

The TRIZ Journal

TRIZ Beyond Technology: The theory and practice of applying TRIZ to non-technical areas

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Introduction

During the 1970s and 1980s, attempts to apply TRIZ to management and administration problems were entertained on occasion by several TRIZ specialists, primarily for the purpose of enhancing various manufacturing processes. Efforts in this area were limited, however, because in the communist Soviet Union, the privilege of making business decisions belonged to people who had no interest in TRIZ. Moreover, there was no chance whatsoever of launching a private business. The situation changed dramatically with the onset of the Russian “acceleration of technical progress” (the so-called *pre-perestroika*) and then *perestroika*; together these programs served to stimulate the use of TRIZ in technological areas. But within a few years the deteriorating economic situation had driven most industries into a deep crisis, virtually eliminating any chance of making a living by solving technical problems. Yet at the same time these conditions gave rise to new opportunities for quickly accumulating successful experiences in working with new commercial (mostly trade) organizations in the areas of business, management, politics, advertising, etc.

When we established Ideation International in 1992, we knew that the highest return on our investment (in terms of time and money) would be achieved by applying TRIZ to business and management rather than technology. But we restricted ourselves to technology because the notion that Russians could teach Americans anything about business sounded absurd. We therefore decided to introduce TRIZ in its “traditional” arena first to prove that a science capable of solving technical problems in a structured, systematic way did in fact exist. Then, when the time was right and TRIZ had established a solid reputation, we would move into the areas of management, business, education, etc.

Today, with TRIZ known in more than 25 countries, taught in 35 universities around the world, and with hundreds of TRIZ sites on the Internet, we believe that finally the time is right.

For over four decades, non-technical applications were not the primary focus of TRIZ. Nonetheless, a great deal of research was conducted and many papers written (the majority of which remain untranslated) on these applications. This paper represents an attempt to share the wealth of information, research findings, and experiences that have been gained over the last 25 years in applying TRIZ to non-technical areas. We have documented numerous facts and events based on available sources (books, papers, manuscripts, correspondence, etc.) and on the recollections of the TRIZ scientists involved. For obvious reasons, we cannot claim that our review is an exhaustive one, but we believe it is fairly comprehensive as it is based on the following:

- From 1974 to 1993, the authors participated in every important TRIZ event and collaborated extensively with Genrich Altshuller (and thus were familiar with the leading TRIZ research)
- Our personal libraries and archives include:
 - Six large volumes of personal correspondence with Altshuller, containing numerous discussions related to the most vital TRIZ issues
 - Nearly all published TRIZ work, numerous manuscripts on various TRIZ subjects, abstracts from TRIZ seminars and workshops, educational materials, and extensive personal notes
- Because we have so greatly enjoyed being part of a community dedicated to carrying out the TRIZ mission, the past years are unforgettable. We therefore cherish - and rely on - our memories.

Chapter 1. Historical review and the theoretical foundation for expanding TRIZ into non-technical areas

Why TRIZ is applicable in non-technical areas

It is well known that Genrich Altshuller began developing TRIZ as a pure engineering science, based on the statistical research of patents and other sources of technical information. The goal of his research was to reveal the “patterns of innovation” so that they could be exploited for the purpose of advancing technological systems. Ultimately, Altshuller established a procedure for developing a methodology for creative problem solving, as follows:

- Accumulate a data bank of numerous creative solutions (inventions, for the technological arena)
- Identify different “levels” of creative solutions, then select the high-level solutions from the data bank

- Reveal typical patterns by which creative solutions of different levels are obtained (innovation principles, patterns of evolution, etc.)²
- Develop algorithms for obtaining these solutions

Since then, the following additional steps have been formulated:

In the area of problem solving:

- Reveal the typical problems found in the targeted area
- Collect powerful solutions and create a corresponding data bank
- Perform multiple test cycles of the obtained algorithms on numerous educational problems (case studies). Tests should be performed first by the author, then by his/her colleagues, and finally by TRIZ students at seminars and workshops
- Introduce appropriate corrections as a result of testing

In the area of “patterns of evolution”:

- Clearly define the boundaries of validity for each pattern (for example, a pattern might apply to mechanical systems only)
- Coordinate and structure the various patterns into a hierarchical system (pattern/line/principle/sub-principle, etc.)
- Test the applicability of the patterns in other areas of technology; clarify and reformulate as necessary to address the additional areas without lessening their reliability or potency

The above procedure, though not published in this format by Altshuller, was for the most part repeatedly addressed by him in numerous seminars and discussions; these steps are also readily seen in his work. Even more significant, however, is that this approach has been applied numerous times in the technological realm - and with great success.

During the early stages in the development of TRIZ, examples of successful attempts to apply selected TRIZ tools and approaches to non-technical areas started to accumulate. TRIZ educators began, in a systematic manner, to address their students’ attempts to apply knowledge gained from TRIZ to various problems, in particular³:

- Problems from subjects they studied in schools and colleges
- Various “everyday life” problems
- Conflicts in family life and in the working environment
- Problems in art, sports, etc.

By the early 1980s, a substantial number of successful TRIZ applications in non-technical areas had been achieved. Several papers were written describing attempts to find similarities in different areas (for example, demonstrating the parallels between contradictions in technology and in the evolution of science)⁴. However, Altshuller repeatedly warned against such hasty “reassignments,” insisting that the same procedure (especially the first four steps) that he had established for the development of TRIZ be followed.

One of the most serious problems was associated with the first step, that is, *accumulating creative solutions in the given area*. Altshuller was fortunate in starting with technology as it was the only area with a well-documented and comprehensive source of solutions (the patent library). Collecting creative solutions in other areas with sufficient completeness would likely have taken decades given the human and financial resources available at the time.

Between 1982 and 1984 Boris Zlotin and Alla Zusman, who were investigating the possibilities for expanding TRIZ, analyzed the existing cases where TRIZ tools were applied to non-technical problems. As described in our previous publications, TRIZ offers two types of tools⁵:

- Analytical tools that help to define, formulate and model a problem; these include ARIZ and Substance-Field Analysis (which were later complemented by the Innovation Situation Questionnaire and Problem Formulator)
- Knowledge-base tools that provide recommendations for system transformation (40 Innovation Principles, 76 Standard Solutions, collections of physical, chemical and geometrical effects, System of Operators, etc.)

In addition, TRIZ included several so-called “psychological operators”⁶ that facilitated the creative process.

Zlotin and Zusman’s analysis resulted in the following conclusions:

- The commonalties in the evolution of various technological systems, as discovered by Altshuller, can be further expanded into various non-technical areas. For example, basic TRIZ concepts such as ideality, contradictions and the systems approach are fully applicable to non-technical problems and situations. Eventually, these considerations led to a definition of Universal Patterns of Evolution⁷
- Analytical tools and psychological operators are directly applicable or can be easily modified to accommodate non-technical applications.
- Although existing knowledge-base tools were, in general, derived from technical information, the process of abstraction and generalization⁸ rendered some innovation

principles universal (examples are *inversion*, *segmentation*, *convert a harm into benefit*, *dynamization*, *self-service*, etc.). Others have proven useful when imaginatively applied.

On the basis of the above conclusions, the following approach was developed to address problem solving and system evolution in non-technical areas:

- Transfer TRIZ patterns, problem-solving tools and algorithms into non-technical areas, identifying their applicability and adapting them to the new area
- Transfer patterns from other areas (biology, sociology, psychology, etc.) into TRIZ; identifying their applicability and adapting them to TRIZ.

This approach substantially accelerated the expansion of TRIZ and provided a common basis for problem solving in the following areas.

- Development of a system of universal and general patterns of evolution
- Solving scientific problems
- Development of methods having to do with safety
- Development of the theory of evolution of organizations, as well as TRIZ applications for solving business, management and social problems
- Computerization of TRIZ and the development of TRIZSoft⁹
- Development of the Directed Evolution application¹⁰
- Children's education

Enhancing the creative imagination, and TRIZ in the arts

It is significant that for most of his life, Altshuller did not capitalize on his work with TRIZ, nor was TRIZ supported by the Soviet government or academia¹¹. From the mid-1950s, Altshuller's main source of income was writing science fiction¹². Working in parallel on TRIZ and science fiction stories, Altshuller (not surprisingly) applied his TRIZ discoveries to the area of science fiction. Following the approach he had developed of amassing a library of solutions, he began collecting and updating a library of science fiction ideas, which eventually contained descriptions of approximately 20,000 science fiction situations. Similar to his Levels of Innovation, Altshuller created a system of classification for this library as well. He also studies the writings of several famous science fiction writers (H. G. Wells, Jules Verne, etc.) and proved that their fantasies had a higher percentage of realization than professional futurists.

As a result of these parallel efforts, Altshuller came to understand that reading, discussing and creating fantastic ideas is very useful in helping inventors increase their creative imagination. Based on the library of science fiction ideas, Altshuller developed several methods of enhancing

creative imagination, along with a set of training exercises. These methods and exercises, together with the book *Science Fiction for Engineers and Inventors* (written by Altshuller's student and colleague Pavel Amnuel) were distributed among leading TRIZ schools and specialists in the early 1970s between, and became the foundation for a course in Creative Imagination Enhancement (CIE).

Besides the study of methods based on science fiction, a typical CIE course contained special training for reducing psychological inertia (including Smart Little Creatures Modeling and Dimension-Time-Cost operators), and the systems approach (multi-screen creative thinking). These courses also entailed the study of famous artists¹³, writers and others.

In 1975-6, St. Petersburg TRIZ University¹⁴ offered the first CIE course for inventors. Besides material developed and recommended by Altshuller, this course contained a broader use of psychological approaches as well as new exercises and case studies. The first course was taught by Boris Zlotin¹⁵; the following year, one of Zlotin's top students, Simon Litvin, began teaching the course. Together, Zlotin and Litvin developed new CIE course materials and published a paper¹⁶, and for many of the years that followed, Litvin was the university's primary CIE teacher.

Later, many other schools began teaching CIE, adding to the course the application of TRIZ elements to non-technical situations (art, sport, human interaction, etc.). It became clear that TRIZ and the arts were mutually beneficial. Some TRIZ schools started including in their CIE courses tours in art museums, attendance at musical concerts, discussions of fiction, etc.

In 1978 Boris Zlotin taught a 120-hour course in creativity for journalists, using the CIE course as a foundation. To establish a method for evaluating the course, a set of high-validity psychological tests was developed that would measure each student's creative capabilities before and after the course. This course included newly-developed techniques for generating ideas for stories, along with elegant analogies and other elements related to creativity in literature. These methods were later utilized by the authors and their colleagues.

During the late 1970s and early 1980s, Simon Litvin taught TRIZ and a CIE course to a group of leading Russian science fiction writers: Olga Larionova, Andrey Balabuha, Boris Strugatskiy, and others.

CIE was both educational and entertaining, and by the end of the 1970s had become a substantial part of TRIZ courses. But in 1980 at the first TRIZ conference for TRIZ developers, Altshuller appealed to the audience to "kill CIE." His reason was that TRIZ was becoming an exact science, with its tools becoming more powerful and methodical, and thus there was no

longer a need for “CIE crutches.”¹⁷ As a result of this discussion, the portion of CIE included in TRIZ courses was reduced. It remained, however, an important part of the TRIZ education for certain types of students, namely children and non-technical audiences.

In spite of his intentions to “kill” CIE, during the 1980s Altshuller developed several other CIE methods, including:

- Utilization of TRIZ elements (ideality, contradictions, etc.) in generating fairy tails and fantasies. Students at TRIZ seminars usually completed these exercises with great enthusiasm. Later, some of them used fairy tails in children’s education (see below).
- Development of the Fantasy Scale¹⁸, which incorporated a technique for evaluating and improving science fiction ideas

In addition to the CIE courses being taught, research was conducted by several TRIZ specialists in various areas of art and performance, including:

- Music¹⁹
- Art and sculpture²⁰
- Cartoons²¹
- Poetry²²

Extensive research was also conducted in the area of human interaction with pieces of art based on an approach similar to substance-field analysis by Juliy and Ingrid Murashkovski (who for many years taught TRIZ creativity methods to professional artists and architects). Their work included numerous illustrations, algorithms, case studies and other educational material.

Conclusion

TRIZ has accumulated a substantial amount of material useful in psychologically preparing an individual to become an inventor. This material is useful in enhancing analogical thinking skills, and can be an important asset to education.

Development of the creative personality²³

In the early 1980s, TRIZ began to gain visibility, due in part to its connections with Value Engineering (which was supported by the Soviet government²⁴). This publicity resulted in numerous seminars and workshops on TRIZ in which several thousand engineers were educated. But in spite of a rigorous (at least 50 hours) education in TRIZ, only a small percentage of students continued to apply TRIZ in their professional activities. This was extremely disappointing to Altshuller, who believed that everyone who learned TRIZ should

become a lifetime fan and adopt the mission of disseminating TRIZ throughout the world. In an attempt to resolve this dilemma, Altshuller initiated a research effort in the mid-1980s, involving numerous TRIZ specialists and students in the collection and analysis of information about various creative individuals. The purpose of this research was to identify patterns in the formation of a creative personality that could be utilized to increase the effectiveness of TRIZ education. First were identified the following qualities necessary to become a lifetime creator:

- A significant personal goal
- The ability to create and carry out an action plan
- Being a hard working individual
- Being experienced in the use of creative problem-solving techniques
- Being persistent (“thick skinned”)
- The ability to achieve intermediate useful results (i.e., to ascertain that you are “on the right track”)

Together with Igor Vertkin, Altshuller developed the Lifetime Strategy for a Creative Individual (LSCI), comprising effective actions recommended for an individual to develop and implement high-level creative goals. LSCI takes the form of a lifetime “game” between a creator and the “external environment” that counteracts the creative lifestyle and attempts to convert the inventor into a passive individual. The six creative qualities along with LSCI eventually resulted in a branch of TRIZ called the *Theory of Building a Creative Personality (TBCP)*²⁵.

According to Altshuller’s usual approach of accumulating a relevant knowledge base, a substantial amount of information related to the lives of famous creative people - from Jesus to Lenin - has been amassed. Absent from this list, however, were contemporary successful business people, politicians, managers, and creators of huge political and financial empires such as Henry Ford, Benjamin Franklin, Lee Iacocca, and others. In fact, LSCI was based upon limited information regarding totalitarian or past societies (before the age of technology) where creative people were neglected or even despised. As a result, it reflected a tragic experience, which discouraged people from devoting their lives to creativity. Yet at the same time it was embraced by a certain type of pessimistic student, as it served to justify their negative experiences.

After the first version of LSCI was published, many TRIZ developers began independently conducting their own research in the area of creative accomplishment. Some results caused certain assumptions of LSCI to come into question, just as the following conclusions were made:

- The tragic lives led by many inventors was related to the fact that because they were extremely creative in certain areas, they didn’t consider that the promotion and

implementation of their ideas was a process that also required creative solutions. They didn't know how to unveil useful resources, make helpful connections, sponsors, etc.

