

40 inventive principles with examples

- 1. Segmentation** - Divide an object into independent parts. / Make an object easy to disassemble. / Increase the degree of fragmentation or segmentation.
- 2. Taking out** - 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 useful function.
- 4. Asymmetry** - Change the shape of an object from symmetrical to asymmetrical. / If an object is asymmetrical, increase its degree of asymmetry.
- 5. Merging** - Bring closer together (or merge) identical or similar objects, assemble identical or similar parts to perform parallel operations. / Make 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. "Nested doll"** - Place one object inside another; place each object, in turn, inside the other. / Make one part pass through a cavity in the other.
- 8. 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 (e.g. use aerodynamic, hydrodynamic, buoyancy and other forces).
- 9. Preliminary anti-action** - If it will be necessary to do an action with both harmful and useful effects, this action 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. 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. Beforehand cushioning** - Prepare emergency means beforehand to compensate for the relatively low reliability of an object.
- 12. Equipotentiality** - In a potential field, limit position changes (e.g. change operating conditions to eliminate the need to raise or lower objects in a gravity field).
- 13. 'The other way round'** - Invert the action(s) used to solve the problem (e.g. 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, use centrifugal forces.
- 15. Dynamics** - Allow (or design) the characteristics of an object, external environment, or process to change to be optimal or to find an optimal operating condition. / 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.
- 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. Another dimension** - To move an object in two- or three-dimensional space. / Use a multi-story arrangement of objects instead of a single-story 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 impulses to perform a different action.
- 20. Continuity of useful action** - Carry on work continuously; make all prts of an object work at full load, all the time. / Eliminate all idle or intermittent actions or work.
- 21. Skipping** - Conduct a process , or certain stages (e.g. destructible, harmful or hazardous operations) at high speed.
- 22. "Blessing in disguise" or "Turn Lemons into Lemonade"** - 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.
- 23. Feedback** - Introduce feedback (referring back, cross-checking) to improve a process or action. / If feedback is already used, change its magnitude or influence.
- 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 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. Cheap short-living objects** - Replace an inexpensive object with a multiple of inexpensive objects, comprising certain qualities (such as service life, for instance).
- 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 (e.g. ferromagnetic) particles.
- 29. Pneumatics and hydraulics** - Use gas and liquid parts of an object instead of solid parts (e.g. 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. 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.
- 33. Homogeneity** - Make objects interacting with a given object of the same material (or material with identical properties).
- 34. Discarding and recovering** - 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. Parameter changes** - A. Change an object's physical state (e.g. to a gas, liquid, or solid. / Change the concentration or consistency. / Change the degree of flexibility. / Change the temperature.
- 36. Phase transitions** - Use phenomena occurring during phase transitions (e.g. 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. Strong oxidants** - Replace common air with oxygen-enriched air. / Replace enriched air with pure oxygen. / Expose air or oxygen to ionizing radiation. / Use ionized oxygen. / Replace ozonized (or ionized) oxygen with ozone.
- 39. Inert atmosphere** - Replace a normal environment with an inert one. / Add neutral parts, or inert additives to an object.
- 40. Composite materials** - Change from uniform to composite (multiple) materials.

39 parameters with examples

Moving objects

Objects which can easily change position in space, either on their own, or as a result of external forces. Vehicles and objects designed to be portable are the basic members of this class.

