

What is TRIZ?

TRIZ is a Russian language acronym for *Teoriya Resheniya Izobreatatelskikh Zadatch*. Translated into English it means “The Theory of Inventive Problem Solving.” TRIZ is the product of an exhaustive analysis of the world's most creative technological innovations as described in worldwide patent literature. This analysis has been conducted over a fifty-year period with the total number of patents analyzed now totaling approximately three million.

The objective of TRIZ is to discover how inventors invent. Trying to understand the inventive process was aimed specifically at inventions that solved difficult engineering problems in novel ways. The problems considered were difficult because they contained one or several contradictory requirements, e.g., speed vs. precision and a situation where compromise was no longer an acceptable solution.

The fifty-year study of inventions has uncovered a comprehensive set of analytical and knowledge based tools that previously existed implicitly in the minds of the world's most creative inventors. TRIZ has codified the implicit process of invention, and by making it explicit, made invention available to anyone with a reasonable amount of intelligence. The result of this combined with the TRIZ Levels of Inventiveness distinguishes it from other problem solving management systems and includes a theory of invention with the following criteria:

Be systematic and provide a step-by-step process

Guide the process of invention through a broad solution space to direct the process to the most ideal solution

The process needed to be reliable and repeatable across a wide spectrum of problems

The process should not be dependent on psychological aids such as brainstorming

The process should take advantage and access the body of inventive knowledge

The process must add to the body of inventive knowledge

TRIZ applies the law of Increasing Ideality. That stipulates that systems evolve towards greater ideality; ideality being the quotient of the sum of the systems useful effects, divided by the sum of its harmful effects.

The TRIZ Process Step-By-Step

- 1) Identifying the problem
- 2) Formulate the problem. Could improving one technical Characteristic to solve a problem cause other technical characteristics to worsen?

- 3) Search for previously well-solved problems by looking at the 39 engineering parameters.
- 4) Find the principle that needs to be changed and then find the principle that is an undesired secondary effect.
- 5) Look for analogous solutions and adapt to my solution.

Let's look at the application of TRIZ to a simple redesign; that of an aluminum beverage can.

Identifying the problem.

The first step is to identify the engineering system being studied, its operating environment, resource requirements, primary useful function, harmful effects, and determining the ideal result.

Example: A beverage can, that is, an engineered system to contain a beverage. The operating environment is that cans are stacked for storage purposes. Resources include weight of filled cans, internal pressure of can, rigidity of can construction. Primary useful function is to contain beverage. Harmful effects include cost of materials, the cost of producing the can and waste of storage space. Ideal result is a can that can support the weight of stacking to human height without damage to cans or beverage in cans.

Formulate the problem.

Restate the problem in terms of physical contradictions. Identify problems that could occur. Could improving one technical characteristic to solve a problem cause other technical characteristics to worsen, resulting in secondary problems arising? Do technical conflicts exist that might force a trade-off?

Example: We cannot control the height to which cans will be stacked. The price of raw materials compels us to lower costs. The can walls must be made thinner to reduce costs, but if we make the walls thinner, it cannot support as large a stacking load. Thus, the can wall needs to be thinner to lower material cost and thicker to support stacking-load weight. This is a physical contradiction. If we can solve this, we will achieve an ideal engineering system.

Search for Previously Well-Solved Problem

Consider the *39 Engineering Parameters* shown in the list below. Find the contradicting engineering principles in your examples. First find the principle that needs to be changed. Then find the principle that is an undesirable secondary effect. State the standard technical conflict.

Example. The standard engineering parameter that has to be changed to make the can wall thinner is "#4, length of a nonmoving object." In TRIZ, these standard engineering

principles can be quite general. Here, "length" is a generalized term and may refer to any linear dimension such as length, width, height, diameter, etc. If we reduce the can wall thickness, stacking-load weight will decrease. The standard engineering parameter that is in conflict is "#11, stress."

