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Theory of inventive problem solving (TRIZ): his-story.

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Abstract

The letters T, R, I, Z in TRIZ (/ˈtriːz/); are the English acronym for the Cyrillic words (Russian: Теория решения изобретательских задач) which pronounce phonetically as: Teoriya Resheniya Izobretatelskikh Zadatch, and which, translated, mean Theory of the Solution of Inventive Problems. Today, TRIZ is commonly used to refer to the Theory of Inventive Problem Solving, a slight variation of the literal translation. TRIZ is one of the most comprehensive systematic innovation and creativity methodology available to mankind; it was invented by Genrich Saulovich Altshuller. Sooner or later and preferably sooner, almost everyone who seriously studies TRIZ, begin getting intrigued about its history. History is often regarded as 'His-story', 'his' being a representative term for mankind. However, today the connotation of "his" is used in a broader sense, with it being significant of anything or any phenomenon that has a story connected to it. So, what is so important about history? After all, it has already happened. There is nothing we can do to change it-hence, what is the big deal? Actually, a vital part of a successful future is the understanding the successes and failures of the past. History is not just chronicles about dead people. It is the DNA of the world today. This article is by no means a comprehensive digest of TRIZ his-story, but rather it focuses on the most significant millstones in the 3 eras of TRIZ evolution. The authors strived to give a fairly good representation of particularly significant events, individuals and achievements of TRIZ evolution.

Key words: Altshuller, creativity, history, invention, TRIZ.

1. Introduction

Sooner or later, and better sooner, almost everyone who seriously studies TRIZ, starts questioning about history of TRIZ: was TRIZ development based on a dedicated research or it was an accident, why there are so many different TRIZ tools, what is the sequence of their development and were they developed solely by the inventor or there were some other contributors and if so who they are and so on...

This article is by no means a comprehensive synopsis of TRIZ his-story; such extensive historical studies are already being conducted by V. Petrov [1, 2] and V. Souchkov [3] who presented exceptionally detailed account of development of major TRIZ techniques. In contrast, the focus of this paper is not on chronological correctness, but rather on most significant millstones and people contributed to TRIZ evolution. The presented information was acquired from the two core above mentioned resources ([1, 2, and 3]) as well as from other reputable published resources available at the time of the study (both in Russian and in English). The manuscript is superficially divided into 3 stages of TRIZ evolution, so called Classical, Kishinev and Ideation eras. The authors strived to give a fairly good representation of particularly important events, people and achievements.

Views on TRIZ development among G. Altshuller and his students apparently vary, which is evident from a number of his books [4, 5, 6, 7, 8]. The situation resembles that of Jesus Christ who also had a lot of followers. The followers resolved the differences of opinion by writing not a history but a number of gospels. To avoid unnecessary discrepancies, neither the "gospel" from Genady Filkovsky - a student in the Altshuller's first School of the Inventive Creativity (Baku, 1970-1971) no the "gospel" from Yevgeny Karasik- member of the Altshuller's "kitchen cabinet" (1973-1981) was considered in this short paper. Nevertheless interested parties can access the summary of the two gospels in English via reference [9, 10].

2. TRIZ evolution overview

TRIZ has an interesting history [11]. Genrich Saulovich Altshuller – the inventor of TRIZ, was born October 15th, 1926 in Tashkent, former Soviet Union and died September 24th, 1998 in Petrozavodsk, Russia. He was only 17 years old when he made his very first patented invention (scuba diving thermo-retaining apparatus) [12]. His passion for inventions led him to pursue a career as a mechanical engineer. In 1946 G. Altshuller was a successful young, Jewish inventor and a patent officer in the "Inventions Inspection" department of the Caspian Sea flotilla of the Soviet Navy. His primary responsibility was to assist inventors in filing patents, but because he himself was an exceptional engineer and inventor, he was often asked for help in solving problems encountered during the innovation process. In his patent work G. Altshuller saw that chemists, biologists, physicists and engineers were unknowingly repeating each other's work because they never looked to see if anyone outside their own area had similar problems and answers to those problems. G. Altshuller saw that science and technology had become a Tower of Babel. Each wrote patents in their own scientific language and technical terminology, and similar problems were solved with analogous solutions but no-one, until G. Altshuller noticed that there was a huge duplication of work. G. Altshuller sought to extract knowledge from inventions, compile that knowledge in usable form, and make the knowledge available to inventors in any area or discipline [11].