- Often the features of a creative individual that were advantageous in the early first stages of a "cause" - such as devotion (or even fanaticism), an inability to compromise and/or maneuver, and very high self-esteem - can be a detriment during the implementation stage.

Beginning in the mid-1980s, Altshuller focused on TBCP, virtually abandoning all other TRIZ work. He considered this subject crucial for the survival of TRIZ, and recommended that related courses be introduced in all TRIZ schools and incorporated in the curriculum of independent TRIZ educators. The results of this promotion were controversial - the majority of students either completely or partially rejected Altshuller's approach, and examples of its positive impact are few²⁶.

For a time, the Kishinev TRIZ School presented LSCI within the context of safety instructions showing dangers that should be avoided and how this might be accomplished. Today, we view the subject as a part of more powerful approach, called *Directed Evolution*, that allows an individual to control his/her future²⁷.

Creative education

Today, it is clear that teaching creativity to children is one of the most significant directions taken by non-technical TRIZ. Altshuller (Altov) pioneered this endeavor in the mid-1970s with a permanent "inventor's page" in the central Soviet children's newspaper *Pionerskaya Pravda* (which had more than 5 million subscribers). Over 50 such pages offered educational material targeted to teenagers covering the basic TRIZ elements and including practice problems and inventor's contests. Typically, between 10,000 to 20,000 responses were obtained per page, all of which were carefully analyzed by Altshuller and served as a source for the further development of TRIZ and for advancing the creative education of children. Eventually, these materials became the foundation for a book²⁸.

During the 1970s, occasional seminars and classes for children (mostly teenagers) were conducted in various locations throughout the Soviet Union, and Altshuller's inventor's pages became the instructional materials for these. In 1982, regular classes were launched in Kishinev. Evgeniya Rabinovich, a manager at the Children Institute's "Pioneers' Palace," organized a two-year TRIZ school which held one or two 4-hour classes each week (among the teachers were Boris Zlotin, Alla Zusman, Len Kaplan, Svetlana Visnepolschi, and Vladimir Oleynikov). An average class was composed of 15 to 25 children ranging in age from 10 to 16

years old. This school served as the foundation for a variety of work, among which resulted the following:

- Teachers and students of a local pedagogical college participated and practiced in the learning and teaching of TRIZ
- 52 monthly TRIZ pages published in the newspaper *Youth of Moldova*, containing new materials on TRIZ and CIE, inventors' contests, contests for the best science fiction stories, etc.
- Television shows in which children who had been educated in TRIZ competed with engineers from Kishinev's industrial companies to solve their problems, the results of which were evaluated on the spot by designated experts
- A documentary film about TRIZ School was produced and widely shown
- For seven years, TRIZ specialists participated in children's summer schools, teaching TRIZ to groups of 30 to 40 children every year. These schools attracted other TRIZ educators as well as professional teachers interested in teaching TRIZ to various audiences. As a result:
 - Over 250 children were taught
 - Over 50 teachers gained theoretical and practical experience in TRIZ, which later allowed them to organize TRIZ educational programs in their originating schools²⁹.
 - A book detailing the experience gained during the summer schools³⁰ was written in the form of a diary spanning thirty days of TRIZ classes. Even today it is a valuable TRIZ educational book for children, parents and teachers.

As mentioned earlier, the first attempts at teaching TRIZ to children mainly addressed students at the middle-school and high-school levels. In 1984, we made the first attempt to teach TRIZ to 6- and 7-year-olds with a year-long program held one hour per week at the elementary school. The experiment clearly showed that very young children can be successfully taught creativity if appropriate adjustments to the problems are made.

At the same time, we began a monthly publication for young children in the Moldovian newspaper *Young Pioneer*. Newspaper articles were written as a set³¹ of fairy tails portraying the adventures of a young boy named Peter and a wise inventor from ancient Greece named Daedalus. Daedalus worked as an all-knowing aide, helping inventors by guiding them through the right process and providing them with useful methods and principles.

In 1986 we started an experiment in which the TRIZ approach was used to teach conventional school subjects. The basic idea was quite simple: students acquired the necessary knowledge by solving interesting technical problems with the help of TRIZ tools. Using methods developed for

solving scientific problems³², students were challenged to find explanations for simple physical experiments. Students who “invented” the Archimedes’ Law on their own found that this complex physical law was much easier to understand than if one had learned by reading a textbook³³. And of course a side effect of this approach is that, together with the main subject, students learn the TRIZ basics.

The above experiments started with physics; later the same approach was used with chemistry, geography, history, literature and social sciences. Eventually, a book was compiled of TRIZ physics and chemistry lessons³⁴. Materials for other subjects were prepared as well, but due to lack of time were never published.

In the 1980s and 90s many members of the Kishinev TRIZ school, along with TRIZ specialists from other cities in the former Soviet Union, were involved in teaching TRIZ to children. In the early 1980s, Len Kaplan became a full-time TRIZ teacher for a special organization devoted to disseminating and teaching technical innovations to children. Luba Begam (now in Israel), who had studied at the two-year TRIZ school mentioned earlier, became a professional TRIZ teacher. Michael Shusterman, together with his wife Zena, organized a special center in Norilsk for teaching TRIZ to 4- and 5-year-olds and their teachers³⁵.

Sergey and Galina Malkin were teaching TRIZ in kindergarten where Galina (a biologist by education) was working as a teacher. Esther Zlotin and Vladimir Petrov taught TRIZ in St. Petersburg and later in Israel. A unique experience was gained by Alla Nesterenko from Petrozavodsk. As daughter of long-time TRIZ specialist Alexander Selutskiy, she became familiar with TRIZ from an early age; after graduation she became a teacher at an elementary school³⁶.

In the early 1990s the economic situation in the former Soviet Union abruptly deteriorated, virtually ending all opportunities regarding technological TRIZ. As a result, the majority of TRIZ specialists switched to other areas (see below), and children’s education became one of the most powerful TRIZ applications. To the best of our knowledge, most of these organizations today are represented by *TRIZ - Chance*, which was organized by a highly-experienced TRIZ professional, Igor Vikentiev (St. Petersburg). In 1989 he arranged the first conference (which was held in Petrozavodsk) of TRIZ specialists and educators involved in educating children. Another noteworthy educational project, *Johnatan Livingston*, was organized in Minsk by Nikolai Khomenko. Numerous books and papers have been published devoted to children’s TRIZ education³⁷.

TRIZ in medicine and biology

One of the most impressive non-technical TRIZ applications was in medicine. From the 1970s, long-time TRIZ specialist Alexander Selutskii began teaching TRIZ to students at Petrozavodsk University medical school. Together with his students, he solved numerous problems related to improving medical equipment and treatment methods.

Example

Extremely cold winters in Petrozavodsk were the cause of many deaths due to hypothermia (overcooling). Often, hypothermic victims were found still alive, but did not survive because there was no safe and effective way to warm them quickly. The usual methods, which included surrounding the patient with a warm environment, rubbing the body, and providing warm drinks (including alcohol), caused blood to rush to the skin surface, depriving crucial organs such as the heart and brain of oxygen and resulting in death. This problem was addressed - without success - by several countries during World War II in an attempt to save the lives of naval and air force personnel operating in cold seas. After the war, the idea of using microwaves for this purpose was considered, but no successful results were reported.

After being educated in TRIZ, doctor Tatti came up with the idea of utilizing the body's own blood flow as a resource for quickly delivering warmth to the heart and other important organs. To implement the idea, he suggested applying heating pads to the places in which the largest arteries are close to the skin surface, including the neck, underarms, and other areas. This simple method was responsible for saving many people and resulted in the design of comfortable work gear for people working in cold open areas. Interestingly, this same idea, applied in reverse, can help people working in hot areas (i.e., instead of heat, ice pads are applied to the targeted areas of the body.)

TRIZ was extensively applied to medicine by physician and TRIZ specialist Arcadiy Lichachev, Gennadiy Predein, an engineer working for an orthopedic company, experienced TRIZ specialist Boris Faber, a director at the Russian Orthopedic Research Institute, and others. Gafur Zainiev utilized TRIZ approaches in his research related to DNA. In the United States, Ideation has achieved positive results working with medical equipment and sanitary products.

We believe that medicine should become one of the most important directions for the utilization of TRIZ, and would like to participate (or facilitate) the work with such widespread diseases as cancer, AIDS, etc.

Solving scientific problems

The first attempt to apply TRIZ to solving scientific problems (i.e., to make discoveries) was made by Genrich Altshuller in the early 1960s³⁸. Following the procedure described earlier, Altshuller analyzed certain facts from the history of scientific discoveries. As a result, he identified two types of discovery:

- Discovery of a new fact/phenomenon
- Finding an explanation (discovering a mechanism) to a fact/phenomenon that doesn't comply with existing theories

As a next step, Altshuller unveiled and formulated a set of methods that proved helpful in discovering new facts or developing plausible theories. He applied these methods to the mystery of Tunguskiy meteorite - a set of mysterious events associated with a huge meteorite that entered the Earth's atmosphere in the early 1900s and disappeared. This work of Altshuller's might be dismissed as an exercise in pure fantasy (which it was); however, it resulted in the invention (prediction!) of the physical phenomenon of the self-concentration of laser beams in non-linear mediums, later discovered by a physicist by the name of Askaryan.

In the 1970s, Altshuller disciples Igor Kondrakov and Gennadiy Filkovskiy completed several works in the above direction discovered by Altshuller. About the same time, Valery Tzourikov and Georgiy Golovchenko made their discoveries in the area of astrophysics and plant biology as a result of applying the TRIZ approach³⁹.

A significant contribution to the subject was made by Volyuslav Mitrofanov. As a chief engineering deputy at the large semi-conductor company *Svetlana* (the Russian equivalent of Intel) he was actually a high-level troubleshooter. At the same time he also managed and taught at the largest public TRIZ University in St. Petersburg, and conducted his own TRIZ research. Working to implement the first microchips, he faced numerous baffling effects in production, which had to be resolved. As a result, he solved numerous inventive and scientific problems and implemented most of his solutions, giving him the ability to quickly test his scientific ideas. In time, scientific problems became his main interest. He published several papers and a book on this subject⁴⁰, in which the most important ideas are the following:

- Unveiling asymmetry in various systems (from machines to molecules) as the underlying cause of contradictions; utilization asymmetry as a driving source of evolution; unveiling ways to compensate for asymmetry

- The idea of conducting opposite experiments - i.e., conducting a pair of experiments directed toward achieving opposite results or utilizing alternative methods. If indeed opposite results were obtained, then a critical third experiment was conducted.
- Modifying conventional TRIZ tools and instruments such as the patterns of evolution, ideality, contradictions, SF formulas, utilization of analogies, etc. for the purpose of solving scientific problems
- A seven-step process for solving scientific problems, including:
 - Unveiling asymmetry and methods of compensating for it
 - Conducting an opposite experiment
 - Identifying and resolving physical or technical contradictions
 - Utilizing patterns of evolution
 - Utilizing resources available in the system and its environment (especially time resources)
 - Building an ideal model of the solution
 - Identifying how to produce an observed phenomenon

Using this approach, Mitrofanov successfully identified the mechanism underlying a physical effect named after the physicist Russell (who had discovered this effect in the 19th century but had no adequate explanation regarding its nature). Solving this scientific problem, Mitrofanov was able to build an important device for producing microchips, for which he received a special award. He also made several other important discoveries in the area of solid state physics, solved numerous inventive problems, and unveiled the root causes of numerous production defects (then eliminated them) in the semi-conductor industry.

In the mid-1970s, Boris Zlotin, Mitrofanov's student and later a TRIZ educator and board member at St. Petersburg TRIZ University, became involved in scientific work led by Mitrofanov. In the early 1980s he continued this work together with Alla Zusman. At that time, they were committed to developing a system for solving scientific problems and started collecting and documenting typical scientific problems and solutions following Altshuller's basic approach. A year of work yielded only several dozen reliable situations (the main obstacle, as discussed earlier, was the absence of a system of documentation - similar to the patent library - of such solutions). It became clear that their work was "a long shot." At the same time, Ms. Zusman suggested utilizing and analyzing a resource that was available - namely, the scientific problems solved by TRIZ professionals. Together with the understanding that the nature of scientific problems and production defects (or failures with unknown root causes) were the same, this approach led to the formulation of the idea of *transferring known TRIZ approaches into a new area*. The only thing that was missing was the actual principle of transfer allowing the new type

of problem to be converted into the known one. In the case of scientific problems, this principle was known as *Problem Inversion*.

The essence of Problem Inversion is simple: instead of asking “*How can a certain phenomenon be explained?*” one asks “*How can this phenomenon be obtained under existing conditions?*”) The problem therefore becomes a typical inventive problem and can be attacked using existing TRIZ tools such as the innovation principles, ARIZ, Operators, etc.

When solving converted scientific problems the concept of utilizing resources becomes extremely important. Of course, the utilization of resources is critical when solving inventive problems, as it helps increase the solution ideality - but in many situations this might not be possible. In solving scientific problems, however, the utilization of resources is *mandatory*, because if a certain event has already taken place, the necessary resources were in fact present.

Besides making available the TRIZ tools and approaches, problem inversion makes it possible to apply conventional technological knowledge to solve scientific problems.

Example

It is well known that a runner should breathe through the nose rather than the mouth. Running while breathing deeply through a wide-open mouth quickly causes the runner to pant for air. Amazing as it sounds, there is no adequate explanation for why this happens (other than the obvious fact that breathing through the nose requires more efforts and yields less air). We asked a physician specializing in sports medicine for an explanation. He gave us two reasons:

- *Breathing through the nose warms the air before it enters the lungs, and therefore does not cause overcooling of the body*
- *The nose works as a filter, preventing dust from entering the lungs.*

After some consideration, both these explanations seemed erroneous. First, in the summertime we were usually concerned with high ambient temperature rather than overcooling. Second, the air where we were running was clean enough.

We decided to apply the principle of Problem Inversion to this situation. The inverted problem therefore became: How can we force a person to pant?

We knew of at least one method: hyperventilation (i.e., breathing deeply and frequently, which produces the same result - usually explained as the result of oversaturating the blood with

oxygen). The cause was still unclear, however, because breathing in an oxygen-rich environment doesn't cause panting. Moreover, when one is running there is usually a lack of oxygen.

The next step was to look for a similar effect in technology. To make this transition, it was necessary to create a mechanical model of "breathing." If we regarded the lung as a pump, the question became: how can we force this pump to work ineffectively? As it happened, one of the authors was at that time working for a company that designed water pumps; he readily ascertained that a pump works ineffectively if it is not properly loaded. That is, if a pump that is designed to pump water from 400 meters is forced to work at 4 meters, or work without any water at all, all the energy consumed by the pump turns to heat and eventually destroys the pump.

