INTRODUCTION

Introduction

Learning Objectives

Methods for generating breakthrough concepts and ideas in innovation are the key to success.

In my experience, innovation challenges that had stumped highly skilled and experienced engineering teams for months or even years were often resolved in just a matter of days or hours.

For example, the cause of an electric arc between the phases of an electric connector in an airplane fuel pump, which developed after 2-3 years of service, was neither successfully identified nor eliminated for 10 years. However, after just 2 hours of discussion in my class, the issue was resolved. The Boeing Company was able to improve the reliability and safety of the connector and was granted several patents.

A Boeing newsletter published the following about another case: 'For John Higgs, Chief Project Engineer for the 767 Tanker Transport, the TOP-TRIZ seminar helped refocus the team's approach to a technical problem that had stumped a group of top Boeing engineers for three years. "By applying TRIZ," says Higgs, "the class came up with two complete solutions that my team had never considered." These solutions helped the company secure new orders while saving millions of dollars.

In another Boeing article was described a wing spar cord manufacturing problem, which had been known for decades. In my class, it was discussed in just one hour. The implemented solution has saved the company $63 million by January 2025.

It was not a magic, we used TOP-TRIZ, the modern generation of TRIZ. Actually, TOP-TRIZ became the way my readers and I think about problems, and I am confident that it will help you as well.

Engineering Innovation is a Sinergy of
Subject Matter Experts' Knowledge + Creativity

I would like to emphasize that in all the cases I was involved in, the teams were highly knowledgeable. However, their Achilles' heel was the ineffectiveness of the creativity methods they were using to solve their challenging problems, such as brainstorming, the 5 Whys, fishbone diagrams, and other techniques relying on random creativity.

This book is focused on systematic engineering creativity. You will learn a TOP-TRIZ process and will be able to invent better engineering products and manufacturing processes and solve challenging engineering problems. The power of the methodology is based on generalization of world-wide breakthrough inventions making it quintessential guide for addressing a wide range of objectives, including technology forecasting, inventing the next generations of products, addressing challenges in new product development, improvement of quality, safety, reliability, and revealing and eliminating the root causes of a failure.

You will learn:

- Methods for developing breakthrough concepts and ideas, as TOP-TRIZ is based on the generalization of groundbreaking global inventions.
- A series of steps and guidelines for problem identification, including a systems approach and function modeling, to identify a comprehensive set of problems worth solving.
- Six types of innovation problems and guides for solving them faster than using conventional methods.
- The Conflict Solving Algorithm to achieve desired improvements without deteriorating the conflicting function. Even the most challenging problems involving contradictions can be solved routinely without making trade-offs.
- Techniques for eliminating harmful actions and converting them into useful actions.
- Methods for introducing new functions or replacing existing ones with more effective alternatives.
- Summarized trends in the development (evolution) of hundreds of products for reliable technology forecasting, allowing you to invent the future of your products.
- Steps to maximize the use of available resources to develop better products at lower costs.
- Documenting the steps of the solution process.
- Using AI as a universal subject matter expert.
- Solving design and production problems without compromising functionality.
- Developing winning concepts more quickly.

In this section, you will receive a brief overview of the history of TRIZ and TOP-TRIZ.

In Section 2, you will learn Tool-Object-Product (TOP) Function Analysis, along with the modeling of useful functions, insufficient functions, absent functions, harmful functions, and unknown harmful functions.

In Section 3, you will learn Problem Formulation. Its steps guide the identification of the complete set of problems within a challenge, with each problem described as a single function, or as two functions in the case of a conflict.

In Section 4, you will learn Ideal Ways or ideal strategies for eliminating components associated with disadvantages, along with guides for formulating problems related to their removal. This method is crucial for simplifying products and processes while reducing costs.

TOP-TRIZ classifies formulated problems into six types, providing algorithms for each to develop a comprehensive set of ideal solutions. This ensures that all possible avenues for innovation are explored and addressed in a systematic manner.

In Section 5, you will learn how to solve problems classified as Absent or Insufficient Action, which require introducing a new function or finding a more efficient way to perform an existing one. The key to this method is a guide for introducing the missing action and identifying potential sources of the action from available resources.

In Section 6, you'll find a list of the most commonly used fields (the physical nature of actions). This list helps to overcome preconceived notions and background barriers when selecting the possible nature of actions.

In Sections 7 and 8, you will learn the TOP-TRIZ Conflict Solving Algorithm. A problem is classified as a conflict if an attempt to eliminate a harmful function results in the deterioration or even disabling of a useful function. The TOP-TRIZ Conflict Solving Algorithm is a step-by-step guide that helps develop breakthrough solutions to conflicts by completely eliminating harmful functions, while preserving and, at times, even enhancing the useful functions.

In Sections 9 and 10, you will learn how to solve problems classified as Harmful Actions, which result in harmful or unnecessary products. The Harmful Action Elimination methods will guide you in eliminating harmful functions and, when possible, converting those harmful functions into useful ones.

In Section 11, you will learn the TOP-TRIZ method for uncovering the root causes of a failure. This method involves inventing ways to recreate the failure. By treating the harmful product of a failure as if it were a desired product, you can apply the full power of TOP-TRIZ to invent potential mechanisms behind the failure."

In Section 12, you will learn solving problems classified as a Detection or Measurement, where there is a need to introduce or improve detection or measurement. Since detection or measurement is often used as an auxiliary function to control an important process, the best approach is to eliminate the need for detection or measurement. If that’s not possible, the method guides you in building the most effective detection or measurement system.

