



## 40 Inventive Principles

### **Principle 1. Segmentation**

- A.) Divide an object into independent parts.
- B.) Make an object easy to disassemble.
- C.) Increase the degree of fragmentation

### **Principle 2. Taking out**

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

### **Principle 3. Local quality**

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

### **Principle 4. Asymmetry**

- A.) Change the shape of an object from symmetrical to asymmetrical.
- B.) If an object is asymmetrical, increase its degree of asymmetry.

### **Principle 5. Merging**

- A.) Bring closer together (or merge) identical or similar objects, assemble identical or similar parts to perform parallel operations.
- B.) Make operations contiguous or parallel; bring them together in time.

### **Principle 6. Universality**

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

### **Principle 7. "Nested doll"**

- A.) Place one object inside another; place each object, in turn, inside the other.
- B.) Make one part pass through a cavity in the other.

### **Principle 8. Anti-weight**

- A.) To compensate for the weight of an object, merge it with other objects that provide lift.
- B.) To compensate for the weight of an object, make it interact with the environment (e.g. use aerodynamic, hydrodynamic, and other forces).



### **Principle 9. Preliminary anti-action**

- A.) 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.
- B.) Create beforehand stresses in an object that will oppose known undesirable working stresses later on.

### **Principle 10. Preliminary action**

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

### **Principle 11. Beforehand cushioning**

- A.) Prepare emergency means beforehand to compensate for the relatively low reliability of an object.

### **Principle 12. Equipotentiality**

- A.) 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).

### **Principle 13. 'The other way round'**

- A.) Invert the action(s) used to solve the problem (e.g. instead of cooling an object, heat it).
- B.) Make movable parts (or the external environment) fixed, and fixed parts movable).
- C.) Turn the object (or process) 'upside down'.

### **Principle 14. Spheroidality - Curvature**

- A.) 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.
- B.) Use rollers, balls, spirals, domes.
- C.) Go from linear to rotary motion, use centrifugal forces.

### **Principle 15. Dynamics**

- A.) Allow (or design) the characteristics of an object, external environment, or process to change to be optimal or to find an optimal operating condition.
- B.) Divide an object into parts capable of movement relative to each other.
- C.) If an object (or process) is rigid or inflexible, make movable or adaptive.

### **Principle 16. Partial or excessive actions**

- A.) 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.



### **Principle 17. Another dimension**

- A.) To move an object in two – or three – dimensional space.
- B.) Use a multi-story arrangement of objects instead of a single story arrangement.
- C.) Tilt or re-orient the object, lay it on its side.
- D.) Use 'another side' of a given area.

### **Principle 18. Mechanical vibration**

- A.) Cause an object to oscillate or vibrate.
- B.) Increase its frequency (even up to the ultrasonic).
- C.) Use an object's resonant frequency.
- D.) Use piezoelectric vibrators instead of mechanical ones.
- E.) Use combined ultrasonic and electromagnetic field oscillations.

### **Principle 19. Periodic action**

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

### **Principle 20. Continuity of useful action**

- A.) Carry on work continuously; make all prts of an object work at full load, all the time.
- B.) Eliminate all idle or intermittent actions or work.

### **Principle 21. Skipping**

- A.) Conduct a process, or certain stages (e.g. destructible, harmful or hazardous operations) at high speed.

### **Principle 22. "Blessing in disguise" or "Turn Lemons into Lemonade"**

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

### **Principle 23. Feedback**

- A.) Introduce feedback (referring back, cross-checking) to improve a process or action.
- B.) If feedback is already used, change its magnitude or influence.

### **Principle 24. 'Intermediary'**

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

### **Principle 25. Self-service**

- A.) Make an object serve itself by performing auxiliary helpful functions.
- B.) Use waste resources, energy, or substances.



### **Principle 26. Copying**

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

### **Principle 27. Cheap short-lived objects**

- A.) Replace an expensive object with multiple of inexpensive objects, comprising certain qualities (such as service life, for instance).

### **Principle 28 Mechanics substitution**

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

### **Principle 29. Pneumatics and hydraulics**

- A.) Use gas and liquid parts of an object instead of solid parts (e.g. inflatable, filled with
- B.) liquids, air cushion, hydrostatic).

### **Principle 30. Flexible shells and thin films**

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

### **Principle 31. Porous materials**

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

### **Principle 32. Color changes**

- A.) Change the color of an object or its external environment.
- B.) Change the transparency of an object or its external environment.

### **Principle 33. Homogeneity**

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

### **Principle 34. Discarding and recovering**

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



**Principle 35. Parameter changes**

- A.) Change an object's physical state (e.g. to a gas, liquid, or solid).
- B.) Change the concentration or consistency.
- C.) Change the degree of flexibility.
- D.) Change the temperature.

**Principle 36. Phase transitions**

- A.) Use phenomena occurring during phase transitions (e.g. volume changes, loss or absorption of heat, etc.).

**Principle 37. Thermal expansion**

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

**Principle 38. Strong oxidants**

- A.) Replace common air with oxygen-enriched air.
- B.) Replace enriched air with pure oxygen.
- C.) Expose air or oxygen to ionizing radiation.
- D.) Use ionized oxygen.
- E.) Replace ozonized (or ionized) oxygen with ozone.

**Principle 39. Inert atmosphere**

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

**Principle 40. Composite materials**

- A.) Change from uniform to composite (multiple) materials.