on the analysis of the world patent library, therefore, it is international by its nature and is fit for use in any country, by anyone.”

Associated problems: This assumption is true with regard to the utilization of the TRIZ knowledge base. However, TRIZ premises, algorithms and other processes, including education, are seen very differently in the United States or in Japan.

Revision: It turns out that TRIZ, created in the former Soviet Union, is heavily tinted by the Russian mentality, which is drastically different from the current American mentality. Among these differences are the following:

- Different types of language, which leads to differences in perception
- The Russian language belongs to the group of synthetic languages aimed at word formation, and is only slightly dependent on the structure of sentences and text
- The English language belongs to the group of analytical languages; it has only a weak ability for word formation but is highly depended on sentence and text structure. Thus, people relate differently to way data is structured. For example, the structure of ARIZ, which is readily accepted by Russian engineers, can serve as a source of torment for Americans
- The whimsical mix of two types of thought process:
- Western, based on logic and analysis (“left brain”)
- Eastern, oriented towards analogies and perception of images (“right brain”)

Directions for future development: Westernize and internationalize TRIZ.