In Section 13, you will learn Technology Forecasting, which is useful when there is a need to invent the next product generation, formulate new problems for further improving an existing system, maximize the utilization of new solutions, develop a roadmap for innovation and marketing strategy, or create concepts for a patent umbrella. Unlike conventional roadmapping of product innovation, which relies on approximating trends of certain parameters without understanding how these changes can be achieved, TOP-TRIZ technology forecasting helps invent future product generations based on the evolutionary trends of many products from their inception to decline. Statistically, there is a very high probability that your product will follow similar steps in its evolution.

In Section 14, Concept Evaluation, you will learn how to assess and improve developed ideas.

Random Creativity is a Conventional Approach to Concept Development in Innovation

Engineers generate new ideas based on their personal background; however, no one is a subject matter expert in everything. It is difficult to come up with the best solution to a challenging problem if it is outside of the background of the person attempting to solve it. But even when the best solution to a challenging problem is within the background of the problem-solver, it is still difficult to overcome preconceived notions and psychological barriers.

When facing a challenge, it’s natural to generate alternative ideas by asking, 'What if we try this?' or 'What if we try that?' This approach works well when all possible alternatives are known, and the task is simply to list them and choose the best option.

If none of the known alternatives are suitable, knowledge and creativity become crucial for modifying existing ideas or developing entirely new ones. This problem-solving technique is commonly known as the trial-and-error method. However, the best solution often remains undiscovered.

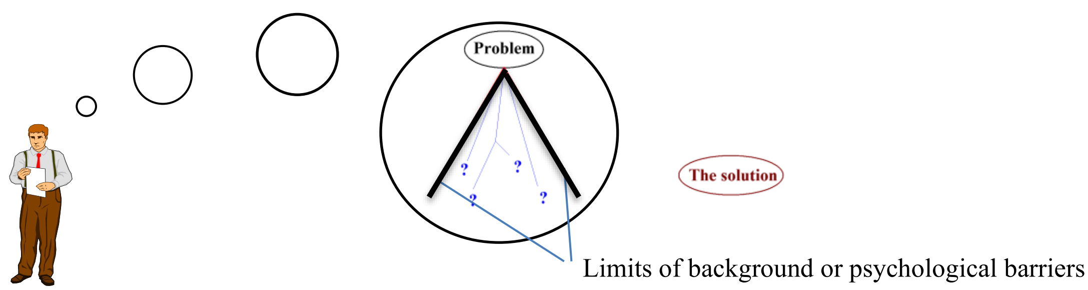


Fig. 1.1

Common thinking accepts recommendations such as “be creative,” “think about your problem all the time,” “hire ‘out-of-the-box’ thinkers,” etc.

Even when the best solutions are within a problem solver's background, it might take months or even years to discover them due to the lack of a clear guide for fostering creativity and generating innovative ideas.

Brainstorming

Alex Osborn, the creator of brainstorming, suggested making a team of people with different background work on a problem. His rules center around how the members of a team should work together. Recommendations for participants in a brainstorming session include focusing on creativity and generating as many ideas as possible.

- “Be creative. “Wild” ideas are fine.
- Generate as many ideas as possible.
- Combine and improve previous ideas.
- Do not criticize.”

Fig1.2

Selecting participants with diverse backgrounds increases the likelihood that the best solution will fall within the expertise of at least one team member. "Wild" ideas should help break free from preconceived notions, but there is no guide on how to foster creativity and generate such ideas. So, each participant still relies on the trial-and-error method to generate ideas. It remains a process of random idea generation without any structured guidance to analyze challenges and formulate problems worth solving. It lacks recognition of the six distinct types of problems in innovation and provides no framework for solving any of these problem types.

As a result, brainstorming and brainstorming based methods of idea generation are both ineffective and inefficient, delaying new product development for a long time. Additionally, it is impossible to rely on a plan that depends on random creativity. With limited time for a project, teams are forced to select their best solutions, often doubting whether they are the best possible choices, or if all the problems worth solving have been identified and addressed, leaving them vulnerable to competitors. In the worst cases, challenges remain unsolved for months or even years. I have been asked many times to facilitate solutions for such long-standing 'unsolvable' challenges.

5-Whys

According to AI, the 5-Whys method is a problem-solving technique used to explore the root cause of an issue by repeatedly asking "Why?"—typically five times. The idea is that by asking "Why?" multiple times, you can uncover the underlying cause of a problem. This method helps to solve the simplest problems, leaving many problems unsolved for months or even years.

"I keep six honest serving men
  (They taught me all I knew),
Their names are What and Why and When
  And How and Where and Who."

"I know a person small—
She keeps ten million serving men…"

   "One million Hows, two million Wheres
And seven million Whys!"

In this excerpt from Rudyard Kipling's poem, published in 1902, he reflects on the six fundamental questions—What, Why, When, How, Where, and Who—that guide inquiry and understanding.

Fishbone Diagram

One commonly used method for root-cause analysis is constructing Ishikawa diagrams, also known as fishbone diagrams or cause-and-effect diagrams, developed by Kaoru Ishikawa in 1968.

