

PROBLEM SOLVING
TRIZ

theory of inventive problem solving

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UPDATED **2020-03-17**

BACKGROUND

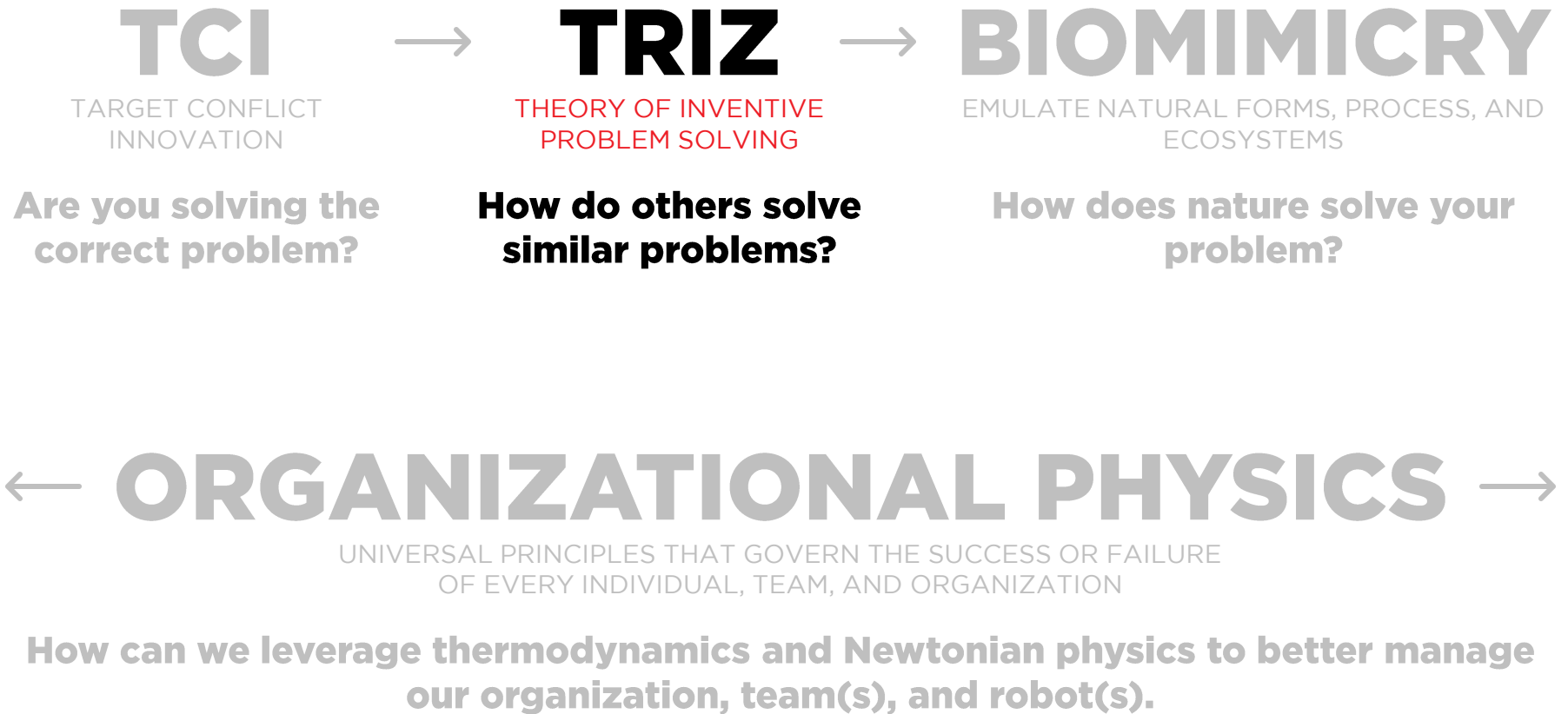
- Most projects reach a point where all the analysis has been done but the team isn't clear on the next steps.
- Common creativity tools are often limited to brainstorming and related methods, which depend on intuition and the knowledge & experience of the team members.
- These methods have unpredictable and unrepeatable results.

TRIZ OFFERS AN ALTERNATIVE SOLUTION.

WHAT IS TRIZ?

- An approach developed by Soviet inventor and science fiction author Genrich Altshuller.
- In Russian:
 - теория решения изобретательских задач
 - “**t**eoriya **r**esheniya **i**zobretatelskikh **z**adatch”
 - literally: “theory of the resolution of invention-related tasks“
- An international science of creativity that relies on the study of the patterns of problems and solutions; not on the spontaneous and intuitive creativity of individuals or groups.
- A logic and data-based problem-solving, analysis, and forecasting tool derived from the study of patterns of invention in the global patent literature. Millions of patents have been analyzed to discover the patterns that predict breakthrough solutions to problems.