The standard technical conflict is: the more we improve the standard engineering parameter "length of a nonmoving object," the more the standard engineering parameter "stress" becomes worse.

The 39 Engineering Parameters

- 1.Weight of moving object
- 2.Weight of nonmoving object
- 3.Length of moving object
- 4.Length of nonmoving object
- 5.Area of moving object
- 6.Area of nonmoving object
- 7.Volume of moving object
- 8.Volume of nonmoving object
- 9.Speed
- 10.Force
- 11.Tension, pressure
- 12.Shape
- 13.Stability of object
- 14.Strength
- 15.Durability of moving object
- 16.Durability of nonmoving object
- 17.Temperature
- 18.Brightness
- 19.Energy spent by moving object
- 20.Energy spent by nonmoving object
- 21.Power
- 22.Waste of energy
- 23.Waste of substance
- 24.Loss of information
- 25.Waste of time
- 26.Amount of substance
- 27.Reliability
- 28.Accuracy of measurement
- 29.Accuracy of manufacturing
- 30.Harmful factors acting on object
- 31.Harmful side effects
- 32.Manufacturability
- 33.Convenience of use
- 34.Repairability
- 35.Adaptability
- 36.Complexity of device

- 37. Complexity of control
- 38. Level of automation
- 39. Productivity

Look for Analogous Solutions and Adapt to My Solution

TRIZ specifies *40 Inventive Principles*. These principles may be used to help an engineer find a highly inventive (and hopefully patent-able) solution to the problem. Examples from patents are also suggested with these 40 inventive principles. To find which inventive principles to use, Altshuller, the creator of TRIZ, created the Table of Contradictions. The Table of Contradictions lists the 39 Engineering Parameters on the X-axis (Undesired Secondary Effect) and Y-axis (Feature To Improve). In the intersecting cells, are listed the appropriate Inventive Principles to use for a solution.

Example. The engineering parameters in conflict for the beverage can are "#4, length of a nonmoving object" and "#11, stress." Therefore, the feature to improve (Y-axis) is the can wall thickness or "#4, length of a nonmoving object" and the undesirable secondary effect (X-axis) is loss of load bearing capacity or "#11, stress." Looking these up on the Table of Contradictions, we find the numbers 1, 14, and 35 in the intersecting cell.

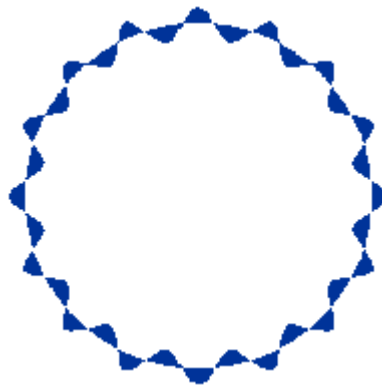
Inventive Principle #1 is Segmentation

Divide an object into independent parts

Make an object sectional

Increase the degree of an object's segmentation

For example, using Inventive Principle 1 c. "Increase the degree of an object's segmentation," the wall of the can could be changed from one smooth continuous wall to a corrugated or wavy surface made up of many "little walls". This would increase the edge strength of the wall yet allow a thinner material to be used. See below.



Cross section of corrugated can wall.

Inventive Principle # 14 is Spheroidality

Replace linear parts or flat surfaces with curved ones; replace cubical shapes with spherical shapes

Use rollers, balls spirals

Replace a linear motion with rotating movement; utilize a centrifugal force

Using Inventive Principle 14 a., the perpendicular angle at which most can lids are welded to the can wall can be changed to a curve. See illustration.



The perpendicular angle has been replaced with a curve. In this case spheroidality strengthens the can's load bearing capacity.

Inventive Principle #35 is

Transformation of the physical and chemical states of an object

Change an object's aggregate state, density distribution, degree of flexibility, temperature

Change the composition to a stronger metal alloy used for the can wall to increase the load bearing capacity.