By identifying and categorizing the patterns in innovative solutions, G. Altshuller realized that one could gain access to solutions that would normally be "unavailable" due to one's specialization or narrow field of vision. G. Altshuller set out to categorise all those solutions in patents to identify all the innovative ways to solve any problem. His objective was to find out if inventive solutions were the result of chaotic and unorganized thinking or there were certain regularities and patterns which governed the process of creating new ideas and inventions. G. Altshuller categorized these patents in a novel way. Instead of classifying them by industry, such as automotive, aerospace, etc., he removed the subject matter to uncover the problem solving process. He found that often the same problems had been solved over and over again using one of forty fundamental inventive principles. Realizing that an innovation represents a fundamental change to a technological system - and is therefore subject to analysis - G. Altshuller turned his attention to the patent field, screening over 400,000 patents from all over the world. After investigating, he found that only 0.3% of all patented solutions were really new, which meant that they used some newly discovered physical principle – such as the first radio receiver or the first film photo camera. The remaining 99.7% of inventions used some already known physical or technological principle but were different in its implementation (for instance, both a car and a conveyer belt may use the same principle: aircushion). He identified patents that constituted "inventive" achievements, and began a rigorous analysis of these. After analyzing the groundbreaking patents, he identified a common set of inventive principles and processes used across numerous areas of technology. He realized that a problem requires an inventive solution if there is an unresolved contradiction in the sense that improving one parameter impacts negatively on another. He later called these "technical contradictions". G. Altshuller codified these inventive principles to make them useful across various areas of technology, engineering and business. In addition, it appeared that a great number of inventions complied with a relatively small number of basic solution patterns. Therefore, G. Altshuller concluded that the vast majority of new inventive problems could be solved by using previous experience - if such experience is presented in explicit way, for instance in terms of principles and patterns. This discovery produced a tremendous impact on further studies which let to development of the basic principles of invention.

Assuming that methods existed to help people solve creative problems, G. Altshuller went to the library and began researching. He found studies based upon the notion that, since innovation is a product of the human mind, the process of innovation can be enhanced using psychological techniques. Several methods (such as brainstorming) had been developed to overcome psychological inertia - that is, to help people generate ideas "outside the box". But G. Altshuller soon began to realize the difficulty of obtaining objective information on the innovation process through psychological means, as the results were neither measurable nor reliable. In contrast, he reasoned, that technical information is objective in nature. While there are no tools that allow us inside the human mind to study the process of innovation, the results of this process can be easily observed by studying the inventions themselves, or the patent literature associated with them. G. Altshuller noticed inventive problems could be codified, classified, and solved methodically, just like other engineering problems" [14].

The results of his efforts formed the theoretical basis of TRIZ and laid the groundwork for the problem-solving tools that would afterwards be developed. Later, as a consequence of 'glasnost', several of G. Altshuller's students emigrated to the USA, Scandinavia, Israel, Germany and other countries, consequently TRIZ has been introduced and spread all over the world. Some of the TRIZ experts have worked on the development of software applications. As the TRIZ methodology grew over the next four decades, the patent research continued; by the mid-1980s over 2.0 million patents had been investigated, which represent roughly 10% of all patents in the world [15].

2.1. Specifics of TRIZ evolution

In the evolution of TRIZ, three stages can be distinguished: (1946-1985) - Classical, (1984-1992) - Kishinev, and (1992-today) - Ideation era. Fig.1 illustrates these stages. The account of most significant events, individuals and developments is followed according to these eras.