If the above technical fact is applied to that of a runner, the following hypothesis can be formulated: When one breathes through a wide open mouth, there is not enough load for the "pump" (lung), which might result in ineffective work and substantial loss of energy. On the contrary, breathing through the nose allows the lung to be properly loaded.

We conducted a simple experiment by attempting to breathe through tightly-closed teeth and half-closed lips. The results were even better than those obtained when breathing through the nose: it became possible to change the air resistance depending on the mode of running (a super-effect!).

The idea of Problem Inversion looks rather simple, yet it resulted in several non-trivial effects. One of these was the relief from the psychological pressure of dealing with a "mystery," which makes scientific problems appear more difficult than they really are. Another effect is that of breaking the inertia of accepting a well-known explanation without challenging its validity. Unfortunately, the accepted explanation is not necessarily the correct one, and often contains circular definitions or, in the worst case, prevents us from looking for the true root causes and explanations.

A solution obtained using Problem Inversion lets us formulate a hypothesis which must be verified (and TRIZ can help with this as well). This approach essentially transforms the process of solving a scientific problem into one of *inventing an explanatory mechanism*. And once the mechanism of a phenomenon is fully understood, it can be controlled (i.e., amplified, weakened, eliminated, etc.).

The approach described above was successfully applied first by the authors for the purpose of solving several research problems related to little understood situations with deep-level water pumps. In 1985 we started teaching the Problem Inversion approach to our students. One

student, Anatoliy Yoisher, used it to solve a critical problem in the area of micro-wire production that had gone unresolved for more than 15 years⁴¹. Based on his solution, he completed his Ph.D. dissertation and was able to quickly begin production of a new type of micro-wire. To date, dozens of scientific problems in different areas, including physics, chemistry, math, and biology, have been solved.

It was also found that the same approach could help in solving criminal problems and in identifying the root causes of production defects and failures. This last application became the most effective one. Apparently, people are usually in no hurry to implement new inventive ideas (especially if the old idea is adequate), however, finding the root causes of failures and fixing them quickly provides a tangible return on investment.

Besides solving specific scientific problems, we continued working in the following areas:

- Refining techniques related to the application of TRIZ tools to scientific problems
- Unveiling and formulating patterns of evolution of scientific systems (theories and hypothesis)
- Developing general methods of building new scientific concepts.

To test our findings, we decided to apply them to some large-scale problems. After careful selection, we identified the following three areas:

- Building TRIZ as a conventional science
- The theory of evolution of social systems
- Enhancing the theory of biological evolution

The first item has been addressed in previous publications⁴². The other two will be addressed in separate publications.^{43 44}

Safety

In 1978 Boris Zlotin, a Value Engineering center leader at *Electrosila*, was facilitating a brainstorming session directed toward improving the quality of one of the company's products - powerful electrical switches. Working with one of the critical parts - a contact - Zlotin suggested a reverse brainstorming: instead of thinking how the part could be improved, try to make it *worse*. The first ideas were rather trivial: break the part with a hammer, make it from non-conductive material, etc. To stimulate more creative ideas, Zlotin offered the following: "Think how you might damage the part in a way that is undetectable to quality control, but

which would later cause the part to break - and nobody would be able to figure out it was our fault." "Do you mean we should think of sabotage?" asked a team member. "Exactly!"

Ten minutes later one of the participants suggested, jokingly, a slight deviation from the standard manufacturing process that could produce a failure. Five minutes later it was discovered that such deviations were happening from time to time without attracting anyone's attention. It was immediately recognized that a very serious accident that had occurred not long before, resulting in millions of dollars in damages and for which the cause was still unknown, might be a result of this deviation. A set of simple experiments proved the hypothesis correct. As a result, the unreliable operation was improved to prevent dangerous deviations, and additional recommendations for retrofitting devices already delivered to the customer were developed.

The above brainstorming session gave birth to the idea of the "subversion approach," which can be formulated as follows:

- Replace the question "***What kind of production defects, failures or other undesirable effects can occur in a given product or process?***" with the following one: "**How can the given product or process be made to fail, or how can the defects/failures be produced?**"

The above problem transformation is similar to the Problem Inversion used to solve scientific problems⁴⁵, and converts the process of failure analysis/prediction into an inventive problem, making available all the advantages of TRIZ. Once the inverted problem is formulated, the main focus becomes searching for potential harmful effects that can be produced in the product or process with the help of the existing resources. In essence, what we are trying to do is "invent" potential failures. And once a failure has been invented, the system in question should be examined to determine if the failure has already occurred or to ascertain the probability that it will occur in the future. If the failure is possible or has already occurred, the next (inventive) problem becomes: How can it be prevented?

For example, during an analysis of chemical equipment, we asked the following question: "How can we create an explosion?" The Subject Matter Experts (SMEs) were certain it was impossible. But a further analysis of the resources required to produce an explosion resulted in the following list:

- Flammable substances capable of burning quickly
- An oxidizer capable of supporting this burning
- An ignitor capable of initiating the burning process

All of the components mentioned above were found in the equipment and its environment, but they were not connected in any way. Thus the next problem to be solved was “How can we bring these things together and assure their interaction?” To their surprise, the SMEs found that on rare occasions while the equipment was being serviced, this dangerous interaction could in fact take place. Moreover, such situations had occurred in the past but, due to nothing more than luck, had not resulted in an accident. The next step, of course, was to eliminate the possibility of an accident, which in this case was not difficult once the mechanism was understood.

Until the mid-1980s, the “subversion approach” was applied by various TRIZ specialists in their professions. The approach itself evolved very little, however, due to the lack of necessary information (in the former Soviet Union, any information about accidents, catastrophes, or serious design failures was not available to the public). This situation changed with *perestroika*, and once this information became available, we were quickly able to develop a ten-step algorithm. To support this algorithm we carried out the usual TRIZ approach of accumulating and organizing knowledge, and the result was a useful knowledge base organized in the form of the following checklists:

- Typical harmful impacts on various systems, including humans and organizations
- Typical harmful effects associated with different stages of a system’s evolution
- Typical dangerous zones and times in the functioning of a system
- Resources capable of providing harmful effects
- Typical mistakes in system evolution
- Typical root causes leading to harmful mistakes
- Typical method of amplifying harmful effects
- Typical methods of “masking” harmful effects
- Typical methods of preventing harmful effects

The subversion algorithm was first tested in 1986 during the analysis of a production line in a large shoe factory in Kishinev. The effort resulted in the generation of 18 potential production failures that were at first regarded as absurd. Later, however, it was found that 12 of these failures had already taken place, with at least three resulting in substantial losses.

From the mid 1990s, Ideation has been marketing “subversion analysis” under the name Anticipatory Failure Determination (AFD) as an application of the Ideation/TRIZ Methodology. AFD contains two main algorithms, or processes:

- Failure Analysis (identifying the root causes of a failure that has already occurred)
- Failure Prediction (identifying potential failures that might occur)

A comparison of AFD with other failure techniques used in American industry (such as FMEA, HAZOP, etc.) has shown the following:

- Because of the TRIZ-nature (i.e., inventiveness) of AFD, it is much more aggressive and proactive. As a result, AFD is repeatedly found to reveal new problems and dangers in products and processes that had been previously analyzed with traditional methods.
- AFD is compatible (and complementary) with traditional techniques, also due to its TRIZ nature (i.e., it targets creativity where other techniques do not)
- Complementing AFD with TRIZ tools and approaches to problem solving allows one to generate cost-effective solutions to hidden problems.

In the late 1990s, software supporting the AFD process was developed. It included the following modules:

- Failure Analysis
- Failure Prediction
- Failure Prevention /Elimination

With this software, together with special educational material, AFD training could be conducted in a 2- to 5-day course.

Social and business applications of TRIZ

Underlying theory

In 1984 Boris Zlotin and Alla Zusman started researching the evolution of social systems using TRIZ as well as their work in developing techniques to build scientific concepts. We defined a social system as one of the following:

- Enterprise
- Government agency
- Professional association
- Social institution
- Educational institution
- Family
- Country
- Society as a whole

At the time, looking for new information about social systems was rather dangerous in the Soviet Union because of the KGB. The authors therefore initially limited themselves to small

organizations such as company divisions or sports teams - areas in which they were knowledgeable. Focusing on small organizations turned out to be a useful endeavor, as it was easier to apply the TRIZ approach and reveal patterns when smaller systems were targeted.

The main idea that we wished to prove was that the evolution of any organization follows certain patterns, which can be ascertained and utilized for the purpose of enhancing an organization.

For several years, the authors pursued this work only halfheartedly - they knew how difficult it would be not only to obtain accurate information but to publish anything that differed from the official communist statements. But things changed significantly with the onset of *perestroika*, and in a short period of time many important Western books in history, economics, sociology, business, marketing and other areas were translated into Russian and made available to the public. At the same time, the establishment of so-called "private" companies was allowed, and in early 1986 the members of the Kishinev TRIZ school established a private engineering company and Scientific and Technological Center (STC) called Progress (which happened to be one of the Soviet Union's first private engineering companies). STC "Progress" began educating various industrial companies in TRIZ and providing analytical services in problem solving⁴⁶.

By working with various commercial and political organizations we were able to gain access to confidential political, social and economic information, and thus we formed a strong foundation for our previous theoretical conclusions, and were able to verify and test the methods and tools we had developed. Our work gained a practical focus and allowed us to apply these methods and tools to solving social, management, business and other problems, and to analyze specific social systems. We were joined in these efforts by many other TRIZ specialists⁴⁷.

The essence of the Theory of Evolution of Organizations was first presented to the students at the January 1987 TRIZ seminar in Moscow. More detailed material was discussed at a TRIZ seminar for professional sociologists (held in Miass in May, 1988⁴⁸) and at a seminar for managers (in Komsomolsk-on-Amur in April, 1991⁴⁹). Later, Zlotin and Zusman conducted two seminars for TRIZ professionals where about half the time was devoted to the Theory of Evolution of Organizations⁵⁰ and to solving problems in management and business (Simferopol, January 1992 and Petrozavodsk, October 1992)⁵¹.

Practical applications of methods developed by the Kishinev TRIZ school

Theoretical findings in the area of organizational and societal evolution were soon tested in the following practical endeavors:

- Organizational and business analysis of various technical projects completed by STC Progress for various industrial companies
- The complex analysis and development of directions for improving and further evolving the Moscow Commodity Exchange (1991-1992). This project resulted in more than 200 suggestions for improvement and growth, in particular:
 - Enhancing MCE operation and service
 - Increasing the volume of operations
 - Developing new services
 - Developing new principles and methods of advertisement
 - Enhancing operational and personnel safety
 - Formation of an effective organizational culture
 - Lobbying for MCE in the Parliament of the former Soviet Union

Later the methods and approaches proven effective in the MCE project were used in:

- The analysis and improvement of banks and insurance companies⁵²
- A government project for supporting people with disabilities⁵³
- Consulting for Gasprom, the largest gas company in Russia⁵⁴

Other applications in business and politics

In the early 1990s Igor Vikentiev began applying and teaching TRIZ principles in advertisement and journalism. He collected a bank of creative solutions and developed principles similar to the 40 Innovation Principles for making impressive publications and advertisements⁵⁵. A book⁵⁶ and an operational web site⁵⁷ are available on the subject.

In the mid-1990s TRIZ principles were applied to political situations - in particular, to election campaigns of several members of the Russian parliament⁵⁸ and to the presidential elections in Moldova⁵⁹. TRIZ was also successfully applied in professional consulting endeavors concerning the election campaign⁶⁰.

Software for non-technical TRIZ applications

In 1992 STC Progress released the first TRIZ software for business consulting, called *Tools for Managers*. It included the following modules:

1. Manual Problem Formulation technique
2. Structured innovation knowledge base containing:
 - Specialized Operators (recommendations) related to the following areas:

- Building an organization
 - Growing an organization
 - Managing an organization and its personnel
 - Increasing the efficiency of an organization
 - Ensuring an organization's stability
 - Transforming (changing) an organization
 - Dismissing an organization
 - Eliminating undesired factors related to organizations
 - Obtaining information
 - Securing information
 - Universal Operators applicable to both technical and non-technical problems
 - Operators related to utilizing resources
 - Examples illustrating the use of Operators in real-life situations
 - A bank of social and psychological effects helpful in solving business/management problems in the most effective way (similar to the role of physical, chemical and geometrical effects in solving technological problems).
3. Recommendations for evaluating and enhancing the generated ideas
4. Software "Help" that included the following information:
- General patterns of evolution of organizations
 - Typical objectives and mistakes related to specific stages of an organization's evolution
 - Typical features of an organization at different stages of evolution

By November of 1992, when we first came to the United States to discuss the possibility of establishing an American TRIZ-based company, the *Tools for Managers* software (later called *Management WorkBench*) was in better shape than the equivalent software for technical problems, the *Innovation WorkBench™*. For the reasons described above, however, further development of management software was put on hold. Today we are moving ahead with the release of the *Knowledge Wizard™* - a new software analytical tool for analyzing and modeling non-technical situations and formulating directions/opportunities for resolving them. The Knowledge Wizard is based on the *Problem Formulator™* (US Patent No 5,581,663) and has a limited number of recommendations for addressing generated opportunities. The next step is the *Management WorkBench* software, which will contain a comprehensive knowledge base in the related area.