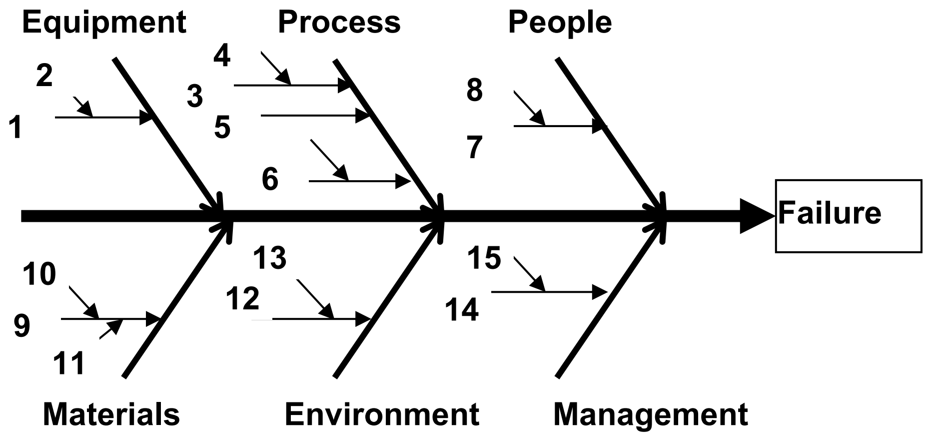


Fig. 1-3 An example of Fishbone Diagram.
(http://en.wikipedia.org/wiki/File:Ishikawa_Fishbone_Diagram.svg)

The entries on the failure diagram, grouped into categories as shown in Fig. 1-3, represent factors or events that could contribute to the failure. An entry could be the actual cause of the failure if it is a one-step cause-effect relationship. However, this method is ineffective when the failure results from a sequence of events. In some cases, the number of entries in the diagram can exceed a hundred or even several hundred. The vast number of possible combinations makes it impractical to consider all of them. As a result, the selection of entries to explain the mechanisms leading to the failure can seem random. Additionally, due to psychological barriers within teams, the diagram may often overlook important factors or events that actually play a role in the development of the failure.

Scientific Approaches in Problem Solving

The scientific approach to solving problems involves using algorithms or, at the very least, checklists developed as generalizations of vast amounts of specific information. This aligns with Francis Bacon's description of the process for advancing practical science in *Novum Organum*: *"The sciences depend upon a vast multitude of observations, and upon a thorough examination of particular facts; and by means of these, we must proceed to the discovery of general principles."*
For example, a scientific approach to solving quadratic equations offers the following algorithm, which you have learned in middle school.

Problem

$3x^2 = 288 - 5x \quad x = ?$

Solution

1. Classify the problem. It is a quadratic equation.

2. Put the problem in the standard form.

   $ax^2 + bx + c = 0$ $3x^2 + 5x - 288 = 0$

3. Use general solution.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

4. Enter your data. $x = \dfrac{-5 \pm \sqrt{5^2 - 4(3)(-288)}}{2(3)}$ $x_1 = 9$,

   $x_2 = -10\,{}^{2}\!/_{3}$

At the end of the 1990s, while I was conducting my TOP-TRIZ course at the Marshall Space Flight Center in Huntsville, AL, a consulting company had just completed the installation of a system for computerized brainstorming and asked me to provide a problem to test it. The system consisted of 10 computers, allowing up to 10 people to participate in a brainstorming session. All participants could see the ideas suggested by others, as well as contribute their own ideas and improve upon those of others simultaneously. By keeping the authors of ideas anonymous, the system ensured complete privacy, enabling participants to propose even the wildest ideas without fear of judgment from their boss. With each participant suggesting at least one idea in 5 minutes, the system could generate a minimum of 10 ideas!

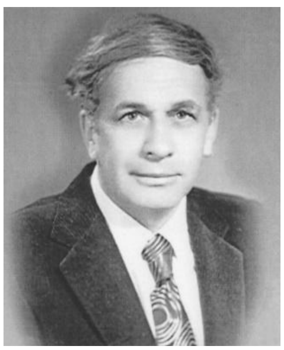
Why wasn't this problem considered good enough? Isn't it valuable to generate as many ideas as possible, as quickly as possible, while encouraging wild ideas and combining and improving upon the ideas of others? You know the answer. There are just two roots. Generating as many ideas as possible is a waste of time. The problem was creative until the algorithm to solve this type of problems was developed by Gerolamo Cardano, a talented and experienced Italian mathematician, and his algorithm was based on the generalization of his vast experience in solving such problems. Cardano's algorithm was published in 1545, making it possible to solve this type of problem routinely, step-by-step and very quickly.

Today, we use the version of the formula published in 1637 by René Descartes, the renowned French scientist. In the 18th century, the quadratic formula was included in university curricula. In the 20th century, it was introduced in high schools and later in middle schools. We can predict that, in the future, it may be taught in elementary schools.

Problems in innovation also have a limited number of best solutions.
Why waste time generating as many ideas as possible when we could follow a step-by-step algorithm that leads directly to the best solutions?

Science to Invent: Theory of Inventive Problem Solving

The first goal of Genrich Altshuller, the creator of TRIZ (a Russian acronym of Теория Решения Изобретательских Задач that means Theory of Inventive Problem Solving) was to eliminate randomness in idea generation and develop a method guiding people invent as most experienced inventors. In line with Francis Bacon's suggestion that any practical science has to be developed as generalization of vast amount of specific information, Altshuller started development of the first practical scientific approach to invent with analysis of hundreds of thousands of patent disclosures, because each patent disclosure describes a problem and a proposed solution to it. It was one of his greatest ideas to focus on studying inventions instead of studying psychology of creative thinking.