TRIZ IS MOST EFFECTIVE AFTER THE IMPORTANT PROBLEMS HAVE BEEN IDENTIFIED.



TRIZ BACKGROUND

TRIZ research began with the hypothesis that there are universal principles of creativity that are the basis for creative innovations that advance technology.

If these principles could be identified and codified, they could be taught to people to make the process of creativity more predictable.

Three primary findings of this research:

1. Problems and solutions are repeated across industries and sciences. The classification of the **CONTRADICTIONS** in each problem predicts the creative solutions to that problem.
2. Patterns of technical evolution are repeated across industries and sciences.
3. Creative innovations use scientific effects outside the field where they were developed.

“Somebody someplace has already solved this problem (or one very similar to it).”

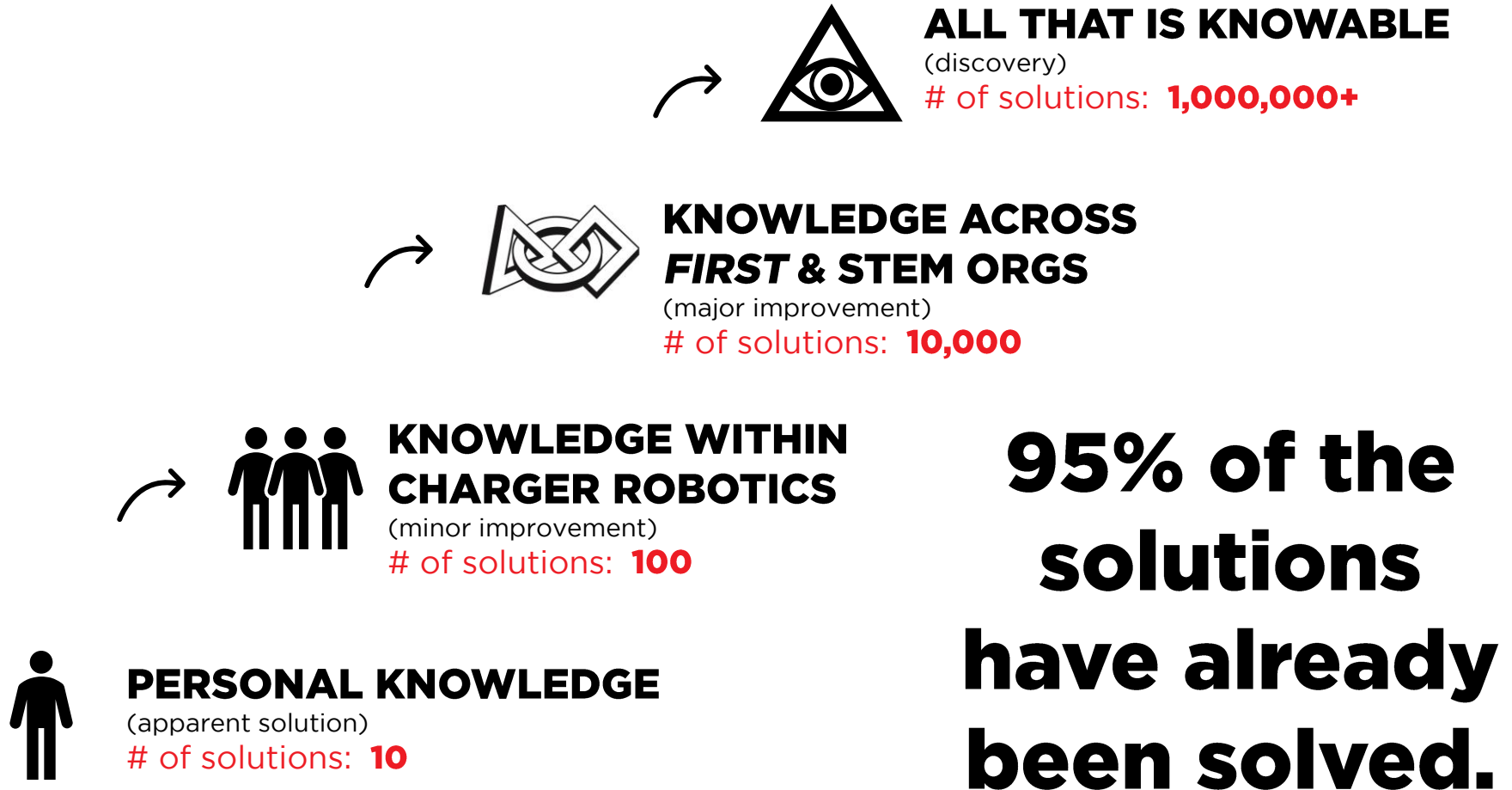
Creativity is now finding that solution and adapting it to this particular problem.”