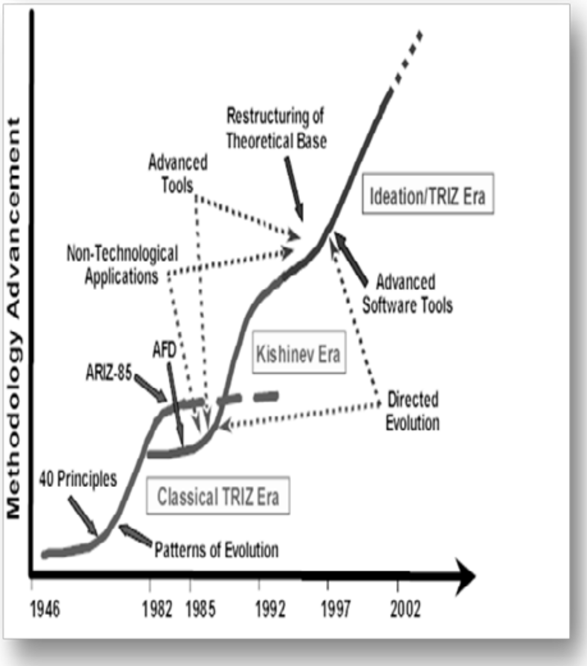

Figure 1: TRIZ evolution [16]

2.1.1 Classical Era (1946 – 1980's)

During this period, the conceptual foundation of TRIZ was formulated, and many methods and tools were developed, but not integrated. Also, a large body of engineering knowledge was accumulated. However, all results were produced in a descriptive form appropriate only for the manual use of TRIZ. For this reason, as well as the general state of apathy in the former Soviet Union which resulted in reluctance to change and resistance to innovation, TRIZ had only limited practical application. Following is a reflection of most important events and individuals of the era:

1) G. Altshuller started developing TRIZ and conducting his first TRIZ training sessions. At this time he realized a key role of resolving a technical contradiction in order to come up with an inventive solution.

2) In 1948, Altshuller wrote a letter to Soviet leader, Iosiff Stalin, with a sharp critique of Soviet system of inventiveness. As a result he was sentenced to 25 years and send to the Rechlag labour camp (Vorkuta) as a political prisoner [12].

3) In 1952, while in prison, a step-by-step procedure of problem solving was developed and was meant as "Instructions to Inventors". G. Altshuller gave it the name ARIZ in 1970.

4) In 1954, following Stalin's death in 1953, he was released and rehabilitated. After coming from prison, because of resistance by the State Committee of Inventive Affairs and the Society of Inventors (Altshuller was an intellectual Jew), G. Altshuller went underground, writing science fiction stories under the pen name H. Altov [17]. At that time the method was studied only by a small group of intellectual's elite. [18]

5) G. Altshuller and R. Shapiro published the article "About Technical Creativity" in the journal Questions of Psychology, # 6, 37-49. 1956 [19]. It was the first official TRIZ publication, which introduced such concepts as technical contradiction, ideality, inventive system thinking (currently known as "System Operator" or "Multi-Screen Diagram of Thinking"), the law of Technical System Completeness, and Inventive Principles. The same year the first algorithm to support a process for inventive solving problems was introduced, which included 10 steps and the first 5 Inventive Principles (which later in 1963 became sub-principles of more general 40 Inventive Principles as known today). Extensive research on discovering new Inventive Principles begins.

6) The term "ARIZ" was introduced, thus an improved algorithm was titled "ARIZ". The algorithm included 18 steps and 7 inventive principles (with 39 sub-principles) [4].

7) G. Altshuller published the first system of the Laws of Technical Systems Evolution.

8) The next algorithm version included 18 steps, 31 inventive principles, and the first version of the Matrix for Resolving Technical Contradictions with generalized technical parameters (16x16 parameters).