Chapter 2. Evolution of Organizations: Theoretical Findings and Practical Applications

The underlying theory, tools and processes

The underlying theory of the evolution of organizations is based on the following assumptions:

- The existence of universal (or general) patterns of evolution
- The transferability of models (explanatory mechanisms) - that is, models proven effective in one area can be applied to other areas given the appropriate conditions and limitations

... and includes the following sections:

- A theoretical foundation providing a unified approach to various problems, including:
 - Poly-model approach
 - Non-linear approach
- Analytical tools and processes which support the analysis of existing organizations and identify effective approaches to enhancing them
- Innovation knowledge-base tools encompassing the best practices in organizational improvement, structured according to typical problems related to desired enhancements
- Computerized tools

Poly-model approach

We define the poly-model approach as a method for creating theories through ***the development of a necessary and sufficient amount of simple but compatible (or complementary) models that together support the understanding and prediction of a system's behavior.***

Ways in which the appropriate models can be created/applied are as follows:

- Application of existing models accepted in various scientific and technological areas (see the transferability of models assumption, above)
- Building of new models based on mechanics, physics, chemistry, cybernetics, biology, etc.⁶¹
- Each model should be accompanied by a description of the conditions and limitations under which it can be effectively utilized

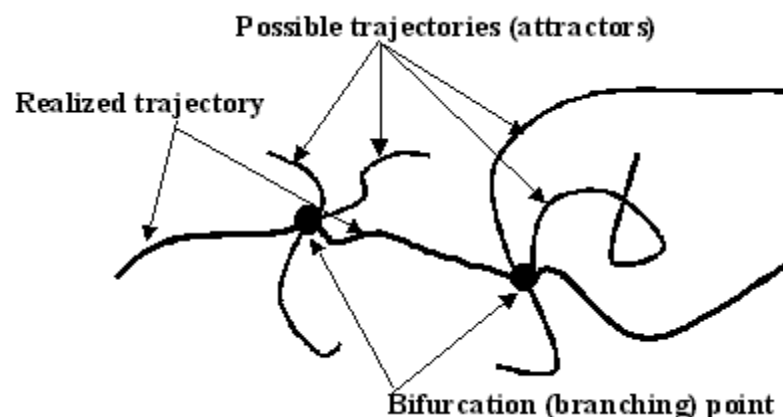
To reveal models that are useful with regard to the evolution of organizations, we have studied the effective models applied to various human activities, primarily in the following areas:

- Existing social and economic sciences
- Synergistic theory of evolution of non-linear systems
- Cybernetics and information theory
- TRIZ as an evolutionary science
- Various evolutionary theories in biology, cosmology, etc.
- Psychology
- Stress concept by H. Selye
- Nosology (study of the incidence, distribution, and control of disease in a population)
- Trophology (science having to do with the natural food chain)
- Physics, chemistry and other natural sciences

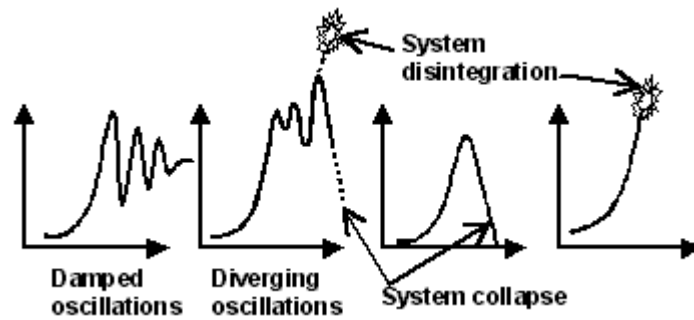
Non-linear approach

The non-linear approach includes the following assumptions:

- Any organization and even humanity as a whole constitutes a non-linear system, the evolution of which is determined by three distinct types of processes:
 - Smooth and predictable evolution, during which the principles of natural selection (market acceptance) are in action.
 - Periodic crises, during which the system's behavior becomes unpredictable (although it can remain controllable). Each crisis ends with the (random) selection of one of the potential "paths" for further evolution, resulting in a change in the system's evolutionary trajectory.



- Periodic avalanche-like events caused by positive feedback (reinforcing loop)



- System structure depends on various flows passing through the system that can change its structure or destroy it (flows passing through the super-system can create the system). Specific flows that pass through and change/form our social system are transposition of people, goods, documents (instructions, assignments, orders), money, credits, bonds, information, services, etc.

Important assumptions related to the linkage between an organization, its business/cause/mission and its stage of evolution

It is known that, in general:

- The majority of an organization's features are determined by the stage of its evolution along the S-curve
- The evolution of an organization strongly depends on the S-curve position of its main business⁶²
- At the same time, the business of an organization can be impacted (positively or negatively) by the S-curve position of an organization

Analytical tools and processes

The TRIZ analytical tools used to analyze organizations include:

- Situation assessment questionnaire
- Situation analysis and development of recommendations process

Situation Assessment Questionnaire

The Situation Assessment Questionnaire helps reveal and document important information related to the given organization and its problems, and includes the following sections:

- Objectives

- Brief assessment of the business
- Brief description of the situation
- Importance of the situation
- History and root causes of the problem(s)
- Assessment of resources, including:
 - Financial
 - Human
 - Technical
 - Other business assets
- Criteria for success (assessment of expectations), including:
 - Expected results
 - Anticipated cost of improvement
 - Anticipated (new) secondary problems
 - Probability of success/risk assessment

Situation analysis and the development of recommendations process

The following aspects of an organization's life are analyzed:

1. Situation (position on the S-curve) of the core technology (business, mission or cause)
2. Organizational structure (formal and informal)
3. An organization's interactions with its super-systems, including:
 - Market or higher-level organizations to which the analyzed organization reports
 - Government regulations (agencies)
 - Environmental issues
 - Professional associations
 - Trade unions
 - Other
4. Functions (internal and external) performed by an organization
5. Organizational resources (obvious and hidden)
6. Motivations and interests of formal and informal groups
7. Various flows (see above) inside the organization, and their exchanges with the super-system(s)
8. Organizational culture
9. History and evolution of the organization, including
 - S-curve analysis

- Contradictions, crises, and other disturbances
- Solutions and decisions related to problems that emerged in the past

10. Mechanisms determining the following:

- Growth of the organization
- Stabilization of the organization
- Hindrances to the growth of the organization

11. Organizational intellectual capital

Based on the analysis described above, the following steps are taken:

12. Utilization of patterns of evolution for revealing potential evolution scenarios
13. Solving the revealed problems in the organization's structure, operation and core business/technology, and clarifying the potential paths for evolution
14. Selecting appropriate paths
15. Restructuring and securing intellectual capital

Innovation knowledge base tools

In the mid-1980s we began collecting and organizing information about the most successful practices related to organizational improvement, economics, politics and other social areas. This work was carried out in accordance with the following principles:

- The general approach developed by Altshuller, including:
 - The gathering of numerous creative solutions (inventions in the technological arena)
 - Identification of "levels" of creative solutions, screening of the gathered solutions according to these levels, and selection of high-level solutions for further analysis
 - Revealing of typical patterns for obtaining creative solutions of different levels (innovation principles, patterns of evolution, etc.)
 - Development of algorithms for obtaining solutions
- The principle of increasing the problem-solving (TRIZ) value of the obtained knowledge described in the table⁶³ below, in which the following results were obtained:

Value Level	Type of Innovation Knowledge	Tool name and short description
4	Patterns/Lines of Evolution	<ul style="list-style-type: none"> • Universal Patterns • General Patterns/Lines dedicated to social systems
3	System of Operators ⁶⁴ / Models ⁶⁵	<ul style="list-style-type: none"> • System of Operators dedicated to solving typical problems in the evolution of organizations, including: <ul style="list-style-type: none"> ○ Universal Operators ○ Operators related to the use of resources ○ Specialized Operators⁶⁶
2	Single Operators / Models / Effects	<ul style="list-style-type: none"> • Bank of models related to the behavior and evolution of organizations • Model of evolution of an ideal organization • Bank of psychological and social effects
1	Selected innovative (creative) solutions	<ul style="list-style-type: none"> • Bank of selected illustrations and case studies related to organizational and personnel management
0	All available information in various sources	

Universal patterns of evolution utilized in the evolution of organizations

The following set of Universal Patterns⁶⁷ as they apply to organizations have been studied and utilized:

- Stages of Evolution (Infancy, Growth, Maturity, Decline)
- Evolution Toward Increased Ideality
- Non-Uniform Development of System Elements
- Evolution Toward Increased Dynamism
- Evolution Toward Increased Controllability
- Evolution Toward Increased Complexity then Simplification
- Evolution with Matching and Mismatching Elements
- Evolution towards Increased Involvement of Resources and Decrease in Limitations

General patterns/lines of evolution

We regard the following patterns/lines as “general” as they have either been adjusted or newly introduced for application with organizations:

- Evolution towards increased structure of flows and processes related to organizations
- Evolution of relationships between an organization and an individual
- Evolution of human and organizational needs
- “Waves” of evolution related to controlling the satisfaction of the following human and organizational needs:
 - food
 - environment
 - health
 - sources of energy
 - safety
 - labor
 - exchange of goods
 - natural resources
 - logical and creative thinking
 - accumulation and utilization of information
 - societal organization
 - the future (destiny)
- The natural (six-stage) evolution of an organization⁶⁸, which includes the following characteristics:
 - Description of each stage with respect to the organization and its business/mission/cause
 - Typical objectives
 - Typical mistakes
 - Typical features
- The influenced evolution of an organization, including:
 - Premature aging
 - Contrived Dynamic Prosperity

Bank of models related to the evolution and behavior of organizations⁶⁹

The following models have been identified:

1. Basic models of evolution, including:

- Darwin model: natural selection in the evolution of organizations
- Bogdanov model: combination of positive and negative selections
- Lamarck⁷⁰ model: inheritance of features obtained by a living creature over the course of its life
- Convergence and divergence of system forms under the influence of natural selection

2. Models based on feedback, including:

- Avalanche-like (chain reaction) evolution
- Stabilizing (homeostatic) evolution
- Oscillations (the result of combined positive and negative feedback)
- Asymmetrical homeostasis (a specific result of combined positive and negative feedback)

3. Non-linear models of evolution, including:

- The combination of smooth, bifurcation, and avalanche-like evolutionary processes
- Interaction (dependence) between the flows and structures of organizations

4. Crisis models

- Emergence of crises and their strengthening during the process of evolution
- Resolution of crises (discharge)
- Crisis as a tool to manage an organization

5. Administrating/managing basic flows within organizations

- Traditional regulation
- Forced administration
- Economic management (based on the utilization of inherent human needs and motivations)
- Charismatic leadership
- Real organizations as a combination of different systems of administration/management
- Formation and evolution of various historical systems of administration/management

6. Models related to the emergence and elimination (dismissal) of an organization

- The emergence of an organization around a “seed flow”
 - Building an organization from elements obtained from other destroyed (i.e., eliminated, dismissed, etc.) organizations
 - Expansion of an organization
 - “Reproduction” of an organization (reproduction of its sub-systems)
 - Organizational “illnesses”
 - Emergence and destruction of forced administration
 - Emergence and destruction of economic management
7. “Hydraulic” models related to the distribution of flows throughout the society or organization, including:
- “Hydrodynamic” effects
 - Spread of flows
 - Flow penetration
 - Flow distribution from the top down and from the bottom up
8. “Energetic” models, including:
- Mechanisms that accelerate evolution
 - Mechanisms that retard evolution
 - Energy of “unhappiness”
 - Non-zero sum games (win-win models)
9. Dynamic models, including:
- Dynamic stability
 - Speed and smoothness of the ride
 - Systems with low stability
 - Push-pull management models
 - “Stone on a slope”
 - “Boiled frog”
10. Models of hierarchical growth, including:
- Growth of bureaucracy
 - Hierarchical bi-systems
 - Forcing people to conform to an organizational structure
 - Organizational structure-culture relationships

11. Model-description of organizational structure and behavior, including:

- Structural description
- Functional description
- Cause-effect description
- Problematic description⁷¹

12. Strategic models of evolution including:

- Defensive strategy
- Attacking strategy
- Opportunity-driven strategy

13. Models related to the transformation of economic and political systems, including:

- Restricted political and economic systems (totalitarian regime)
- Restricted political system and free economic system (authoritarian regime)
- Free political and economic systems (democracy)
- Free political system and restricted economic systems (chaos)
- Transitional models

14. Innovation models of evolution (based on the universal patterns of evolution), including:

- Evolution as a process of increasing ideality
- Evolution as a process of generating and utilizing resources
- Evolution as a process of accumulating and resolving (eliminating) contradictions
- Evolution as a process of generating super-effects

15. Models derived from the pattern *Matching-Mismatching* with respect to organizations and their environments, including:

- Adaptation of an organization to its environment
- Adaptation of the environment to the organizations
- Compensating mechanisms
- Over-compensation
- Adaptation via mediators

16. Models related to popular fallacies and prejudices, including:

- Fairness and equality

- Wealth
- Exploitation people
- Social revolutions
- Exhaustiveness of natural resources

Computerized tools

The following computerized tools are used in the analysis and improvement of organizations:

- Knowledge Wizard™ software, to support the decision-making process (see earlier)
- Failure Analysis software, for revealing hidden agendas and mechanisms operating within an organization
- Failure Prediction software, for the prediction and timely prevention of potential undesired events in an organization's evolution
- Management WorkBench software, to support the solving of creative problems related to the management of business units and personnel (see earlier)

Selected examples of practical models: administrating/managing basic flows within organizations

Definitions and assumptions

The following definitions and assumptions will be used:

Social system - an organization (commercial or non-profit), association, country, society, political institution, groups, etc. This section will mostly address society.

Social (system) structure - a combination of elements, along with the connections (links) between them that provide the system with the ability to operate.

Social flows - flows passing through a social system, such as the transposition of people, goods, documents (instructions, assignments, orders), money, credit, bonds, information, services, etc. Historically, social flows emerge as a result of the distribution of work between people and the resulting need to exchange products. The social structure is randomly formed in a way that supports the increase of useful flows⁷². Useful structures can be established and administered/managed through the establishment, administration, and management of the social flows passing through the given structure.

Mechanism - a driving force or chain of events resulting in a certain outcome. An *explanatory (hypothetical) mechanism* supports credible speculation that explains the nature of an event (outcome).

The main assumptions are as follows:

1. Social flows are produced by *resource gradients* - i.e., the excess of a specific resource in one place and its deficit in another.
2. Any social flow (or its component) that passes through a specific social system produces (supports and/or strengthens) a certain structure.
3. A social system produced by a certain flow tends toward self-preservation (homeostasis) and growth in the following ways:
 - Growing (strengthening) the flow that originated this system
 - Flow diversification - i.e., an increase in the structure of flow components
 - Prevention of (or resistance to) flow interruption
 - Generation of a “flow substitute” if exhaustion of the initial flow is inevitable
4. The structurization and diversification of a flow results in the structurization and diversification of social structure

The above mechanisms result in positive feedback (reinforcing loop) between the flows and structures: the growth/structurization of a flow produces the growth/structurization of social structures that support this flow, and vice versa.

Example

Soon after the prohibition laws were passed in the United States, the random flow of illegal alcohol sales began. Soon afterwards, however, Mafia organizations arose and quickly evolved into complex, well-developed structures which were managed at least as effectively as legal corporations and sometimes more effectively than many government agencies. These structures successfully supported an increase in alcohol consumption and fought against the abolishment of prohibition. When prohibition ended, the Mafia did not disappear (as some legislators had probably hoped) but instead switched to another illegal activity (such as drugs trafficking).

It has been proven that special organizations established for the purpose of distributing limited goods attempt to support the deficit; organizations established to fight certain crimes tend to merge with criminal organizations (corruption).