WHY USE TRIZ?

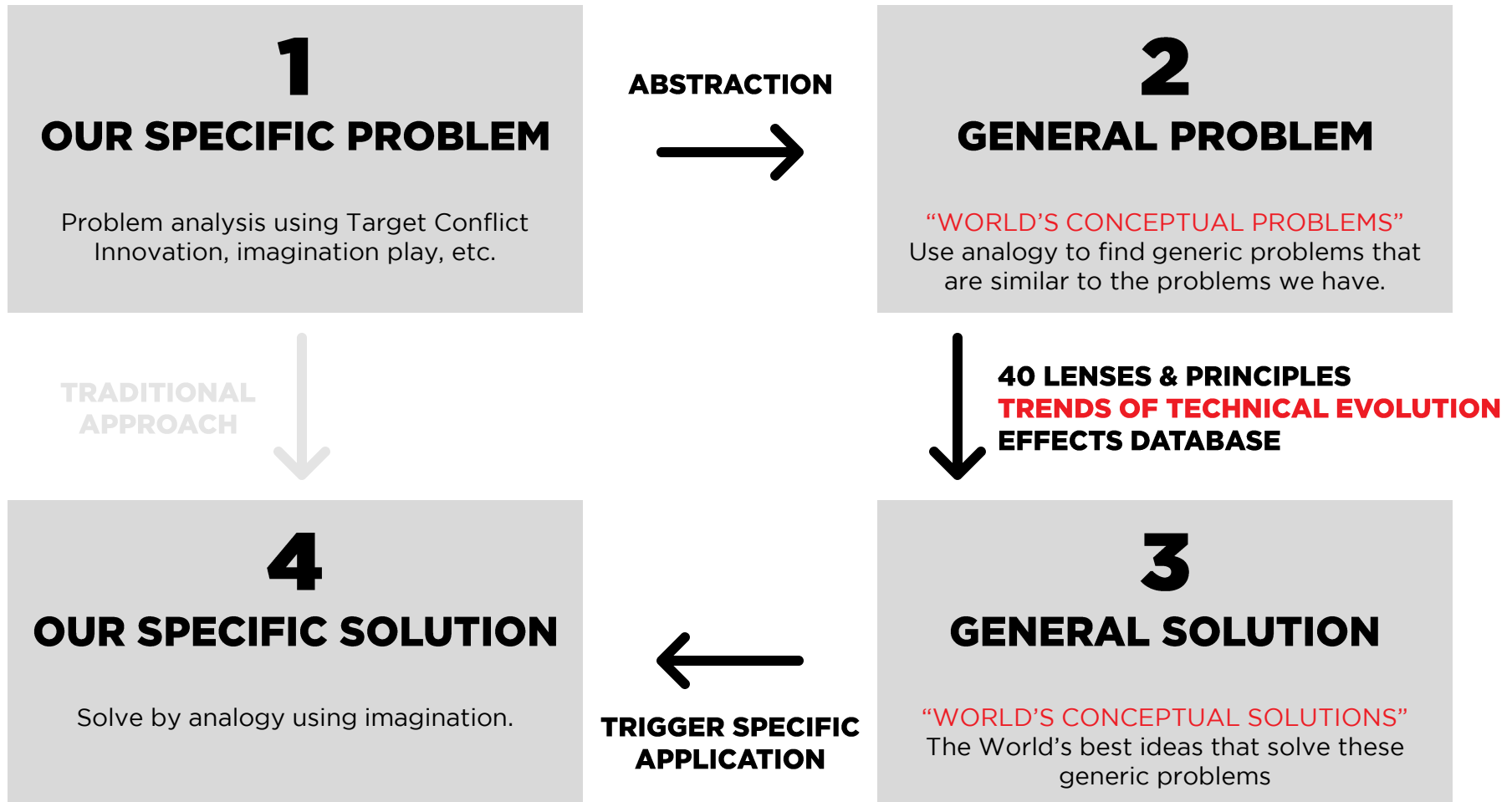
IT ACCELERATES OUR ABILITY TO SOLVE PROBLEMS CREATIVELY.

IT PROVIDES REPEATABILITY, PREDICTABILITY, AND RELIABILITY DUE TO ITS STRUCTURE AND ALGORITHMIC APPROACH.