- 1. Weight of moving object:** The mass of the object, in a gravitational field. The force that the body exerts on its support or suspension.
- 2. Weight of stationary object:** The mass of the object, in a gravitational field. The force that the body exerts on its support or suspension, or on the surface on which it rests.
- 3. Length of moving object:** Any one linear dimension, not necessarily the longest, is considered a length.
- 4. Length of stationary object:** Same as 3.
- 5. Area of moving object:** A geometrical characteristic described by the part of a plane enclosed by a line. The part of a surface occupied by the object. OR the square measure of the surface, either internal or external, of an object.
- 6. Area of stationary object:** Same as 5
- 7. Volume of moving object:** The cubic measure of space occupied by the object. Length x width x height for a rectangular object, height x area for a cylinder, etc.
- 8. Volume of stationary object:** Same as 7
- 9. Speed:** The velocity of an object; the rate of a process or action in time.
- 10. Force:** Force measures the interaction between systems. In Newtonian physics, force = mass X acceleration. In TRIZ, force is any interaction that is intended to change an object's condition.
- 11. Stress or pressure:** Force per unit area. Also, tension.
- 12. Shape:** The external contours, appearance of a system.
- 13. Stability of the object's composition:** The wholeness or integrity of the system; the relationship of the system's constituent elements. Wear, chemical decomposition, and disassembly are all decreases in stability. Increasing entropy is decreasing stability.
- 14. Strength:** The extent to which the object is able to resist changing in response to force. Resistance to breaking .
- 15. Duration of action by a moving object:** The time that the object can perform the action. Service life. Mean time between failure is a measure of the duration of action. Also, durability.
- 16. Duration of action by a stationary object:** Same as 15 .
- 17. Temperature:** The thermal condition of the object or system. Loosely includes other thermal parameters, such as heat capacity, that affect the rate of change of temperature.
- 18. Illumination intensity:** Light flux per unit area, also any other illumination characteristics of the system such as brightness, light quality, etc..
- 19. Use of energy by moving object:** The measure of the object's capacity for doing work. In classical mechanics, Energy is the product of force times distance. This includes the use of energy provided by the super-system (such as electrical energy or heat.) Energy required to do a particular job.
- 20. Use of energy by stationary object:** same
- 21. Power:** The time rate at which work is performed. The rate of use of energy.
- 22. Loss of Energy:** Use of energy that does not contribute to the job being done. See 19. Reducing the loss of energy sometimes requires different techniques from improving the use of energy, which is why this is a separate category.

Stationary objects

Objects which do not change position in space, either on their own, or as a result of external forces. Consider the conditions under which the object is being used.

- 23. Loss of substance:** Partial or complete, permanent or temporary, loss of some of a system's materials, substances, parts, or subsystems.
- 24. Loss of Information:** Partial or complete, permanent or temporary, loss of data or access to data in or by a system. Frequently includes sensory data such as aroma, texture, etc.
- 25. Loss of Time:** Time is the duration of an activity. Improving the loss of time means reducing the time taken for the activity. "Cycle time reduction" is a common term.
- 26. Quantity of substance/the matter:** The number or amount of a system's materials, substances, parts or subsystems which might be changed fully or partially, permanently or temporarily.
- 27. Reliability:** A system's ability to perform its intended functions in predictable ways and conditions.
- 28. Measurement accuracy:** The closeness of the measured value to the actual value of a property of a system. Reducing the error in a measurement increases the accuracy of the measurement.
- 29. Manufacturing precision:** The extent to which the actual characteristics of the system or object match the specified or required characteristics.
- 30. External harm affects the object:** Susceptibility of a system to externally generated (harmful) effects.
- 31. Object-generated harmful factors:** A harmful effect is one that reduces the efficiency or quality of the functioning of the object or system. These harmful effects are generated by the object or system, as part of its operation.
- 32. Ease of manufacture:** The degree of facility, comfort or effortlessness in manufacturing or fabricating the object/system.
- 33. Ease of operation:** Simplicity: The process is NOT easy if it requires a large number of people, large number of steps in the operation, needs special tools, etc. "Hard" processes have low yield and "easy" process have high yield; they are easy to do right.
- 34. Ease of repair:** Quality characteristics such as convenience, comfort, simplicity, and time to repair faults, failures, or defects in a system.
- 35. Adaptability or versatility:** The extent to which a system/object positively responds to external changes. Also, a system that can be used in multiple ways for under a variety of circumstances.
- 36. Device complexity:** The number and diversity of elements and element interrelationships within a system. The user may be an element of the system that increases the complexity. The difficulty of mastering the system is a measure of its complexity.
- 37. Difficulty of detecting and measuring:** Measuring or monitoring systems that are complex, costly, require much time and labor to set up and use, or that have complex relationships between components or components that interfere with each other all demonstrate "difficulty of detecting and measuring." Increasing cost of measuring to a saticfactory error is also a sign of increased difficulty of measuring.
- 38. Extent of automation:** The extent to which a system or object performs its functions without human interface. The lowest level of automation is the use of a manually operated tool. For intermediatel levels, humans program the tool, observe its operation, and interrupt or re-program as needed. For the highest level, the machine senses the operation needed, programs itself, and monitors its own operations.
- 39. Productivity:** The number of functions or operations performed by a system per unit time. The time for a unit function or operation. The output per unit time, or the cost per unit output.

Sources:

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