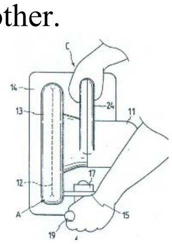


1925-1998

Genrich S. Altshuller began in 1946 an in-depth study of the best inventions and the history of the development of successful products and technologies in different industries.
He created TRIZ, a science to invent, published 14 books and hundreds of papers.
Today TRIZ is used in more than 50 countries.

40 Inventive Principles
The first stage of Altshuller's work took about 15 years, including a four-year break—during which time he was a political prisoner in one of Stalin's Gulags. Starting in 1946, he first focused on studying inventions aimed at solving conflicts or contradictions, (I use these words as synonyms) which are one of the most challenging type of problems that engineers encounter in innovation every day. Usually, an attempt to improve a feature or a function affects another feature or function. In most cases, engineers resort to trade-offs, sacrificing one or both conflicting functions.

For example, the handle of a circular saw needs to be aligned with the blade to ensure straight cuts. However, this positioning makes it more difficult to lift the saw from a shelf and to carry it. On the other hand, positioning the handle in line with the saw's center of gravity makes it easier to carry the saw but compromises the ability to make straight cuts. This illustrates a conflict between two functions, where improving one inevitably worsens the other.



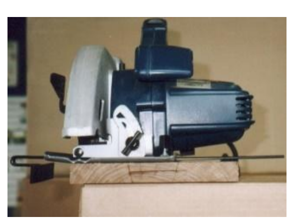


Fig. 1-4 Fig 1-5

A trade-off, compromise, or optimization is often suggested as a solution to such conflicts, typically involving the sacrifice of one function or even both. In this case, the position of the saw's handle was optimized to be located between the blade and the center of gravity, compromising both conflicting functions: the saw hinders making straight cuts, and it is not the easiest to carry.

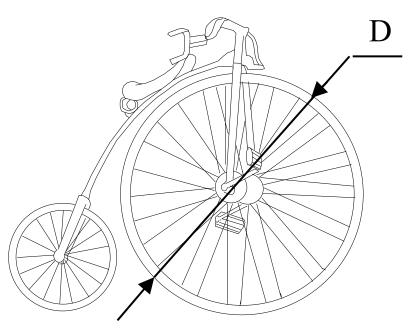
Trade-offs are not the best solutions to conflicts. We will discuss steps to develop solutions that ensure the saw can make both straight cuts while also providing the easiest portability.

In any conflict, there is a single parameter controlling both of the conflicting functions. This parameter needs to have one value for the best performance of one function and a different value for the best performance of the conflicting function. The need to establish two different values for the same parameter is what Altshuller called a *physical contradiction*, which is the root cause of the conflict.

The parameter responsible for the conflict in the circular saw is the position of the handle. To make a straight cut, the handle must be aligned with the blade, while for easier portability, it must be aligned with the saw's center of gravity.

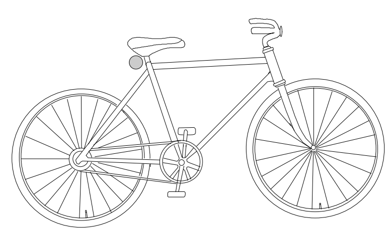
Altshuller also discovered that when a system reaches its limits, preventing significant improvement, there is a conflict behind the limit. Typically, resolving such conflicts takes a considerable amount of time.

For example, the speed of a bicycle, with the pedals attached to the front wheel and the seat positioned above it as shown in Fig. 1-6, was increased by enlarging the diameter (D) of the front wheel, which reached 5 feet by 1846.



1846.

Fig. 1-6



1884. Safety bicycle.

Fig. 1-7

It was already not a safe ride when the rider had to sit 5 feet above the road. With this design, it was impossible to increase the wheel diameter significantly, let's say, to 10 feet to further boost speed. The safety concerns of sitting the rider so high would make such a design impractical. Additionally, the rider would not be able to reach the pedals.

Behind the design limitation lay a conflict between two key functions: speed and safety. However, this was only the surface-level understanding of the problem.
The parameter that controlled both conflicting functions was the diameter of the front wheel. A larger diameter was necessary to increase the bicycle's speed, while a smaller one was required to improve safety. This created a physical contradiction, where the front wheel's diameter needed to be two different sizes simultaneously. It took many years to resolve this conflict, eventually leading to the invention of the safety bicycle (shown in Fig. 1-7), which dramatically increased speed while also improving safety. (We will discuss the application of TOP-TRIZ to resolve this conflict in Section 8.)

Altshuller referred to inventions like this—where inventors managed to achieve the best performance in both conflicting functions, or at least improve one function without compromising the other—as *'breakthrough inventions*.'

Altshuller discovered that when optimization or compromise is not feasible, such conflicts often remain unresolved for extended periods—sometimes even for years. For example, in one case, it was necessary to replace an existing component with a larger one. However, this replacement was associated with prohibitive costs. The physical contradiction in this problem was that the component needed to be new in order to provide the required performance, but it also had to remain the same in order to avoid the significant costs associated with replacement. Since a tradeoff was not possible, the problem remained unresolved for several years until TOP-TRIZ was applied.

After analyzing about 200,000 patent disclosures, Altshuller discovered that roughly 20% of the inventions were breakthrough solutions to conflicts, achieving necessary improvements without any deterioration of the conflicting functions—without trade-offs or compromises.