9) The next version of ARIZ included 25 steps, 35 inventive principles, and the Matrix for Resolving Technical Contradictions (32x32 parameters). At this time, in addition to developing a tool for inventive problem solving, G. Altshuller and his associates put considerable attention to the development and teaching techniques for Creative Imagination Development [20] (e.g. Method

of Focal Objects, Fantograma, Operator "Size-Time-Cost").

10) G. Altshuller also introduced definition of an "Ideal Machine".
11) G. Altshuller established AZOIIT (Azerbajdzhan Public Institute for Inventive Creativity) which becomes the first TRIZ training and research centre in the USSR. In parallel, G. Altshuller establishes OLMI (a Public Laboratory of Invention Methodology)-the first public open source initiative targeted at uniting efforts on developing TRIZ nationwide.
12) ARIZ-71 included 35 steps, 40 inventive principles (with 88 sub-principles), and the Matrix for Resolving Technical Contradictions with 39x39 parameters (it is the same matrix for resolving technical contradictions which is still in the wide use today). ARIZ-71 was a major step in TRIZ development. It introduced Operator "Time-Size- Cost", the first version of the Method of Little Men, and included references to physical effects for solving inventive problems.
13) At the same time, development of a Database of Physical Effects [21] had begun by Yuri Gorin, which linked generic technical functions with specific physical effects and phenomena.
14) Establishing a St. Petersburg (ex USSR) School of TRIZ under chair of V. Mitrofanov, probably the most influential school of TRIZ in the former USSR.
15) A new approach to solving inventive problems was introduced: Substance-Field Modelling (also known as Su-field Modelling) and the first 5 Inventive Standards (which were later extended to 76 Inventive Standards [22]) were published by G. Altshuller.
16) ARIZ-75B included 35 steps, and introduced several new major TRIZ concepts.
17) G. Altshuller realized that to find most ideal technical solutions, it was not enough to use the Matrix of Resolving Technical Contradictions, which he considered although a refined, but still a variation of the trial and error method. Thus the Matrix of Resolving Technical Contradictions was excluded from the main text of ARIZ (only used as additional material), and all operations on solving inventive problems were targeted at formulation and elimination of a physical contradiction.
18) ARIZ-77 included 31 steps, and introduced the concepts of a physical contradiction at micro-level, a pair of conflicting components, operational time and operational zone. Although the Matrix of Resolving Technical Contradictions still remained as a part of ARIZ as an additional material, its use was limited.
19) 18 Inventive Standards were presented.
20) Altshuller publishes "Creativity as an Exact Science", which is still considered as his major book [6]. At the same time Altshuller defined a Theory of Technical Systems Evolution (abbreviated TRTS in Russian) as a separate subject for study, and identified a number of Life Lines of Technical Systems which later became known as "9 Laws of Technical Systems Evolution".
21) In 1980 the first TRIZ Specialist conference took place in Petrozavodsk, Russia [23].
22) TRIZ receives publicity in the former USSR. Many people become devotees of TRIZ and of G. Altshuller; the first TRIZ professionals and semi-professionals appear.
23) G. Altshuller is highly proficient in developing TRIZ due to the large number of seminars conducted, the various TRIZ schools established, and individual followers who join the ranks, allowing for the rapid testing of ideas and tools. TRIZ schools in St. Petersburg, Minsk, Novosibirsk, and others become very active under G. Altshuller's leadership.
24) The strong development of classical TRIZ results in the first serious attempts to move TRIZ beyond the strictly technological domain (the book "Life Strategy for a Creative Individual", children's education, "subversion" analysis, Theory of Evolution of Organizations, etc.).