LEVELS OF INVENTIVENESS



THE TRIZ PROCESS



HOW TO USE TRIZ

1. Identify Technical & Physical Contradictions
2. Use TRIZ Contradiction Matrix to identify applicable principles/lenses.

NOTE: The www.TRIZ40.com website is a great resource!

3. As a group or sub-group, construct analogies between the recommended examples and our situation.
4. Create solutions to our problem that build directly on the concept of the principle/lens and the analogies.

THE PRINCIPLES / LENSES OF TRIZ

1. SEGMENTATION

- Divide an object into independent parts
- Make an object easy to assemble or disassemble
- Increase the degree of fragmentation or segmentation

2. TAKING OUT / ABSTRACT - EXTRACT

- Separate an interfering part or property from an object, or single out the only necessary part (or property) of an object

3. LOCAL QUALITY

- Change an object's structure from uniform to non-uniform
- Change an external environment (or external influence) from uniform to non-uniform
- Make each part of an object function in conditions most suitable for its operation
- Make each part of an object fulfill a different and/or complementary useful function.

4. ASYMMETRY

- Change the shape or properties of an object from symmetrical to Asymmetrical
- Change the shape of an object to suit external asymmetries (ex. ergonomic features)
- If an object is asymmetrical, increase its degree of asymmetry

5. MERGING

- Bring closer together (or merge) identical or similar objects or operations in space
- Make objects or operations contiguous or parallel; bring them together in time

6. UNIVERSALITY

- Make a part or object perform multiple functions; eliminate the need for other parts

7. NEST / RUSSIAN "NESTED DOLL"

- Place one object inside another / place multiple objects inside others
- Make one part pass (dynamically) through a cavity in the other

8. COUNTERWEIGHT / ANTI-WEIGHT

- To compensate for the weight of an object, merge it with other objects that provide lift
- To compensate for the weight of an object, make it interact with the environment (ex: use aerodynamic, hydrodynamic, buoyancy and other forces)

9. PRIOR COUNTER ACTION / PRELIMINARY ANTI-ACTION

- If it is necessary to perform an action with both harmful and useful effects, it should be replaced with anti-actions to control harmful effects
- Create beforehand stresses in an object that will oppose known undesirable working stresses later on

10. PRIOR ACTION / PRELIMINARY ACTION

- Perform, before it is needed, the required change of an object (either fully or partially)
- Pre-arrange objects such that they can come into action from the most convenient place and without losing time for their delivery

11. PRIOR / BEFOREHAND CUSHIONING

- Prepare emergency means beforehand to compensate for the relatively low reliability of an object ('belt and braces')

12. EQUIPOTENTIALITY

- If an object has to be raised or lowered, redesign the object's environment so the need to raise or lower is eliminated or performed by the environment

THE PRINCIPLES / LENSES OF TRIZ

13. INVERT / “THE OTHER WAY AROUND”

- Invert the action(s) used to solve the problem (ex: instead of cooling an object, heat it)
- Make movable parts (or the external environment) fixed, and fixed parts movable)
- Turn the object (or process) ‘upside down’

14. SPHEROIDALITY / CURVATURE

- Instead of using rectilinear parts, surfaces, or forms, use curvilinear ones; move from flat surfaces to spherical ones; from parts shaped as a cube (parallelepiped) to ball-shaped structures
- Use rollers, balls, spirals, domes
- Go from linear to rotary motion (or vice versa)
- Use centrifugal forces

15. DYNAMISM / DYNAMICS

- Allow (or design) the characteristics of an object, external environment, or process to change to be optimal or to find an optimal operating conditions
- Divide an object into parts capable of movement relative to each other
- If an object (or process) is rigid or inflexible, make it movable or adaptive
- Increase the degree of free motion

16. PARTIAL OR EXCESSIVE ACTIONS

- If 100 percent of an object is hard to achieve using a given solution method then, by using ‘slightly less’ or ‘slightly more’ of the same method, the problem may be considerably easier to solve

17. DIMENSION / ANOTHER DIMENSION

- If an object contains or moves in a straight line, consider use of dimensions or movement outside the line
- If an object contains or moves in a plane, consider use of dimensions or movement outside the current plane
- Use a multi-storey arrangement of objects instead of a single storey arrangement
- Tilt or re-orient the object, lay it on its side
- Use ‘another side’ of a given area.