5. The main problem associated with social flows is that the free exchange of goods in a non-linear, uncontrollable (i.e., unregulated) social system causes the system to become unstable. Flow stabilization can be achieved if a special regulating system for administrating/managing/controlling the production and distribution of goods is established.
6. The following types of regulation exist:
 - Traditional regulation - a situation in which all procedures are regulated by established traditions. This system is effective in small groups and under stable conditions. Significant change (growth or reduction) in flows causes dissociation of the traditional regulating systems.
 - Forced administration - involves purposefully established organizations that possess certain powers that do not depend on flow parameters.
 - Economic management (based on free market principles)
 - Charismatic leadership - based on various ideological (political) influences involving emotions, faith (religious or otherwise), hopes, etc. Such a system might be very effective for a short period of time and/or for a limited audience (involves psychology, as different people react differently to ideological issues).

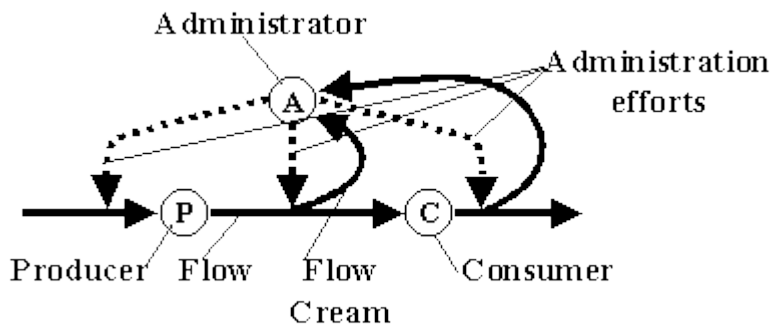
We will address further the two main regulation systems: Forced Administration (FA) and Economic Management (EM).

Forced Administration (FA)

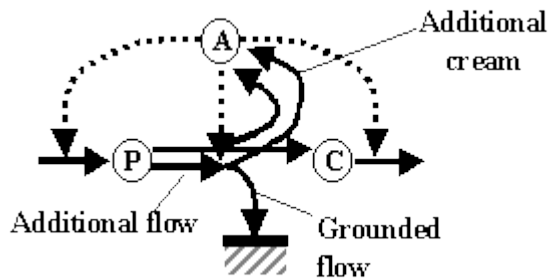
The FA system can be characterized by the following features:

1. Every individual (or organization) is a “consumer” of certain flows. Some individuals/organizations complement this role by being a flow “producer” or a flow “administrator.”
2. The administrator controls the flow between consumers and producers, getting a certain portion of the flow as a reward. Also, the administrator has the prospect of

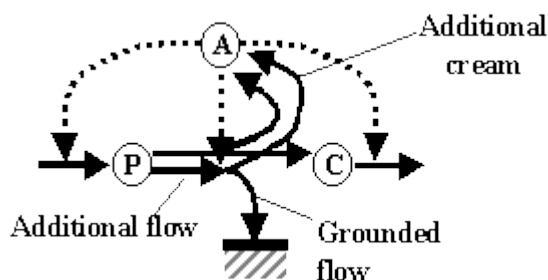
obtaining the best portion (“skimming the cream”).



3. The administrator controls the activities of the producer and consumer by cutting off the incoming flows. This works *only* if the producer or consumer does not have access to independent flow sources or cannot accumulate resources. To ensure absolute control, the FA system does not allow independent flows to exist.
4. The FA system is sufficiently stable if flows in the social system are not entirely sufficient for completely satisfying the primary living requirements of the people.
5. To maintain the ability to “skim the cream” and to provide a certain stability (e.g., in case of a poor harvest), it is necessary to motivate the producer to supply a higher flow. The administrator, however, cannot consume the entire flow all at once, and also cannot allow the excessive flow to reach the consumer (which will make the consumer less controllable and can eventually destroy the system).
6. This problem stated in 5 above has been intuitively resolved in all known FA systems by the following: a portion of the flow is “grounded” - i.e., removed from circulation.



7. A grounded flow must be managed by its own administrator (A1), who benefits from the flow and thus is motivated to increase it - a special positive feedback for the grounding.



8. Flow grounding can be achieved in the following ways:

- Sacrifices to gods
- The accumulation of treasures, building of pyramids, temples, palaces, etc.
- Army and safety
- Prestigious projects
- Investing in fundamental science, arts⁷³, etc.
- The freeing of certain groups of people (e.g., soldiers, ministers, clerks) from producing
- The prosecution of people capable of producing an excess of products (such as entrepreneurs and inventors); suppression of creativity and ambition; the converting of creators into administrators.

Example

Typical examples of grounded flows are: the Egyptian and Mexican pyramids; the Great Wall of China (which made no military sense); the ambitious construction plans of Hitler and Stalin; the ridiculous production of huge numbers of military tanks; the building of hydro-stations on flat land (plains), which is not economically prudent and damages the environment; projects in the former Soviet Union to reverse great Siberian rivers, etc⁷⁴. To an extent, some of the Pentagon's expensive projects can be included here, as well as the race to the Moon, the purchasing of corporate jetliners, etc.

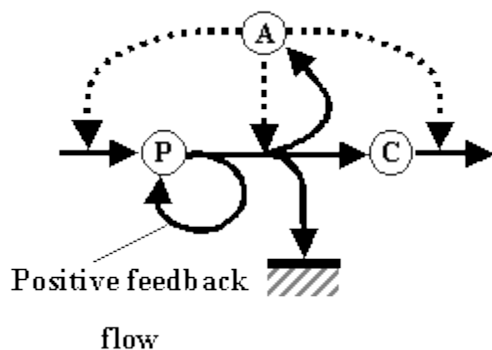
9. A typical contradiction associated with an FA system is as follows: **A continuous increase in productivity is followed by an increase in the amount of grounded flow**. Sooner or later, however, the rate of increase of the grounded flow outpaces the rate of increase in production, as the latter is limited by the availability of resources. The eventual outcome is the waste of resources, damage to the environment, and a deterioration in the quality of life.
10. FA systems are a usual attribute of totalitarian and authoritarian societies (organizations), which allow the existence of only two classes: the poor and the elite (no middle class) and in which is formed a typical style of relationships between producers, consumers and administrators, usually leading to the formation of castes and the suppression of personal initiative.
11. The stability of an FA tends to decline for the following reasons:
 - The power and complexity of a social structure increases to such an extent that effective control is no longer possible, resulting in various deficits and the necessity of continuously correcting the plans
 - Information transmitted from the bottom up about real flows becomes invalid

- Disorder and disturbances in bureaucratic operations, resulting in a loss of coordination between elements of the bureaucracy, etc.
- Flow growth and diversification always decrease an FA's rigidity, loosening its restraints and thus facilitating its decomposition (a paradox).

12. The simplest way to improve an FA is expansion - that is, spreading out into other organizations, lands, activities, etc. This "kills two birds with one stone": for a short period of time increased flows outpace grounding; military conditions justify increasing an administration's strictness. Altogether, this process improves the situation for a while (sometimes for one or two generations), however, because the problem is not completely resolved it will require the next expansion within time, rendering the policy of any FA country (or commercial organization) aggressive and expansionistic.

13. When the possibility of expansion is exhausted, an FA launches experiments directed to the growth of flows in the following ways:

- Improvement of tools
- Improving the organization of collective work
- Motivating producers to increase their productivity by turning over a portion of the produced flows to them



14. Turning over to the producers a portion of the produced flows inevitably leads to the destruction of the FA, for the following reasons:

- The producer accumulates economic resources (i.e., an excess of products) that provide him/her with a certain independence from the administrator (i.e., the latter cannot manage the producer by cutting off the incoming flows)
- The producer can sell or exchange the excess with another producer, creating "side" flows that are independent of the existing administrators. These side flows generate their own structures that compete with the original FA.

15. The FA tries to protect itself from destruction in the following ways:

- Economic (confiscation, inflation, etc.)
- Administrative (centralization, planning, bureaucratic obstacles)
- Political (enforcement of power, various prohibitions, declaring a “state of emergency,” etc.)

16. Further flow growth can lead to the following two variants:

- Catastrophic disintegration of the FA and a return to the previous stage in the societal evolution in the form of smaller, separated, independent (and often fighting one another) tribes or countries, followed by an abrupt reduction of flows (e.g., the fall of the Roman Empire, the disintegration of the USSR).
- Transition to the economic management (EM) system if the following conditions are in place:
 - Sufficient level of social flows (wealth)
 - Existence of money as a universal equivalent of cost
 - Restrictions in basic economic laws; human rights protection
 - People’s readiness to accept a democratic form of government

Example

Most historians believe that ancient Rome was destroyed because of the inefficiency of slavery. The facts do not support this theory, however. On the contrary, the Roman Empire had by that time widely introduced several significant improvements in production:

- *Utilization of slaves (live machines) analogous to the principle of distribution of work in a factory. This resulted in the growth of large estates and ruined small farms.*
- *Creation of a system of small producers who rented land and paid their landlords with a portion of the production*
- *Implementation of more effective agricultural tools*
- *Diversification of flows (production of luxurious products, arms, legal systems, etc.)*

Also, granting permission for barbarians to settle on Roman lands provided the introduction of fresh power, new technologies (such as the treatment of iron) and - most important of all - new markets. Altogether, this led to a substantial growth of flows and caused an unprecedented expansion of? bureaucracy and methods for grounding flows. This in turn resulted in crisis, disintegration, and five centuries of barbarism, wars and collapsing economies until finally a powerful new government consisting of Roman Popes and kings in Germany, France and

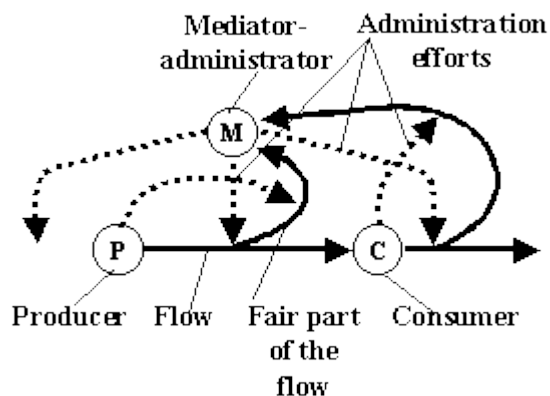
England was established. Rome was ruined by growing flows, which made its FA system fat; the Romans started grounding too many flows and their production became ineffective. Reasons similar to these - the incapability of an FA system to “digest” growing flows - led to the Crusades during the Middle Ages, the French Revolution, and Russian perestroika.

The transition to an EM system eventually increases the wealth of all members of the society. However, in the beginning of this transition it is necessary to concentrate resources as possessions of individuals (or groups) that are capable of better organizing and utilizing them. These individuals/groups are usually the most entrepreneurial and often immoral, which decreases the quality of life of the average member of the society until the new system is fully established and benefits all members.

Economic management (EM)

The EM system is characterized by the following features:

1. Every individual (or organization) serves as producer, consumer and administrator of certain flows.
2. Everyone is involved in various feedback circuits representing free market relationships that convert administrators into mediators. Mediators (wholesale and retail salesmen) connect producers and end consumers.

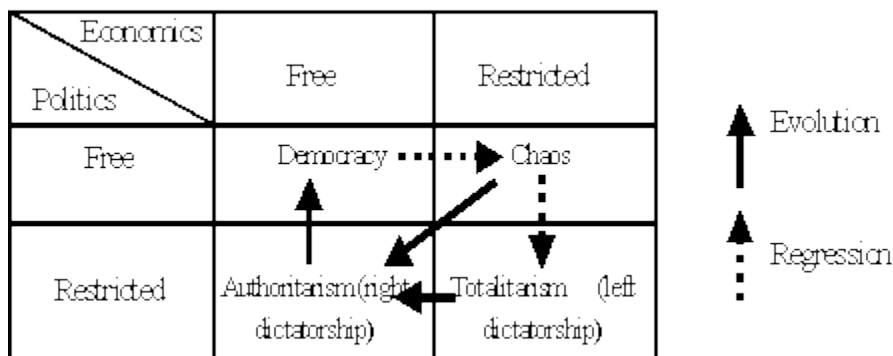


3. An EM is always associated with democracy; it assumes a high level of responsibility, motivates independent and entrepreneurial ways of thinking which in turn leverages the wealth of the individual members involved.
4. A flow analysis shows that EM and democracy are not compatible with poverty. This fact explains why attempts to build a democratic society (similar to that of the United States or Europe) in developing countries are dangerous mistakes, usually resulting in a return to an authoritarian or totalitarian system.

5. The stability of an EM depends on the level of wealth, which should be high enough to ensure that even the poorest have food and shelter. Also, some excessiveness is required to compensate for the natural oscillation (potential abrupt downsizing) of flows. In the absence of a reserve, natural catastrophes (poor harvests, wars, etc.) lower the flows and produce crises; people whose elementary needs are not satisfied often riot. These riots may become serious disturbances, initiating a chain reaction of disintegration. For this reason, it is often very useful to temporarily switch to an FA system in an emergency, as when Franklin Roosevelt introduced his New Deal in the United States, or when governmental control of industry was instituted in England during the Second World War.
6. If the temporary introduction of an FA is under the control of a democratic institution, it can be successfully reversed when it is no longer needed. The situation is much worse if power is illegally seized by a group of FA adepts, as occurred in Russia in 1917. In this case it meant robbing the limited number of wealthy people and dividing their wealth among the masses. In the beginning, the life of the average individual improved - however, the lack of protection of personal property eventually eliminated the majority of flows and resulted in decades of deterioration⁷⁵.

Basic political systems and their transformations

The matrix below demonstrates various models of social systems developed by Bulgarian dissident Zheliu Zhelev⁷⁶, who defined three main political systems as follows:



From Totalitarianism to Democracy. Zheliu Zhelev discovered that the transition from a totalitarian system to a democracy must go through an authoritarian (dictatorship) system (as occurred successfully in Spain, Chili, South Korea, Taiwan, etc.). The reason for this is that, as mentioned earlier, a democracy cannot exist without a middle class representing a certain level of wealth (flows). The economic growth in turn requires a stable political situation with appropriate legal support, which can be provided by strong leadership in the case where a

democracy does not yet exist. Once the required level of wealth has been accumulated and the middle class is established, the transition to democracy can be relatively smooth.

As stated previously, attempts to jump from totalitarianism to democracy without an intermediate authoritarianism can be fatal. For example, a free political system with a restricted economy typically leads to chaos. The escape lies in dictatorship - however a dictatorship can be of a "right-wing" or "left-wing" type. A "right-wing" dictatorship (authoritarianism) represents the power of a wealthy, economically competent minority; it usually restricts political life and allows the economy to grow. A leftist dictatorship represents the power of the poor, economically incompetent majority; it restricts both the economy and politics, and eventually returns to totalitarianism. The FA system inherent in totalitarianism usually tries to maintain its position, and thus does not stimulate flow growth and eventually reproduces the poverty.

From Democracy to Totalitarianism. As mentioned earlier, democracy is stable until the a sufficient level of wealth is attained. If for any reason the flows decline, a lack of control can lead to chaos -an unstable situation that can fall into one of two types of dictatorship (see above).