2.1.2. Kishinev Era (1982-1992)

The second period, often called the Kishinev Era (1982-1992), started when a number of outstanding pupils, headed by one of them Boris Zlotin, an accomplished inventive problem solving expert, established, along with Alla Zusman, a TRIZ technical school in Kishinev. This school provided various forms of training, but also continued research on TRIZ. The school's objective was to integrate the individual TRIZ methods, tools, and accumulated knowledge, and to present TRIZ in a form acceptable for an international audience and for computerization. Also, they wanted to develop TRIZ as a technology for dealing with all stages of the inventive problem solving process, since the original TRIZ was focused mostly on the concept development stage.

1) The accomplishments of the Kishinev TRIZ School included [24]:
   a. over 6,000 students taught, more than 4,000 technological problems solved or facilitated, development of a methodology for solving scientific problems and for identifying possible causes of failures as well as potential failures, identified numerous lines of evolution, published nine books on TRIZ (three together with G. Altshuller), contributed monthly to popular magazines on the practical application of TRIZ, launched a monthly contribution to Russian newspapers on TRIZ for children, published numerous other articles on the TRIZ methodology, developed the basic patterns of evolution of organizations, developed recommendations for using students' unresolved real-life problems as a teaching process, developed educational programs for various audiences at a range of technical levels and provided analytical services for business organizations among others.
2) By 1989, the extensive experience of the Kishinev TRIZ School in teaching and problem solving allowed Zlotin and Zusman to define the main limitations of the classical TRIZ methodology. These include [25]:
   a. Its non-rigorousness (i.e., many analytical skills that were required for the successful application of TRIZ tools had not been transformed into documented rules, algorithms and recommendations).
   b. A limited amount of the TRIZ knowledge-base had been documented and was available for study and use.
   c. Each tool had been developed separately and as a result the tools did not form an integrated system.
   d. Problems of different types had to be treated differently, but there were no clear recommendations for which tool to use for a particular type of problem or situation.
   e. The tools did not support all stages of the problem-solving process. For example: problems had to be pre-formulated in TRIZ terms before the tools could be applied.
3) As a result of the above limitations, TRIZ was characterized by the following:
   a. Considerable education (from 100 to 250 hours) was required to effectively utilize TRIZ.
   b. Extensive practice (from 1 to 5 years) was required to become self-sufficient in the methodology.
   c. Making TRIZ available for mass utilization posed an overwhelming challenge.
4) In addition, these same drawbacks made the process of computerizing TRIZ -- which had already begun - very difficult.
5) Given the above considerations, Zlotin and Zusman determined to advance the TRIZ methodology in the following directions:
   a. Develop integrated tools so that all types of problems can be treated in the same manner.
   b. Add the "missing" tools so that TRIZ supports all stages of the problem-solving: problem identification, formulation, and categorization; identifying and utilizing the appropriate tools; evaluating results; planning the implementation.
   c. Restructure and extend the TRIZ knowledge base to take advantage of computerization.
   d. Continue development of the lines of technological evolution and on problem-solving tools.
   e. Reveal patterns of evolution in non-technological areas.
6) This work resulted in the following accomplishments:
   a. A new, comprehensive version of ARIZ, which is much more rigorous and suited to computerization.
   b. A problem formulation process, first for mental use and then for computerization.

c. A System of Operators that incorporates the entire existing TRIZ knowledge base.
d. Substantial extension of the TRIZ knowledge base (twice as many operators, many additional examples, added technical applications of effects).
e. A complete problem-solving process (later called the Ideation Process).