All these solutions involved changes that inventors made to their products or systems. Generalizing the changes in products suggested by about 40,000 breakthrough inventions led him to identify 173 typical modifications. He grouped these modifications into a set known as the *40 Inventive Principles*, or, in a literal translation, the *40 Principles to Solve Technical Contradictions*. In addition, Altshuller developed a two-dimensional Contradiction Matrix, which includes 39 of the most common parameters or features that require improvement or are likely to deteriorate. (The Contradiction Matrix and 40 Inventive Principles are included in Appendix.)

To match a conflict from a real-life problem with one in the Matrix, a user selects the parameter that needs improvement and the parameter that would be deteriorated by the improvement. In this intersection, the Matrix will offer a cell with up to four Inventive Principles that are most used to solve similar contradictions. Although the Matrix provides solutions for about 1,200 of the most common contradictions in hardware engineering, it is often challenging to match a real-life contradiction with one in the Matrix, as the 39 parameters may not be sufficient to cover all possible scenarios.

The 40 Principles and the Matrix have been described in many publications. Due to the simplicity of the 1971 method, it has become popular among some consultants, leading to the misconception that the Inventive Principles are synonymous with TRIZ or, at the very least, the foundation of modern TRIZ. In reality, the 40 Principles were just the starting point in the development of TRIZ.

In recent years, there have been attempts to increase the number of parameters in the Matrix and add more Principles. However, these efforts failed to address the underlying reasons why Altshuller completely abandoned the Inventive Principles and the Matrix, replacing them with Classical TRIZ, which he had been developing until 1985.

Altshuller believed that if inventors had known these Inventive Principles, many of the analyzed inventions could have been created much earlier. However, by the early 1970s, he realized that although his method for solving conflicts using the Inventive Principles and the Matrix was far more effective than random creativity, such as brainstorming, his goal of eliminating randomness in solving contradictions had still not been fully achieved. He also understood the reasons behind this limitation.

First, Altshuller realized that most problems could not be solved in a single step from problem to final solution. As he wrote in his book *And Suddenly the Inventor Appeared*, most problems require a combination of two or more Principles. He explained, "Ten thousand two-method combinations can be produced out of one hundred methods! You can imagine the number of solutions we can get if we use a combination of three, four, or five methods. So, let us stop solving problems by sorting out different solutions or using the trial-and-error method."

Second, the Matrix helps identify a conflict between two functions—when one function is improved, the conflicting function is affected. However, Altshuller discovered that a conflict between two functions is merely a surface-level understanding of the problem. In any conflict, there is a single parameter controlling both of the conflicting functions. This parameter needs to have one value for the best performance of one function and a different value for the best performance of the conflicting function.
The need to establish two different values for the same parameter is what Altshuller called a *physical contradiction*, which is the root cause of the conflict. He questioned why we should try to solve a conflict without understanding its root cause. To address this, Altshuller began developing an algorithm to resolve conflicts, which would lead a user from understanding the conflict between two functions to recognizing its underlying physical contradiction. There are just a few rules to separate physical contradictions. Without knowledge of TRIZ, engineers are trained to optimize the functions of a conflict or adjust the values of the parameter controlling those functions. Trade-offs, however, are not the best possible solutions. The ideal or breakthrough solution should allow for the improvement of one function without any deterioration of the other. Yet, in many cases, a trade-off is not possible, leaving problems unresolved for months, years, or even decades.

Third, how can we match the vast number of parameters possible in real-world problems with just the 39 parameters of the Matrix? Attempts to increase the number of parameters to 50 or 100 still fall short of capturing all potential parameters. Altshuller solved this problem by inventing a way to describe conflicts using symbols. With this approach, any conflict can be described without relying on specific parameters at all.

Fourth, each Matrix cell offers only up to four principles, but not all the principles that could be used to solve a respective contradiction. Inventive Principles were the first and very primitive method for solving contradictions without addressing their root causes.

Classical TRIZ

Altshuller completely abandoned the Inventive Principles and the Matrix, replacing them with Classical TRIZ, which he had been developing until 1985. He even omitted mention of the Inventive Principles and the Matrix in his book *To Catch an Idea*, his last book on problem-solving.

Classical TRIZ, as developed by 1985, addresses five types of problems in innovation, with conflicts being only one of these types. Altshuller regarded ARIZ (the Russian acronym for Algorithm for Inventive Problem Solving) as his next-generation conflict-solving method. He continuously worked on developing and refining ARIZ until 1985, when his health deteriorated, forcing him to halt further work on Classical TRIZ. Up until then, he had been publishing new versions of ARIZ almost every year.
ARIZ-85 is an algorithm guiding step-by-step from a conflict between two functions to its deepest problem domain called physical contradiction, where a parameter controlling both conflicting functions has to have two values. This method proved so powerful that just a few rules of Physical Contradiction Separation replaced the entire set of Inventive Principles.

Until 1971, Altshuller considered a problem "inventive" only if it involved a contradiction. Later, however, he identified four additional types of inventive problems beyond conflicts. These are: 1) the need to eliminate detrimental or harmful functions; 2) the need to introduce new functions or improve existing ones; 3) the need to introduce or enhance detection or measurement capabilities; and 4) the need to invent next-generation products, thus addressing a wider array of innovation challenges.