Example

The French revolutions and Napoleon's wars destroyed existing social structures, spread revolutionary ideas throughout Europe, and readied the masses ready for riots, robbery, and the re-allotment of land, diminishing the value of human life. It also became clear that attempts to quickly establish democratic institutions led to corruption and sometimes terror. As a result the situation in Europe was unstable and very dangerous.

The Viennese Congress arranged in 1815-16 stabilized the situation by instituting strong measures. The Holy Alliance established by the Viennese Congress ruthlessly suppressed any attempt at revolution or violence, flooded the countries of Europe with political spies, and introduced strict censorship of books and public speeches. Doesn't look promising, does it?

Although called as the "Age of Reaction", the next 40 years were peaceful; industry and trade received significant support - for technology, transportation, and financial systems it was a Golden Age. Life for many people and the economy as a whole improved significantly, creating a basis for a real democracy.

Combination of various administration/management systems

Usually, in a mature organization elements of all administration/management systems exist, having the following functions:

- A Forced Administration (FA) system usually play the role of a “skeleton” around which the organization is constructed. The FA includes people (usually strong administrators), structure and hierarchy, rules and regulations (written or not, both mandatory), and cultural elements. The organization’s skeleton can be rigid or soft; each type has its own advantages and disadvantages, as follows:
 - A rigid skeleton ensures an organization’s survival during difficult times, and increases its stability against destructive impacts. However, a rigid skeleton limits an organization’s dynamism and adaptability, as well as the initiative and creativity of its people.
 - A soft skeleton provides greater flexibility and adaptability to changing conditions. Too much freedom, however, can result in a loss of focus.
- An Economic Management (EM) system serves as the “flesh and muscle” of an organization and provides for its effective functioning, rapid growth, and the appropriate treatment and consumption of flows. It also connects various parts of the organization and resolves contradictions that arise inside the rigid skeleton.
- Elements of traditional regulations help establish the organizational culture
- Elements of charismatic leadership help motivate people.

Different administration/management systems can have additional relationships that are useful for an organization. Unfortunately, this can create the opposite effect as well. The FA system often takes charge and enforces a bureaucracy that can ruin the organization. The “treatment” lies in splitting the power between several institutions (as with the American principle of separating the legislative, presidential, and judicial systems).

The contradiction is as follows: FA systems are necessary to provide the skeleton of an organization, however (and as was shown earlier), the FA system is responsible for grounding the useful flows. This contradiction can be resolved, for example, by the redirection or redistribution of the grounded flows so that they work for the society. Other creative resolutions of this contradiction are possible.

Administration/management systems and an organization’s evolution along the S-curve

The evolution of an organization begins in Stage 1 - infancy or start-up - with the formation of its main business/mission/cause; this might be the production of something, a service of some

sort, research, the establishment of an entertainment group, etc. To run the business, certain flows have to be organized through the system (materials, energy, information, money, etc.). In the beginning the flow routes are not completely defined, and thus the entire structure is rather amorphous. Usually there is a recognized leader who serves to “cement” the organization. There might also be a small team (from 5 to 9 people) that the leader can manage. Power and assignments are distributed randomly, according to the principle of self-organization. Everyone does whatever is most needed at the moment (this requires people who are flexible and possess initiative). There are usually more functions than there are people to perform them - it is therefore important that people possess universal skills.

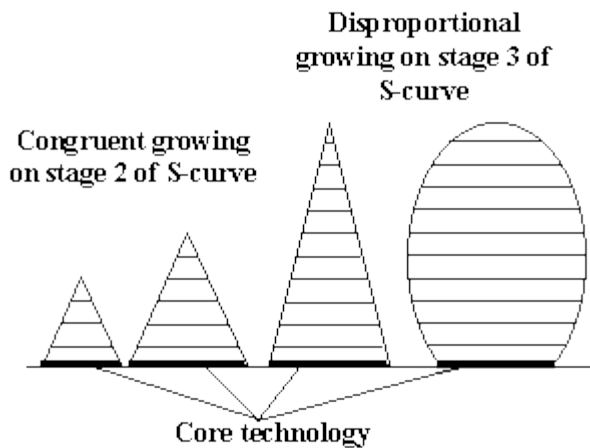
As the flow grows and properly channels the organization, its structure becomes certain and solidifies. The process of distributing functions, responsibilities and rewards (specialization and work distribution) takes place, increasing the overall effectiveness of the organization. New people with appropriate (and specialized) educations join the organization. Those having universal skills who were present during start-up leave or move to the top of the organization where there is always room for people with universal and entrepreneurial skills.

The transition to Stage 2 (rapid growth) is associated with the establishment of a well-defined structure both of the organization and its business. Organizational rules and regulations have been developed. The organization’s skeleton becomes coherent and logical, although it is not yet rigid (cartilage instead of bones): some parts may still be absent and complemented by amorphous, start-up elements. Gradually the skeleton becomes complete and includes all the elements necessary for normal operation along with some protective elements. By the middle of the second stage the skeleton is solid, however, it has points of growth and transformation (“hinges” or meristems) which allow for some change, such as re-orientation for the purpose of performing other functions. Resting on the rigid skeleton, other, softer parts of the organization (such as marketing or research) can successfully function while maintaining a high level of initiative (within certain limitations defined by the skeleton, however).

The structure of the organization becomes pyramid-shaped (hierarchical) with the core technology or business serving as the base of the pyramid. The hierarchy can become larger, multiplying itself in a nearly unlimited fashion. Typical growth at this stage is in the form of expansion (including conquest) and is fairly congruent - that is, the growth of the pyramid’s upper structures is in proportion with its base (there is no distortion to the pyramid shape).

The exhaustion of the resources required for business growth brings the organization to Stage 3 (maturity), where the growth of the pyramid base is very limited. The upper layers of the pyramid continue grow in accordance with the Parkinson’s law⁷⁷, however. Bureaucracy begins devouring the resources that belong to the business (for example, a “brain drain” of the best

people into administration and management takes place, providing them with better chances for lucrative careers). As a result, the pyramid becomes disproportionate or even loses its pyramid shape (see figure below). Growth of the bureaucracy requires a strengthening of the administration/management system, and results in a decrease in the quality of decisions.



Analysis of an organization utilizing flow models

We will now consider the following components of flows within an organization:

1. Distribution of monetary (financial) flows including:
 - Salaries and bonuses
 - Stocks and other monetary incentives
 - Mechanism of monetary distribution
2. Distribution of non-monetary incentives
 - Promotion
 - Prestige
 - Mechanism of non-monetary distribution
3. Distribution of flows of information
 - Related to the business or core technology
 - Related to the organization
 - Related to the top-most circles
 - Mechanism of flow distribution

4. Mechanisms of the distribution of resources
5. Organizational system of administration/management
 - Revealing the structures and interactions of the FA and/or EM
 - Identifying grounded flows
6. Conflicts, official and hidden competition for resources, and mechanisms and methods of competition (both documented and factual)
7. Revealing conflicts associated with flow distribution
8. Revealing the possibility of eliminating harmful or unnecessary flows.

Selected examples of practical models: the evolution of organizations along the S-curve

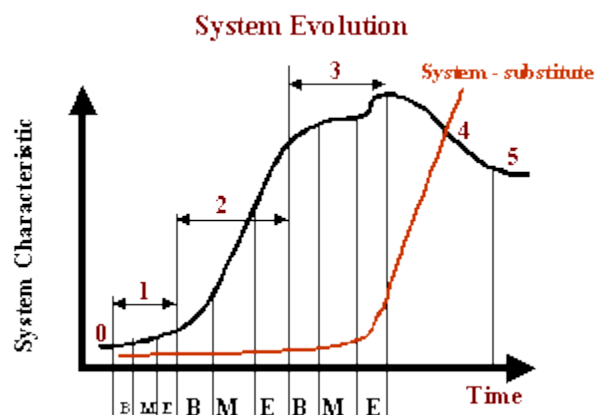
Definitions and assumptions

The following definitions apply:

*Organization*⁷⁸ - an enterprise (commercial or non-profit), government agency, professional or other association, social institution, educational institution, family, country, or human society⁷⁹ as a whole.

The *business* of an organization - its core technology, actual business, mission, cause or any main activity for which the organization was created; the “outcome” that justifies the consumption of resources.

Organization’s *S-curve plus* - the traditional S-curve extended to six (instead of the usual three) main stages. Stages 1, 2 and 3 are divided into sub-stages (the beginning, middle, and end) as follows⁸⁰:



B - Beginning of the stage
 M - Middle of the stage
 E - End of the stage

Each stage (sub-stage) of evolution⁸¹ is characterized by its own:

- Short description/features⁸²
- Typical objectives
- Typical mistakes

The main assumptions are as follows:

1. The majority of an organization's features are determined by its stage of evolution along the S-curve.
2. Selected features (such as the number and size of hierarchical levels) can drive an organization to the stage they represent.
3. The evolution of an organization strongly depends on the S-curve position of its main business.
4. At the same time, the business of an organization can be impacted (positively or negatively) by the S-curve position of an organization.
5. The "S-curve plus" presented above represents a natural evolution (without any purposeful corrections or other impacts).
6. The evolution of an organization may be influenced. The following induced deviations from the natural lifecycle have been identified:
 - Premature aging of an organization - the result of having the wrong management system and culture, which initiates stagnation before the resources of the business are exhausted.
 - Contrived Dynamic Prosperity - the result of purposeful cultural transformations that prevents natural aging.

Analysis of an organization's position on the "S-curve plus" and the development of recommendations for improvement⁸³

The analysis of an organization's position on the S-curve plus includes the following approaches:

- Analysis of the business
- Analysis of organization

An analysis of the organization's position includes the following steps:

- Utilization of the Organization Feature Matrix as a diagnostic tool to identify position
- Identification of typical objectives and mistakes for the identified position

- Identification of features that must be corrected to improve the situation

Utilization of the Matrix

The matrix contains several dozen features, including the main contradiction, the organization's size, management system, the organizational structure, prestige, morale and environment, discipline, and others. Each feature has a different content for each of the three main S-curve stages and desired Contrived Dynamic Prosperity stage.⁸⁴?

For each feature we have identified the stage that matches the organization's "reality" and have mapped it on the S-curve (see figure). The place where the features are concentrated shows the position of the organization.

Once the position is defined (Stage 1, end) we can identify the typical objectives and typical mistakes from the bank of knowledge. For the selected sub-stage this will be:

Typical objectives

1. Typical objectives for Stage 1 (start-up) as a whole:
 - Develop the business (technology) that can satisfy certain needs of the customer
 - Find and establish an initial market for the new business
 - Attract the financial resources necessary to begin production or services
 - Establish limited but steady commercial use of the new technology
 - Specific description related to Stage 1e (end):
2. In general, the business is ready for wide implementation including:
 - The principle parts of the design, theory, etc. have been worked out but there is no demand for the system; insufficient material has been invested for advertising, fabrication of the next level of production, building factories for long-term manufacturing, etc.
 - All tasks are oriented to accelerate the transition to the second stage, i.e., for wide-spread implementation.
 - This sub-stage smoothly transforms into the second stage of development when everything is ready for wide implementation and with the emergence of positive feedback for the development of the business.
3. Typical objectives for the core technology or business

- Selection of the best variants of the system for wide implementation, working it out to the necessary quality level.
- Search for auxiliary design solutions that provide the best satisfaction of needs - convenience of use, comfort, and the possibility of introducing the solutions to the market.
- Creating the main components of the reproduction technology to support reasonable production of the system.

4. Typical objectives for internal management

The main objective - develop a seed for the future Stage 2 organization, including:

- Formation of a structure typical for Stage 2, in particular, a system of distribution of responsibilities and delegation of work missing in Stage 1
- Solidification of the internal organizational culture, including the verbalization of unspoken rules and traditions in preparation for the next stage
- Preparing personnel that had been working in an informal environment (and who therefore have maximum initiative and minimum formal discipline) to work under a formal administration; preventing possible problems associated with people being dissatisfied with the new working conditions
- Selection and appropriate education of future management (management -2), i.e., selecting people with start-up experience who can also build and manage formal structures, productively communicate with the business environment, and who know the main rules of the games inherent in Stages 2 and 3
- Selection and hiring of “new players” and ensuring their smooth implementation into the existing organizational structure
- Development of formal, structured centers that later will be deployed into large departments

5. Typical objectives for external management⁸⁵:

- Testing (on a small scale) the reaction of the market or society to the new business or technology
- Final selection of the market sector (or social group) to be “attacked”
- Search for alliances and the building of a complete sale/distribution net
- Formation of cash reserve and building of a “cash cow” required for wide dissemination of the business
- Reducing the psychological inertia of potential customers, organizing the necessary PR, etc.

- Overcoming (if necessary) the direct and organized resistance of the business that will be rendered obsolete as a result of the new technology.

Typical mistakes

A. Typical mistakes in the development of the business or core technology

Typical mistakes in evolution are usually associated with deviations from a certain optimal strategy. The selection of this optimal strategy is usually a matter of the leader's intuition and experience in implementing something new. Deviations (mistakes) always require that contradictions be resolved quickly and creatively (TRIZ can help here).

The main mistakes are usually associated with the underestimation and insufficient utilization of creativity and intelligence, and the inability to solve problems requiring creative solutions without increasing the cost and complexity of the technology. In particular:

- Failure to understand the systemic nature of evolution, interconnections between useful and harmful factors, and attempts to work on separate elements without considering systemic effects
- Failure to understand the essence and role of contradictions; attempts to improve one feature without considering the features that will deteriorate as a result
- Attempts to capitalize on resources that are obviously limited, insufficient utilization of resources that are not obvious, failure to understand the possibility of resource transformation and of involving new resources from other areas (knowledge and technology transfer).

During Stage 1, when the business or core technology was relatively small in size, all necessary creative solutions were usually found by the creative leader. When the business grows, however, one individual cannot cover everything, yet people still expect this. Besides, an authoritarian leader often does not welcome the ideas of others. The result - the right solutions might be too late.

Specific typical mistakes are:

1. Too novel, that is, too many new (and sometimes not properly tested) ideas implemented in the technology that make it difficult to achieve an acceptable level of reliability, safety, etc. Besides, in most situations, customers cannot psychologically digest products or services that are too radically new.