7) A prototype of the Innovation Workbench software system, which incorporates the complete problem-solving process.
8) A software prototype for personnel management.
9) ARIZ-82 included 34 steps, and introduced the concepts of “X-element” and a mini-problem, a table of Typical Conflicts, Principles for Resolving Physical Contradictions, Method of Little Men. The Matrix of Resolving Technical Contradictions and 40 Inventive Principles were completely excluded from ARIZ.
10) G. Altshuller positioned ARIZ as a tool for solving “non-standard” inventive problems, while the remaining, “standard” inventive problems can be solved with Inventive Standards. It becomes clear that Inventive Standards were not separate stand-alone patterns for solving problems, but they mapped the Laws and Trends of Technology Evolution. Therefore newly emerging Inventive Standards incorporated the lines of technical systems evolution.
11) Rather extensive research on Inventive Standards as well as on the Laws and Trends of Technology Evolution was conducted by the TRIZ community.
12) A system of 54 Inventive Standards was presented.
13) G. Altshuller also initiated a new research into Biological Effects [8] which he considered as analogies of Physical Effects.
14) Extensions of TRIZ applications in other areas rather than technology began, such as arts [26] and mathematics [27].
15) A major step in TRIZ evolution: appearance of ARIZ-85C [28, 29]. Even today, it is the only officially accepted version of ARIZ. It included 32 steps, and introduced a number of new rules and recommendations, as well as put a special focus on using time, space, and substance-field resources to obtain most ideal solutions.
16) References to Inventive Standards were introduced in several parts of ARIZ.
17) The system of Inventive Standards was organized into 5 classes, included 76 Inventive Standards (which is still remains in use today).
18) In addition to the Database of Physical Effects, the Databases of Geometrical [30] and Chemical effects [31] were developed.
19) G. Altshuller concluded that ARIZ- 85C was a complete tool for solving inventive problems, and did not need to be improved further very much since its application had been tested at thousands of real problems and proven to be effective. Now he considered further evolution of ARIZ and a Theory of Technical Systems Evolution as a major step towards OTSM (a Russian abbreviation for a “General Theory of Powerful Thinking”).
20) In parallel, a group of TRIZ experts including B. Zlotin, S. Litvin and V. Guerassimov developed Function-Cost Analysis (FCA) [32] for analyzing technical systems and products, and a new extended version of TRIZ was titled “FCA-TRIZ” (currently Function-Cost Analysis is mostly referred as Function Analysis, and the term FCA-TRIZ is not in the wide use assuming that FCA is a part of TRIZ).
21) At the same point in time, research was conducted on the TRIZ Laws and Trends of Systems Evolution, which resulted in identifying a number of specific trends and lines of technology evolution.
22) An “officially” accepted version of FCA-TRIZ at that time included: ARIZ-85C, Databases of Physical, Chemical, and Geometrical effects, 76 Inventive Standards, a system of Laws of Technology Evolution, Function Analysis, and Functional Idealization (also known as “Trimming”).
23) New techniques Alternative Systems Merging, Subversion Analysis, Functional Analysis of Inventive Situations were proposed. Application of TRIZ tools was extended to the area of patent circumvention.
24) For the first time in the history of TRIZ, Russian ‘perestroika’ allowed TRIZ to be applied commercially. Consequently, it is estimated that TRIZ has been taught to about 50,000 Russian engineers [33].