Altshuller introduced Substance-Field Models (or Su-Field models) to represent conflicts and other types of inventive problems using symbolic notation. This approach was as revolutionary in innovation as the use of symbols in mathematics, which led to the development of algebra, or the introduction of symbolic notation in chemistry.

By employing symbols to describe problems and their solutions, Altshuller developed a set of 76 Standard Solutions. These were based on his analysis and generalization of ideal solutions found in patent disclosures of groundbreaking inventions worldwide. The Standard Solutions provided a structured framework within TRIZ, enabling inventors and engineers to systematically approach and solve complex problems by leveraging proven patterns from highly innovative solutions.

Altshuller discovered that all products and technologies tend to follow similar developmental steps over time. Based on this insight, he proposed using these steps as trends, known in literal translation as the Laws of Engineering System Evolution (LESE), to guide the invention of next-generation products. LESE outlines predictable patterns in technological evolution, offering a roadmap for anticipating and shaping future innovations in a systematic way.

With his Classical TRIZ, Altshuller moved closer to his goal to eliminate randomness in idea generation. However, as with any pioneering scientific framework, there was ample room for further development.

This became clear to me from the very beginning of my extensive professional TRIZ training and consulting, which started when I co-founded one of the first private companies in Kishinev, in the former Soviet Union, as soon as private enterprises were permitted, dedicated to TRIZ training, consulting, and further development of the methodology. Approximately 3,000 engineers participated in our month-long TRIZ training courses, held in Kishinev or at on-site locations, using a curriculum specifically approved by Genrich Altshuller himself. Guiding participants to solve their real-life problems and answering their questions revealed that Classical TRIZ needed further development to make it more powerful while making it easy to learn and apply.

Classical TRIZ lacked a structured approach for problem formulation. While users learned to model problems, they often struggled to identify which specific problem to model. The various TRIZ methods were not well integrated, leading to confusion as multiple techniques were available for addressing similar types of problems, without clear guidance on which method to apply. Additionally, the final version of ARIZ—with its nine parts and 40 rules—was too complex for easy learning and application. Beginners frequently made errors in Step 1, rendering the remainder of the process ineffective. Efforts to create a flowchart just for using the 76 Standard Solutions resulted in extremely large, complex diagrams spanning several pages in some TRIZ books, which further underscored the need for simplification and integration.

TOP-TRIZ

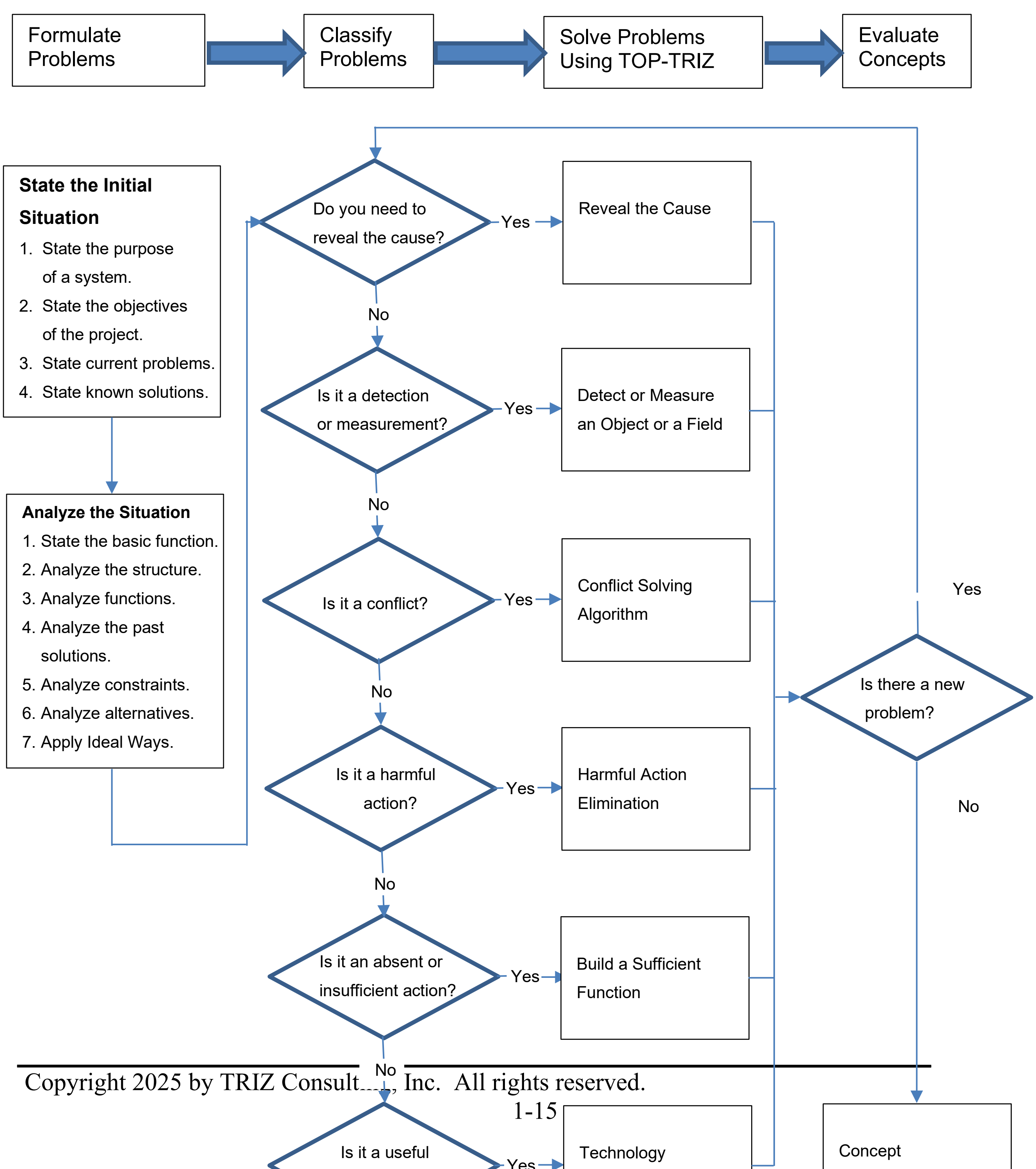
TOP-TRIZ is the next generation of TRIZ, developed through my three-and-a-half decades of practical experience and continuous refinement of TRIZ methods. In early 1992, I founded TRIZ Consulting, Inc., the first company in the U.S. dedicated to applying TRIZ, introducing the methodology to industry leaders like Boeing, Hewlett-Packard, Samsung and many others. Facilitating teams on complex challenges and training thousands of engineers (including more than 2,000 at Boeing alone) helped me identify essential improvements to TRIZ methods—refinements that became integral to TOP-TRIZ.