2. Lack of new attractive features; implementation of small improvements without proper differentiation from existing products and services
3. "Perfectionism" - that is, endless attempts to improve the system, failure to "freeze" development and focus on production and sales
4. Premature release of technology with a high level of harmful effects (insufficient reliability, complex and expensive maintenance, etc.)
5. Attempts to imitate "mature" systems (systems in the second and third stages) and premature complication of the system before it is refined to its simplest variant.
6. The technology seems too simple and does not meet customer expectations of a "serious" product/service
7. Utilization of elements (materials, assemblies, technologies) that are satisfactory at this stage but do not have the resources for further development (or that would prevent mass production)
8. Attempts to immediately start with mass production that requires substantial investment that can be justified if mass demand is in place
9. Attempts to implement the system without providing the proper conditions, such as complementary systems and other systems in conjunction with the system

B. Typical mistakes in internal management:

The main mistakes are usually associated with a loss of control or with excessive control in an organization that still requires creativity (and people who are free to create). The main reason for mistakes is the failure to understand the transitional processes and problems associated with organizational changes. Basic mistakes are usually associated with inadequate (or wrong) leadership, in particular:

- A leader from Stage 1 (the founder, for example) manages the transition to Stage 2. In this case the danger is that s/he may lack knowledge and/or experience in business and management; s/he relies too much on intuition and personal connections, hates "bureaucracy," is accustomed to making voluntary decisions, etc.
- A typical administrator is hired who does not understand and does not accept the informalities of Stage 1; and who prefers an administrative style when it is unnecessary; who brings in his/her own team (who often conflicts with the people from Stage 1).

The specific mistakes are:

1. Lack of planning and administration
2. Attempts by people from the past (Stage 1) to fight against necessary changes
3. Premature introduction of a complex hierarchy, creating a bureaucracy that will later try to take over the business
4. Generating organized resistance. Unavoidable conflicts inherent to the process of radical change force the leader to make decisions that usually cause unhappy members of the group to organize. These sporadic groups try to maintain their existence (homeostatic effect), become self-sustainable, and become capable of supporting and escalating conflicts. In this case, even if the original conflict was resolved long ago, the “rebel” group will continue to interfere with management and originate new conflicts.
5. Establishing permanent structures to fight negative effects. Fighting for their homeostasis (survival) they might try to extend the existence of negative effects to justify their unlimited activities.

C. Typical mistakes in external management

These are usually the most dangerous mistakes as they can seriously jeopardize the reputation of the new business in the eyes of the customers, financial investors, the government, public, etc. The main reasons for these mistakes might be lack of marketing experience, failure to understand the details of the new business, and failure to understand its most attractive features and real value.

The specific mistakes are:

Dilettantism, that is, lack of understanding (or hating the idea) that marketing and sales require professional knowledge and experience. Attempts to judge the product or a service based on common sense or personal preferences

1. Failure to listen to the voice of the customer. Attempts to dictate to customers what they should do and like; excessive aggressiveness in approaching potential customers; overconfidence that the value of the new product or service is obvious
2. Groundless trust that the customer always knows better what he/she needs (this is especially wrong when trying to promote a “pioneer” product)
3. Choosing the wrong market sector, misinterpreting customer expectations
4. Attempts to sell raw technology; overselling

5. Premature focus on a variant that has been selected without proper research of the market needs and expectations
6. Luck of focus
7. Attempts to sell without proper support and packaging
8. Attempts to seek financing from powerful (and conservative) organizations that would be reluctant to take risk or to be involved in a small business

Conclusions

From the analyses of organizations according to the above approaches we have developed the following conclusions:

1. The analysis of features (see figure) that do not match the organization's position (i.e., that deviate) have revealed three dangerous problems:
 - Feature # 12 - Discipline still matches the previous evolutionary stage and is one of the factors that systematically disturbs the operation.
 - Feature # 35 - The relationship between the Board and the presidential structure did not change with the transition to the new stage. The Board interferes too much with the operation.
 - Feature # 29 - Top management's style is more suitable for Stage 3 - that is, top management does not understand the core technology, prefers to play bureaucratic games.
2. The analysis of typical mistakes revealed the following mistakes that must be corrected:
 - In business or core technology - # 1, 2,4,5,8.
 - In internal management - # 2,3,4.
 - In external management - # 2,7,8.

A set of recommendations has been created to correct the situation.

Case study. Controlling brokers at the Moscow Commodity Exchange⁸⁶ (MCE)

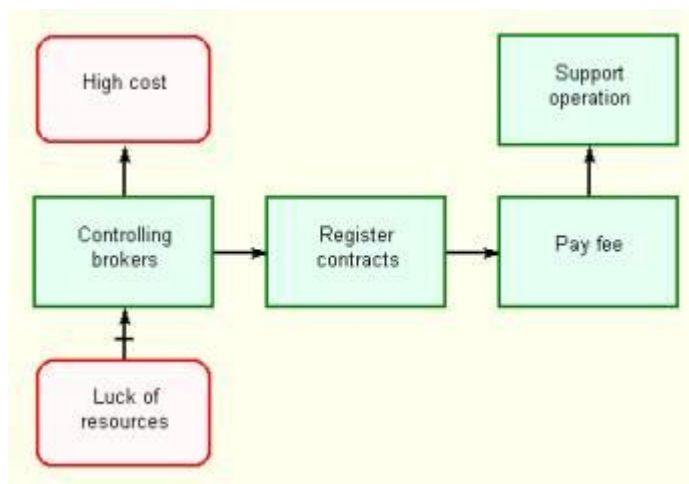
Problem Description

Every broker at the Moscow Commodity Exchange was required to pay a small fee for each deal closed on the Exchange⁸⁷. In spite of the fact that this fee amounted to a very small percentage of the deal, some brokers tried to avoid paying it. In a typical situation one broker would hear on the MCE floor about a potential purchase/sale of goods, he/she is interested in, then get

together with the broker offering these goods. According to the MCE rules, after brokers had agreed on a deal they were required to register the contract and pay the fee. Instead, however, the two brokers would conclude the deal without involving the MCE, and paid nothing. The uncollected fees became a problem as they were necessary to support the MCE operation. To ensure that this money was collected, several methods of controlling the brokers were attempted - these were costly and ineffective, however.

Problem Formulation

The following simple diagram was built:



An analysis of the diagram showed that the problem statement should be changed. Let us consider the list of Problem Statements/Directions for Innovation generated by the Knowledge Wizard:

1. Find an alternative way to obtain [the] (Controlling brokers) that offers the following: provides or enhances [the] (Register contracts), does not cause [the] (High cost), is not influenced by [the] (Luck of resources).
2. Find a way to protect [the] (Controlling brokers) from the harmful influence of [the] (Luck of resources).
3. Try to resolve the following contradiction: The useful factor [the] (Controlling brokers) should be in place in order to provide or enhance [the] (Register contracts), and should not exist in order to avoid [the] (High cost).
4. Find an alternative way to obtain [the] (Register contracts) that offers the following: provides or enhances [the] (Pay fee), does not require [the] (Controlling brokers).

- 4.1. Find a way to increase the effectiveness of [the] (Register contracts).
- 4.2. Find additional benefits from [the] (Register contracts).
- 4.3. Find a way to obtain [the] (Pay fee) without the use of [the] (Register contracts).
5. Find an alternative way to obtain [the] (Pay fee) that offers the following: provides or enhances [the] (Support operation), does not require [the] (Register contracts).
6. Consider replacing the entire system with an alternative one that will provide [the] (Support operation).
7. Find an alternative way to obtain [the] (Support operation) that does not require [the] (Pay fee).
8. Find a way to eliminate, reduce, or prevent [the] (High cost) under the conditions of [the] (Controlling brokers).
9. Find a way to eliminate, reduce, or prevent [the] (Luck of resources).

From the list, the Direction # 4 was selected for further consideration and additional Directions (4.1-4.3) have been generated:

4. Find an alternative way to obtain [the] (Register contracts) that offers the following: provides or enhances [the] (Pay fee), does not require [the] (Controlling brokers).
 - 4.1. Find a way to increase the effectiveness of [the] (Register contracts).
 - 4.2. Find additional benefits from [the] (Register contracts).
 - 4.3. Find a way to obtain [the] (Pay fee) without the use of [the] (Register contracts).

Suggested recommendation

Instead of trying to control the brokers, find ways to motivate them to register their contracts. For example:

- Provide each broker with an account; rate the brokers according to the number of registered deals
- Create a lottery using contract numbers as lottery chances

Bibliography

A. In Russian

Creative Imagination Enhancement (CIE) and TRIZ in the arts; Creative Education:

1. Altshuller, Genrich. "Vector of Fantasy." In *Fantasy 73-74*. Moscow: Molodaya Gvardiya Publishing House, 1975.
2. Altshuller, Genrich. *Course in CIE*. In *Inspiration on Demand*, Alexander Selutskii, and Gennadii Slugin. Petrozavodsk: Kareliya Publishing House, 1977.
3. Zlotin, Boris and Simon Litvin. "Enhancement of Creative Imagination." In *Basics of Technical Creativity for Trade Schools*. St. Petersburg: BNIIproftechobr, 1979.
4. Zlotin, Boris and Simon Litvin. "A Lesson in Fantasy." In *Want to Know Everything!* Moscow: Detskaya Literatura, 1980.
5. Altshuller, Genrich and Pavel Amnuel. *Fantasy Scale*. Sverdlovsk: IPK Minzvetmet, 1982.
6. Altov, Genrich and Valentina Zhuravlyova. *Ballad of the Stars*. New York: Macmillan Publishing Co., 1982.
7. Altov, Genrich. *And Suddenly the Inventor Appeared*. Moscow: Detskaya Literatura, 1989 (3rd ed., revised and updated). For the English translation, see Section B.
8. Zlotin, Boris and Alla Zusman. 33 articles published in *Youth of Moldova* newspaper, 1985-1988.
9. Zlotin, Boris, Alla Zusman and Svetlana Visnepolschi. *Young Pioneer* (Kishinev), 19 issues, 1985-1987.
10. Selutskii, A., ed. *Daring Formulas of Creativity*. Technology - Youth - Creativity Series. Petrozavodsk: Kareliya Publishing House, 1987.
11. Ivanov, Gennadii. . . . *And Start Inventing*. Vostochno-Sibirskoe Publishing House, 1987.
12. Zlotin, Boris and Alla Zusman. *A Month under the Stars of Fantasy*. Kishinev: Kartya Moldovenyaska Publishing House, 1988.
13. Selutskii, A., ed. *A Clue to the Labyrinth*. Technology-Youth-Creativity Series. Petrozavodsk: Kareliya Publishing House, 1988.
14. Selutskii, A., ed. *Rules for the Game that Has No Rules*. Technology - Youth - Creativity Series. Petrozavodsk: Kareliya Publishing House, 1989.
15. Zlotin, Boris and Alla Zusman. *The Inventor Came to Class*. Kishinev: Kartya Moldovenyaska Publishing House, 1990.
16. *Pedagogy: Journal of TRIZ* vol. 2.2.91 (special issue on creative education). Obninsk: TRIZ Association, 1991.
17. *Pedagogy: Journal of TRIZ* vol. 3.4.92 (special issue on creative education). Obninsk: TRIZ Association, 1992.

18. Vikentiev, Igor and Igor Kaikov. *Stairs of Ideas: TRIZ Basics, Examples and Case Studies*. Novosibirsk, 1992.
19. Shusterman, Michael and Zena. *A Science of Thinking for Children and Adults*. Moscow: Pedagogics-Press Publishing House, 1993.
20. Shusterman, Michael, Zena Shusterman and Valentina Vdovina. *A Cookbook for Kindergarten Teachers*. Norilsk: 1994.
21. Ivanov, Gennadii. *Formulas for Creativity*. Moscow: Prosveshenie Publishing House, 1994.
22. Shusterman, Michael and Zena. *How to Enter a Fairy Tail*. Moscow: Prosveshenie Publishing House, 1995.
23. Kryachko, V., ed. *TRIZ for Schoolteachers* (collection of articles). St. Petersburg, 1996.

Development of Creative Personality

24. Altshuller, Genrich and Igor Vertkin. *A Working Book on the Theory of Building a Creative Personality*. Kishinev: STC Progress in association with Kartya Moldovenyaska Publishing House, 1990.
25. Altshuller, Genrich and Igor Vertkin. "How to Become a Heretic." *Technology - Youth - Creativity Series*, ed. A. Selutskii. Petrozavodsk: Kareliya Publishing House, 1990.

Solving Scientific Problems

26. Altshuller, Genrich. "How Scientific Discoveries are Made." 1960. Later published in *Solving Scientific Problems*. Kishinev: STC Progress in association with Kartya Moldovenyaska, 1991.
27. Altshuller, Genrich, and Alexander Selutskii. *Wings for Ikar: How to Solve Inventive Problems*. Petrozavodsk: Kareliya Publishing House, 1980.
28. Zlotin, Boris and Alla Zusman. *Utilizing TRIZ Tools to Solve Scientific Problems*. 1985. Reprinted in the *Institute of Cytology and Genetics*, Novosibirsk, 1988.
29. Zlotin, Boris and Alla Zusman. "Solving Scientific Problems." In *Searching for New Ideas: From Insight to Methodology; The Theory and Practice of Inventive Problem Solving*, Genrich Altshuller, Boris Zlotin, Alla Zusman, and Vitalii Philatov. Kishinev: Kartya Moldovenyaska Publishing House, 1989.
30. Mitrofanov, Voluyaslav. "Tracing an Excited Molecule." In *Solving Scientific Problems*, Kishinev: STC Progress in association with Kartya Moldovenyaska, 1991.
31. Golovchenko, Georgiy. "Wind Power of Plants." In *Edges of Creativity*. Sverdlovsk: Sredne-Uralskoe Publishing House, 1989. Also published in *Solving Scientific Problems*, Kishinev: STC Progress in association with Kartya Moldovenyaska, 1991.

32. Tsourikov, Valery. "Target - Radio-Contact." In *Solving Scientific Problems*. Kishinev: STC Progress in association with Kartya Moldovenyaska, 1991. (First published in *A Path to Invention: Ten Steps*, Nikolai Petrovitch and Valery Tsourikov. Moscow: Molodaya Gvardiya. 1986.)
33. Mitrofanov, Volyuslav. *From Manufacturing Defect to Scientific Discovery*. St. Petersburg: TRIZ Association of St. Petersburg, 1998.
34. Zlotin, Boris and Alla Zusman. "A Brain for Evolution." In *Solving Scientific Problems*, Kishinev: STC Progress in association with Kartya Moldovenyaska, 1991. (To be published in English in *TRIZ in Progress 2*, Ideation International, 2000.)
35. Zlotin, Boris and Alla Zusman. "Searching for New Ideas in Science." In *Solving Scientific Problems*, Kishinev: STC Progress in association with Kartya Moldovenyaska, 1991.

Safety

36. Zlotin, Boris and Alla Zusman. "A Process for the Prediction of Potential Failures, Disasters and Other Undesirable Effects." Kishinev: STC Progress, 1991.