25) G. Altshuller switched his attention from developing technical TRIZ to studying creative personality. Together with his associate, I. Vertkin, they studied an enormous amount of biographies of outstanding creative people and started developing a "Theory of Creative Personality Development" (abbreviated TRTL in Russian), which identifies what types of contradictions creative people face during their lifetimes and how they resolve these contradictions.
26) A version of TRIZ for children was developed, and numerous experiments were conducted in schools and preschools.
27) If in the past TRIZ was mostly identified with ARIZ (both words used to be almost synonyms), which organized the use of different TRIZ techniques together, now some TRIZ techniques were often used independently (e.g. Inventive Standards, Physical Effects, etc).
28) In 1986, the situation changed dramatically. G. Altshuller's illness limited his ability to work on TRIZ and control its development, thus he almost discontinued his work on technological TRIZ.
29) The first TRIZ software "Invention Machine™" was released by Invention Machine Labs (later evolved to "TechOptimizer™" and "Goldfire Innovator™" by Invention Machine Corp. [34]), which included Function Analysis, 40 Inventive Principles, Matrix of Resolving Technical Contradictions, 76 inventive Standards, Databases of Physical, Chemical, and Geometric Effects, and Feature Transfer (Alternative Systems Merging). The software brought back the Matrix of Resolving Technical Contradictions as an independent tool due to its simplicity of use by TRIZ beginners (a modern version of software also includes Semantic Search Engine to index patent and document information according technical functions, and the Database of Effects now includes thousands of entries).
30) At the same time a Database of Technological Effects [35] was demonstrated which links technical functions with specific technologies.
31) N. Khomenko started massive research within OTSM [36], which introduces principles and develops skills with domain-independent "powerful" thinking for kids and adults.
32) Russian TRIZ Association is established.
33) In 1990 Russian-language "Journal of TRIZ" is launched (discontinued in 1997 due to financial constrains, and re-launched in 2005) [37].
34) The pioneering research, its rapid progress, and the initial prototype computer tools of the Kishinev school's efforts, caught the attention of Zion Bar-El, an engineer and a wealthy entrepreneur in the areas of high technology and innovation. He immediately recognized the colossal potential of TRIZ and decided to build a company to utilize it in the American industrial environment. Detroit, the capital of the American automobile industry was wisely chosen for the location of the company; there, orders and projects from several leading automobile companies were already waiting. Ideation International Inc. was born. Consequently, almost the entire TRIZ Kishinev School team was relocated (with their families) to the United States, becoming part of Ideation International Inc.

2.1.3. 1992 and Beyond - the third period, called the Ideation Era.

The rapid deterioration of the economic situation in the former USSR forced many competent TRIZ specialists to immigrate into the U.S., Israel and other countries and start promoting TRIZ individually. Others found international partners and established TRIZ companies, e.g. as mentioned above, Ideation International Inc. - an American company incorporated in 1992. During the following years, Ideation accomplished the following:

1) Translated and repackaged an extensive amount of information on TRIZ
2) Became familiar with the U.S. marketplace, Learned the requirements of potential TRIZ users, Adapted TRIZ to the American engineering process
3) Delivered products and services to numerous industrial companies
4) Trained hundreds professionals in the methodology
5) Established educational programs to help an individual become self-sufficient in TRIZ and develop further mastery
6) Developed a family of software tools and installed thousands of copies