As a result of years of continuous improvement of Classical TRIZ, it gradually evolved into TOP-TRIZ, the most powerful yet user-friendly iteration for solving complex problems in product innovation and developing future generations of products. This transformation was achieved through the development of advanced problem formulation techniques, including my Tool-Object-Product (TOP) Function Modeling. TOP-TRIZ uses a step-by-step process to uncover a comprehensive range of problems worth solving. Moreover, TRIZ methods were advanced and integrated into a single, cohesive system, complete with algorithms for creating ideal breakthrough solutions across the six types of innovation problems. By organizing techniques that address the same class of problems together, TOP-TRIZ not only helps in solving problems but also guides users in formulating, classifying and solving subsequent challenges while maximizing resource use and minimizing costs.

TOP-TRIZ has proven invaluable for solving difficult problems, improving quality, reliability, productivity and reducing costs. It has enabled customers to develop next-generation products, secure new orders, increase market share, save hundreds of millions of dollars, enhance product reliability, develop new products and protect innovations through new patents.

The TOP-TRIZ Flow Chart, the simplest and the most user-friendly TRIZ flow chart.

TOP-TRIZ Flow Chart



A universal set of steps in TOP-TRIZ guides the formulation of an exhaustive set of problems, including:

1. Current problems.
2. Disadvantages of the known solutions to the current problems.
3. Problems revealed by function analysis.
4. Problems formulated by analysis of the history of the current problem.
5. Problems formulated by challenging constraints.
6. Problem formulated by analysis of the alternative system.
7. Problems formulated by applying Ideal Ways, an algorithm guiding four different ways to eliminate any component or even its feature associated with any disadvantage, such as cost, complexity, difficulty to make, low reliability, not easy to use or affecting something else.

Every problem is presented as a single function or two functions if it is a conflict.

TOP-TRIZ Problem Solving

TOP-TRIZ classifies formulated problems into six distinct types: an unknown harmful function, a need to introduce or improve detection or measurement, a conflict, a harmful function, an absent or insufficient function, and a need to invent a product's next generation. For each of these classes, TOP-TRIZ provides algorithms to develop a comprehensive set of ideal solutions, ensuring that all possible avenues for innovation are explored and addressed systematically.

A problem is classified as an Unknown Harmful Function if its action is unknown. The method for revealing the root causes of a failure is based on inventing ways to recreate the failure. Here the TOP-TRIZ user turns the problem on its head, pretending that the harmful product of a failure is a desired product. This allows the user to apply all of the power of TOP-TRIZ to invent potential mechanisms of the failure.

A problem is classified as a Detection or Measurement if there is a need to introduce a detection or measurement or improve existing ones. Since in most cases detection or measurement is needed to control an important process, the best approach is to eliminate the need for detection or measurement. If it is not possible, the method guides to build the most effective detection or measurement system.

A problem is a Conflict if an attempt to eliminate a harmful function deteriorates or even disables a useful function. The TOP model of a conflict consists of these two functions. TOP-TRIZ Conflict Solving Algorithm is a step-by-step guide to developing breakthrough solutions to a conflict while eliminating the harmful function completely without any deterioration of the useful function and even sometimes with the improvement of it as well.

A problem is classified as a Harmful Action if it results in a harmful or not needed product. Harmful Action Elimination methods guide a TOP-TRIZ user to eliminate a harmful function and, if possible, leads to turning the harmful function into a useful function.

A problem is classified as an Absent or Insufficient Action if there is a need to introduce a new function or find a better way to perform an existing function. Solving this class of problems is guided by a method called Build a Sufficient Function. The key to this method is a guide to introduce a missing action and identify one or more possible sources of the action among available resources. A list of most used fields (the physical nature of actions) helps to overcome preconceived notions and background barriers (psychological inertia) in the selection of possible nature of the action.

A problem is classified as Technology Forecasting if there is a need to invent next product generation, formulate new problems for further improvement of an existing system, maximize utilization of new solutions, develop a road map of innovation and marketing strategy, or develop concepts for a patent umbrella.