Social and business applications of TRIZ

37. Zlotin, Boris and Alla Zusman. "Patterns of Evolution of Organizations." In *Searching for New Ideas: From Insight to Methodology* by Genrich Altshuller, Boris Zlotin, Alla Zusman and Vitaliy Philatov; Kishinev: Kartya Moldovenyaska Publishing House, 1989.
38. Zlotin, Boris and Alla Zusman. "Evolution of Organizations." Kishinev: STC Progress, 1990.
39. Zlotin, Boris and Alla Zusman. "Evolution of Organizations and Social Systems." Paper presented at a seminar for TRIZ specialists, Simferopol, January 1992.
40. Vikentiev, Igor. "Techniques of Journalists: a Bank of Creative Principles." *Journal of TRIZ* vol. 3.1.92: 56-68.
41. Zlotin, Boris and Alla Zusman. "Evolution of Organizations and Social Systems." *Journal of TRIZ* vol. 93.1: 73-81.
42. Zlotin, Boris and Alla Zusman. "Creative Models for Business and Management." *Journal of TRIZ* vol. 93.1: 82-91.
43. Vikentiev, Igor. *Creative Principles for Advertisement and Public Relations*. Novosibirsk, 1993.
44. Kaplan, Len and Vladimir Shapiro. "Active TRIZ Management." *Journal of TRIZ* vol. 1.93: 63-66.
45. Faer, Sergey. *Strategic and Tactical Techniques in Election Campaigns*. St. Petersburg: Stolnigrad Publishing House, 1998.

B. In English

46. Altshuller (Altov), Genrich. *And Suddenly the Inventor Appeared*. Translated by Lev Shulyak. Worcester, Massachusetts: Technical Innovation Center, 1996.
47. Zhelev, Zheliu. *Fashizmut* (Social Science Monographs). East European Monographs, 1991.
48. Adizes, Ichak. *Corporate Lifecycles*. New Jersey: Prentice Hall, 1987.
49. Kaplan, Stan, Svetlana Visnepolschi, Boris Zlotin and Alla Zusman. *New Tools for Failure and Risk Analysis; an Introduction to Anticipatory Failure Determination (AFD) and the Theory of Scenario Structuring*. Southfield, Michigan: Ideation International, 1999.
50. Zlotin, Boris and Alla Zusman. "Evolution of Organizations: Evolution Along the S-Curve." To be published in *TRIZ in Progress 2*, Ideation International, 2000.
51. Zlotin, Boris and Alla Zusman. "Evolution of Organizations: The Underlying Theory and Models." To be published in *TRIZ in Progress 2*, Ideation International, 2000.
52. Proseanic, Vladimir, Svetlana Visnepolschi, and Vladimir Oleynikov. "Presidential Elections in Moldova." To be published in *TRIZ in Progress 2*, Ideation International, 2000.

Internet sites

- <http://www.triz.minsk.by>
- <http://www.triz-chance.spb.ru>
- <http://www.triz.ri.ru>
- <http://ideationtriz.com>

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Endnotes:

1. Edited by Vicki Roza
2. Revealed principles and/or patterns were required to meet certain criteria, such as be specific and instrumental, that is, clearly define actions required to achieve innovations.
3. A recent experience is the following: Several years ago we supplied five students of professor Glenn Mazur of the University of Michigan with the Ideator System software for evaluation purposes. In exchange we received reports of their work with the software. One student reported that he had used the software to successfully resolve a problem with his girlfriend.
4. See below.

5. Boris Zlotin and Alla Zusman, "Managing Innovation Knowledge," TRIZ in Progress (Ideation International, 1999): 123.
6. Smart Little Creatures Modeling (SLCM), Dimension-Time-Cost (DTC) operator, special course directed at Creative Imagination Enhancement (CIE).
7. TRIZ in Progress, 31.
8. Stan Kaplan, An Introduction to TRIZ, the Russian Theory of Inventive Problem Solving (Ideation International, 1996).
9. TRIZ in Progress, 43
10. TRIZ in Progress, 27
11. For a short time, Altshuller received limited support from the Soviet Society of Inventors and Innovators.
12. Altshuller's stories (published under the pseudonym Genrich Altov) became very popular, as did those of his wife, Valentina Zhuravlyova. A book of their stories was translated in English and published under the title Ballad of the Stars.
13. Altshuller conducted research in creative inheritance produced by a genius artist from Lithuania - K. Churlenis, who was born in the early 1900s. Altshuller showed how the artist intuitively used the systems approach, ideal vision, resolution of contradictions, and other creative approaches.
14. St. Petersburg Public TRIZ University was founded in 1972 and has been headed since then by Volyuslav Mitrofanov (for more about Mitrofanov, see the section entitled "Solving Scientific Problems").
15. Boris Zlotin attended the university in 1974-5, then began teaching there the following year. After teaching the CIE course he taught a course in the Patterns of Technological Evolution.
16. Boris Zlotin and Simon Litvin, "A Lesson in Fantasy," Want to Know Everything! (Moscow: Literature for Children Publishing House, 1980).
17. Obviously, this was a premature statement. Even today there is still a long way to go to convert the art of inventing into a science (and we personally doubt the possibility of full conversion. It is, however, a great target.)
18. Together with Pavel Amnuel
19. Esther Zlotin (1947-1998), after obtaining a professional music education, analyzed patterns in the evolution of music.
20. Research conducted by Boris Zlotin.
21. Vladimir Gerasimov, a highly-regarded TRIZ specialist as well as a cartoonist, developed methods for inventing new high-level cartoons.
22. Kirill Sklobovskiy completed a very interesting study on the patterns of evolution of the Golden Age of Russian poetry.

23. According to Altshuller's definition, a creative personality is found in an individual who devotes his life to the invention and promotion of something new.
24. TRIZ in Progress, 174.
25. Genrich Altshuller and Igor Vertkin, A Working Book on the Theory of Building a Creative Personality (Kishinev: STC Progress, in association with Kartya Moldovenyaska Publishing House, 1990. In Russian.)
26. TRIZ in Progress 2, (Ideation International, 2000): Appendix 2.
27. TRIZ in Progress
28. Genrich Altshuller (Altov), And Suddenly the Inventor Appeared, translated by Lev Shulyak (Worcester, Massachusetts: Technical Innovation Center, 1996).
29. Among others, attendees at summer schools included Sergey and Galina Malkin (Simferopol), Michael Shusterman and Leonid Shub (Norilsk), Yakov Skir (Minsk), Sergey Kravtsov (Semipalatinsk), Yuriy Buchkov (Novosibirsk), Vladimir Kovalev (Samara).
30. Boris Zlotin and Alla Zusman, A Month under the Stars of Fantasy (Kishinev: Kartya Moldovenyaska Publishing House, 1988. In Russian). Each chapter in the book represents one day (topic) and is complemented by special recommendations for teachers and parents. It also includes numerous educational problems and case studies.
31. 19 issues have been published. A book was compiled based on these, but was never published.
32. For more detail, see below.
33. Upon first examination, this the method is similar to a well-known method in the former Soviet Union called "problematic education," in which the teacher helps the student to come to a conclusion via a set of guiding questions. This method, however, requires a great deal of preliminary work to prepare an adequate set of questions for each topic. For our approach, a set of universal guiding questions were developed that could be used by teachers of any subject with minimal preparation.
34. Boris Zlotin and Alla Zusman, The Inventor Came to Class (Kishinev: Kartya Moldovenyaska Publishing House, 1990. In Russian.)
35. Michael and Zena Shusterman have published several books, including A Science of Thinking for Small Children and Adults (Moscow: Pedagogics-Press Publishing House, 1993), and How to Enter a Fairy Tail (Moscow: Publishing house Prosveshenie, 1995).
36. TRIZ specialists Marat Gafitullin, Anatoliy Gin, Victor Timokhov, and Juliy and Ingrid Murashkovski, as well as many others, were conducting notable work with children at the time.
37. More information about children's education is available on numerous Internet sites.
38. Genrich Altshuller. How scientific discoveries are made. Manuscript, 1960. Published later in the collection of works Solving Scientific Problems, Kishinev: STC Progress in association with Kartya Moldovenyaska, 1991. (In Russian).

39. In the collection of works Solving Scientific Problems, Kishinev: STC Progress in association with Kartya Moldovenyaska, 1991. (In Russian).
40. Voluyaslav Mitrofanov, From Manufacturing Defect to Scientific Discovery, (St. Petersburg: TRIZ Association of St. Petersburg, 1998).
41. Genrich Altshuller, Boris Zlotin, Alla Zusman and Vitaliy Philatov, Searching for New Ideas: From Insight to Methodology (Kishinev: Kartya Moldovenyaska Publishing House, 1989, in Russian): 124.
42. TRIZ in Progress.
43. Boris Zlotin and Alla Zusman, "A Brain for Evolution," TRIZ in Progress 2.
44. Boris Zlotin and Alla Zusman, "Evolution of Organizations," TRIZ in Progress 2.
45. In fact "subversion approach" was created first, and was instrumental in developing the idea of Problem Inversion for scientific problems.
46. The main customers were a mine and metal company and Norilsk, aviation and tank plants companies, and a company that produced lifting cranes. We later started working with new business organizations and political institutions.
47. Vladimir Proseanic, Svetlana Visnepolschi, Len Kaplan, Vladimir Shapiro, Sergey Malkin, Naum Feygenson, Alexander Limarenko, Alexander Chistov, Igor Kholkin, Vladimir Kovalev, Michael Shusterman, Lubov Kozevnikova and others.
48. A 40-hour seminar with 35 participants, conducted by Boris Zlotin and Alla Zusman.
49. TRIZ educators: Boris Zlotin, Alla Zusman, Alexander Chistov, and Len Kaplan
50. See Genrich Altshuller, Boris Zlotin, Alla Zusman and Vitaliy Philatov. Searching for New Ideas: From Insight to Methodology (Kishinev: Kartya Moldovenyaska Publishing House, 1989. In Russian): 124. Also see Boris Zlotin and Alla Zusman, Solving Scientific Problems (Kishinev: STC Progress in association with Kartya Moldovenyaska Publishing House, 1991. In Russian).
51. Boris Zlotin and Alla Zusman, "Evolution of Organizations and Social Systems," Journal of TRIZ 93.1: 73-81 (1993), and "Creative Models for Business and Management": 82-91.
52. Vladimir Proseanic and Vissarion Sibiryakov
53. Vissarion Sibiryakov
54. Igor Kholkin
55. Igor Vikentiev. "Techniques of Journalism: a bank of creative principles," Journal of TRIZ 3.1.92: 56-68
56. Igor Vikentiev. Creative principles for Advertisement and Public Relations.
57. www.triz.ri.ru and www.triz-chance.spb.ru
58. Igor Kholkin
59. Vladimir Proseanic, Svetlana Visnepolschi, Vladimir Oleynikov. See more detail in TRIZ in Progress 2000.
60. Sergey Faier. Strategic and tactical techniques in election campaigns.

61. In general, models of these types are understandable to people with a contemporary education. Sometimes, however, those whose education is based primarily in the liberal arts will reject these modeling processes as being too “mechanistic” in nature. We address these objections by explaining that it is through just such a mechanistic (i.e., technological) approach that our modern-day world has come into existence, and because of its effectiveness we cannot ignore it. One of the 20th century’s most interesting scientists, Alexander Bogdanov, remarked: “The mechanical side of life is simply that which we have managed to explain. “Mechanism” means something that we understand.” We are in full agreement with this statement.
62. We define an organization’s business as its main business (for non-commercial organizations, its mission or cause). This can be any main activity for which the organization is created - i.e., the “output” that justifies the consumption of resources.
63. For more on this subject see Boris Zlotin and Alla Zusman “Managing Innovation Knowledge,” TRIZ in Progress: 123-140
64. An integrated, net-like innovation knowledge-base tool containing numerous pre-determined associative chains that guide the user in the direction of the highest degree of ideality and feasibility. The tool is structured to allow quick access to the portion of the knowledge base dedicated to resolving a specific problem or class of problems. For more detail see Boris Zlotin and Alla Zusman “An Integrated Operational Knowledge Base . . .,” TRIZ in Progress: 114-122, and “Managing Innovation Knowledge,” TRIZ in Progress: 123-140.
65. Single models integrated into inter-related concepts (theories).
66. Mentioned previously in the section entitled “Software for Non-Technical TRIZ Applications.” More detail can be found in TRIZ in Progress 2 (Ideation International, 2000).
67. For more information see TRIZ in Progress (Ideation International, 1999): 27-32.
68. S-curve plus including 9 sub-stages. First was published in the educational materials prepared for TRIZ specialists’ seminar in February 1992, Simferopol.
69. Some models were published in Boris Zlotin and Alla Zusman, “Evolution of organizations and social systems,” Journal of TRIZ 93.1 (1993): 73-81. For more detail see TRIZ in Progress 2.
70. Lamarck (1744-1829) a naturalist and Darwin’s predecessor, developed the first integrated concept of natural evolution.
71. A problematic description presents an organization or other system as a set of inherent problems that must be solved to improve the current situation.
72. The validity of this assumption is limited (more detail later is presented later in this paper).
73. Some of which can be beneficial to the society, however.

74. The Communist government was constantly trying to convince Soviet citizens that their lives were poor because they did not work enough. "Work better and you will live better" was the motto - in reality, however, "working better" did not make life better. Instead, it led to increased environmental damage and waste of resources. People in the USSR felt this intuitively, and thus their work mostly resembled a decades-long Italian strike.
75. The Russian perestroika brought about many sad jokes on this subject. In one, a little girl who had learned about Lenin and the October Revolution in kindergarten shared her understanding of the situation with her parents: "Lenin hated rich people, that is why we are all poor."
76. Zheliu Zhelev, *Fashizmut (Social Science Monographs)*. East European Monographs, 1991.
77. C. Northcote Parkinson (1909-1993), British historian, author and formulator of "Parkinson's Law," the satiric dictum that "Work expands to fill the time available for its completion".
78. See also the definition of social system in the previous section.
79. The material in this section does not necessarily cover the complete range of possible organizations. It is not, for example, directly related to a family or to civilization as a whole.
80. As mentioned earlier, the extended S-curve was presented by Zlotin and Zusman at TRIZ seminars held in late 1980s. In 1994 we discovered the book *Corporate Lifecycles* by Ichak Adizes and published in the end of 1987. This book contains the best phenomenological description of organizational behavior and recommended strategies on each of ten well-defined stages. It does not focus on deep mechanisms that determine that behavior, however.
81. See the complete description of each stage and its parameters in TRIZ in Progress 2.
82. For main stages only.
83. The following analysis was done for the Moscow Commodity Exchange.
84. See the matrix (with over 25 main features) in TRIZ in Progress 2.
85. We define external management as all activity directed toward interaction with the business environment, including establishing strategic alliances, acquiring appropriate financing, establishing the market, etc.
86. This problem was given by the MCE Board of Directors for the purpose of evaluation of the TRIZ methodology.
87. In the beginning of its existence, MCE operated rather as a trade organization.