7) Continuously advanced the Ideation/TRIZ methodology (I-TRIZ)
8) TRIZ was used to solve a number of complex and difficult inventive problems in US for the car manufacturing, aerospace, textile, wood and petrochemical industries. For example, a novel containment ring for an airplane engine fan was invented for Allied Signal, and a new type of brake system for a golf cart was invented for the automotive division of Rockwell International.
9) G. Altshuller and I. Vertkin published the book "A Life Strategy of a Creative Person" [6], in which they summarized their work on the Theory of Creative Personality Development.
10) A new TRIZ-based software package Innovation Workbench™ was released in the US by Ideation International [38], which included the first TRIZ technique for causal modelling of inventive situations: Problem Formulator and a restructured database of Inventive Operators, based on Inventive Principles, Inventive Standards and Physical Effects (currently Ideation International offers a range of various TRIZ related software packages).
11) A database of Biological Effects was published by V. Timokhov [39].
12) Software (IM-Lab, TechOptimizer 2.5, TechOptimizer 3.0) was developed by Invention Machine Corporation, USA
13) Software (Ideator, Improver, Eliminator, Ideation Work-Bench, AFD) was developed by Ideation International Incorporated, USA
14) In 1995 the Altshuller Institute for TRIZ Studies was established in Boston, USA.
15) The Russian TRIZ Association becomes International TRIZ Association.
16) The Online TRIZ Journal is launched in 1996 [40].
17) In 1998, G. Altshuller had passed away suffering from complications from Parkinson's disease and further centralised coordination of TRIZ developments almost stopped[41].
18) In 1999, 14 of the world's top 18 TRIZ specialists worked at Ideation International Inc. [42]. Ideation's TRIZ specialists built upon G. Altshuller's earlier work and Classical TRIZ to create Modem TRIZ (ITRIZ) In addition, Ideation International Inc. developed software (known as I-TRIZ software) that cover some of the complexities of TRIZ methodology. This allows people to begin solving problems more quickly. The Innovation Workbench software (IWB) is the most sophisticated toot developed to date. It combines a structured TRIZ knowledge base with analytical tools (e.g., ISQ and Problem Formulator) [43].
19) Different organizations with TRIZ expertise developed their own versions of TRIZ (TRIZ+, xTRIZ, CreaTRIZ, and OTSM-TRIZ among others), thus a set of TRIZ tools developed under a guidance of G. Altshuller before 1998 is now titled "Classical TRIZ" to avoid confusion [44].
20) Creax (Belgium) releases the first version of "Innovation Suite" software [45].
21) Research and applications of TRIZ in other areas rather than technology continued (most developed today are TRIZ for Business and Management [46], OTSM-TRIZ for kids [47] and TRIZ for Pedagogy [48]).
22) Although officially abandoned from classical TRIZ, new versions of the Matrix for Solving Technical Contradictions emerge (e.g. Matrix 2003 [49]), as well as adaptations of 40 Inventive Principles for the use in different application areas (business, arts, architecture, specific industries, etc.) [40].
23) A simplified version of TRIZ, Systematic Inventive Thinking (SIT) [50] and its variations (e.g. ASIT: Advanced Systematic Inventive Thinking [51] and USIT: Unified Structured Inventive Thinking [52]) are introduced (although not very much supported by the majority of the TRIZ community due to oversimplification and elimination of some key TRIZ concepts).
24) European TRIZ Association (ETRIA), TRIZ France Association, and Italian TRIZ Association APEIRON are established.
25) A number of new tools emerge to help with complex problem analysis and management, which still remained a weak part of TRIZ: Root Conflict Analysis (RCA+)[53] for decomposing inventive problems, Problem Flow Technology, Problem Networking [36] for managing complex problems involving networks of contradictions.
26) New tools based on previous studies emerge, such as Hybridization [54] (further development of Alternative Systems

Merging), Functional Clues [55], Anticipatory Failure Determination (AFD) [38], Function-Oriented Search [56], Inventive Standards for Business Systems, and Radar Plot for Mapping Trends of Systems Evolution.

27) New experimental versions of ARIZ appear, but their use is limited due to complexity and necessity to be tested on a larger number of problems.
28) There is a proposal for a system of 150 Inventive Standards [1].
29) Different systems of the Trends of Technology Evolution emerge, and new lines of systems evolution are introduced: for instance, a current version of Directed Evolution [57] by Ideation International presents 400 lines of technical systems evolution.
30) A number of attempts are undertaken to integrate TRIZ with modern methods of Quality Management (e.g. Quality Function Deployment - QFD), and such systems as Six Sigma (e.g. TRIZ is used within Design for Six Sigma - DFSS).
31) The Japan TRIZ Society is established in 2007, which main focus is proliferating TRIZ to younger people. The approaches used: (a) to challenge the atmosphere of the current era for younger people, (b) to present TRIZ in the form acceptable to the background of the younger people, (c) to make TRIZ easier to understand/accept, (d) to let them practice rather than to let them study the knowledge, (e) to expand the applicable areas of TRIZ, etc.

3. Concluding remarks

Our view of history shapes the way we view the present, and therefore it dictates what answers we offer for existing problems. History teaches values. If it is a true history, it teaches true values; if it is a pseudo-history, it teaches false values. In this spirit, the authors have strived to avoid inconsistencies and contradiction with previous researches. In this regard only very few verified dates are indicated, rather the information spread within specific eras of TRIZ evolution. In parallel, the authors also attempted to stay true and put some zest into the past. Nevertheless, we invite our readers to send their comments and constructive criticism (if any).

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