Solving Subsequent Problems

It is rare for a challenging problem to be solved in just one step. Usually, a new concept introduces a new problem. Most often, a solution to the initial problem leads to the deterioration of another aspect, creating a conflict, or reveals the need to modify an available resource (an absent action), or both. In such cases, a subsequent problem is not a reason to reject an idea. TOP-TRIZ guides users in identifying, classifying and solving these subsequent problems.

There is another type of subsequent problem to consider. No matter how good your new concept is, there are always next steps according to technology forecasting. So, why not reveal these steps right away? Many engineers view technology forecasting solely as a tool for roadmapping innovation, which leads them to overlook its application in solving individual problems.
This oversight leads to missed opportunities to enhance their best concepts further.

TOP-TRIZ encourages the proactive use of technology forecasting to reveal these next steps, helping to refine and improve the solutions.

TOP-TRIZ Solution Process

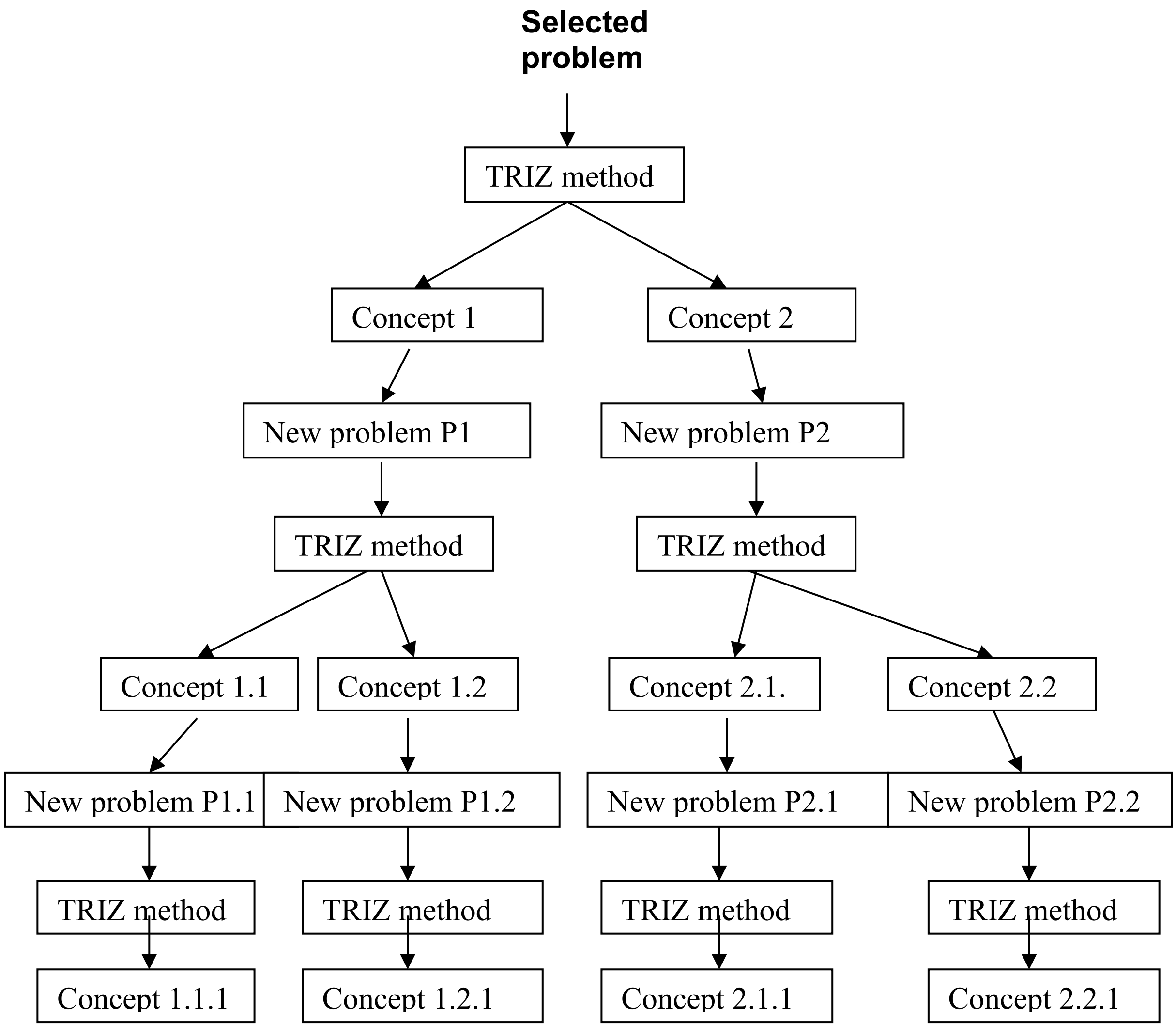


Fig. 1-

TOP-TRIZ allows users to document every step of the solution process and guides them in constructing a Solution Tree for each problem. This approach enables the review and correction of any step, if needed. The documented steps can then be used as reference samples for solving future challenges, ensuring consistency and efficiency in the problem-solving process.

TOP-TRIZ guides the overcoming of preconceived notions and maximizing the utilization of available resources.

Elegant and valuable solutions to your most difficult design and manufacturing problems can be obtained much faster than they can be obtained by traditional ways. The right solution at right time can potentially save hundreds of man-hours, millions of dollars, and accelerate a project by days, months, even years.

TOP-TRIZ is guided systematic innovation. Take full advantage of TOP-TRIZ!