18. MECHANICAL VIBRATION

- Cause an object to oscillate or vibrate
- Increase its frequency (even up to the ultrasonic)
- Use an object’s resonant frequency
- Use piezoelectric vibrators instead of mechanical ones
- Use combined ultrasonic and electromagnetic field oscillations

19. PERIODIC ACTION

- Instead of continuous action, use periodic or pulsating actions
- If an action is already periodic, change the periodic magnitude or frequency
- Use pauses between actions to perform a different action

20. CONTINUITY OF USEFUL ACTION

- Carry on work continuously; make all parts of an object work at full load or optimum efficiency, all the time
- Eliminate all idle or intermittent actions or work

21. SKIPPING / SKIP THROUGH

- Conduct a process, or certain stages (ex: destructible, harmful or hazardous operations) at high speed

THE PRINCIPLES / LENSES OF TRIZ

22. NEGATIVE TO POSITIVE

- Use harmful factors (particularly, harmful effects of the environment or surroundings) to achieve a positive effect
- Eliminate the primary harmful action by adding it to another harmful action to resolve the problem
- Amplify a harmful factor to such a degree that it is no longer harmful

23. FEEDBACK

- Introduce feedback (referring back, cross-checking) to improve a process or action
- If feedback is already used, change its magnitude or influence in accordance with operating conditions

24. INTERMEDIARY

- Use an intermediary carrier article or intermediary process
- Merge one object temporarily with another (which can be easily removed)

25. SELF-SERVICE

- Make an object serve or organize itself by performing auxiliary helpful functions
- Use waste resources, energy, or substances

26. COPYING

- Instead of an unavailable, expensive, fragile object, use simpler and inexpensive copies
- Replace an object, or process with optical copies
- If visible optical copies are already used, move to infrared or ultraviolet copies

27. SHORT-LIVED / DISPOSABLE OBJECTS

- Replace an expensive object with a multiple of inexpensive objects, compromising certain qualities, such as service life

28. MECHANICS SUBSTITUTION

- Replace a mechanical means with a sensory (optical, acoustic, taste or smell) means
- Use electric, magnetic and electromagnetic fields to interact with the object
- Change from static to movable fields, from unstructured fields to those having structure
- Use fields in conjunction with field-activated (ex: ferromagnetic) particles

29. FLUIDITY / PNEUMATICS AND HYDRAULICS

- Use gas and liquid parts of an object instead of solid parts (ex: inflatable, filled with liquids, air cushion, hydrostatic, hydro reactive)

30. FLEXIBLE SHELLS AND THIN FILMS

- Use flexible shells and thin films instead of three-dimensional structures
- Isolate the object from the external environment using flexible shells and thin films

31. POROSITY / POROUS MATERIALS

- Make an object porous or add porous elements (inserts, coatings, etc.)
- If an object is already porous, use the pores to introduce a useful substance or function

32. COLOR CHANGES

- Change the color of an object or its external environment
- Change the transparency of an object or its external environment
- In order to improve observability of things that are difficult to see, use colored additives or luminescent elements
- Change the emissivity properties of an object subject to radiant heating

THE PRINCIPLES / LENSES OF TRIZ

33. HOMOGENEITY

- Make objects interacting with a given object of the same material (or material with identical properties)

34. DISPOSE AND RETRIEVE

- Make portions of an object that have fulfilled their functions go away (discard by dissolving, evaporating, etc.) or modify these directly during operation
- Conversely, restore consumable parts of an object directly in operation

35. TRANSFORM STATES / PARAMETERS

- Change an object's physical state (ex: to a gas, liquid, or solid)
- Change the concentration or consistency
- Change the degree of flexibility
- Change the temperature
- Change the pressure
- Change other parameters

36. PHASE TRANSITIONS

- Use phenomena occurring during phase transitions (ex: volume changes, loss or absorption of heat, etc.)

37. THERMAL EXPANSION

- Use thermal expansion (or contraction) of materials
- If thermal expansion is being used, use multiple materials with different coefficients of thermal expansion

38. OXIDATE

- Replace common air with oxygen-enriched air or pure oxygen
- Expose air or oxygen to ionizing radiation
- Use ozonized (or ionized) oxygen or replace it with ozone

39. INERTNESS

- Replace a normal environment with an inert one
- Add neutral parts, or inert additives to an object

40. COMPOSITES / COMPOSITE MATERIALS

- Change from uniform to composite (multiple) materials where each material is tuned to a particular functional requirement

ADDITIONAL RESOURCES

- WWW.TRIZ40.COM
- <https://www.slyasafox.com/DV40.pdf>
- https://www.mindtools.com/pages/article/newCT_92.htm
- <https://innovationmanagement.se/imtool-articles/what-is-triz-and-how-can-it-be-used-in-problem-solving-or-brainstorming/>
- <https://www.triz.co.uk/what-is-triz>