Handout 7

(40)

Inventive Problems

40 INVENTIVE PRINCIPLES FOR SOLVING TECHNICAL CONTRADICTIONS

(Translated and edited by Lev Shulyak and Steven Rodman, 1997. Published by Technical Innovation Center, Inc.)

1. Segmentation

a. Divide your object into independent parts.
b. Make an object sectional.
c. Increase the degree of the object's fragmentation.

2. Extraction

a. Extract the "disturbing" part or properly from an object.
b. Extract only the necessary part or property from an object.

3. Local Quality

a. Instead of uniform structure of your project, use non-uniform structure of the object.
b. Instead of uniform structure of environment, use non-uniform structure of the environment.
c. If two functions are to be performed by the same object but this causes problems, divide the object into two parts.
d. Redesign your object and environment so that each part of the object must be conditions proper for operation.

4. Asymmetry

a. If your object has symmetrized shape, make it asymmetrical.
b. If your object is already asymmetrical, increase the degree of asymmetry.

5. Consolidation

a. Consolidate in space homogeneous objects destined for contiguous operations.
b. Consolidate in time homogeneous or contiguous operations.

6. Universality

a. If you have two objects which deliver different functions, design a new single object that would be capable of delivering both functions.

7. Nesting ("Matrioshka")

a. Place one object inside another.
b. Increase a number of nested objects.
c. Make one object dynamically pass through a cavity of another object when necessary.

8. Counterweight

a. Compensate for the weight of your object with merging it with another object that provides lifting force.
b. Place your object into environment that provides aerodynamic, hydrodynamic or other lifting force.

9. Prior Counteraction

a. If your object is subjected to harmful factor(s) of environment, subject it to antipodal action beforehand. This will compensate with the harmful factor.

10. Prior Action

a. If your object is subjected to harmful factors of environment, create conditions that will prevent the object from harmful factors beforehand.
b. If your object has to be changed and this is hard to achieve, perform the required change of the object (fully or partially) beforehand.

11. Early Cushioning

a. If your object is unreliable, create conditions in advance that will prevent the object.

12. Equipotentiality

a. If your object has to be lowered or raised, redesign the object's environment so that the necessity to raise or lower the object ceases.

13. Do it in Reverse

a. Instead of actions defined perform opposite action.
b. Make the movable part of your object fixed or the fixed part movable.

14. Spheroidality

a. Instead of linear parts of the object, use curve parts.
b. Use rollers, balls, spirals.
c. Use rotary motion.
d. Use centrifugal forces.

15. Dynamicity

a. If your object is immobile, make it movable.
b. Divide your objects into parts capable of moving relatively each other.
c. Increase the degree of free motion.
d. Make your object or environment dynamically change in accord with the required conditions at each stage of operation.

16. Partial or Excessive Action

a. If it is not possible to precisely achieve the required change, or to perform some action, reformulate the problem: how to make slightly less or slightly more and then achieve the required result.

17. Another Dimension

a. If your object moves along a line, consider movement within two-dimensional space.
b. If your object moves in plane, consider movement within three-dimensional space.
c. Rearrange objects so that instead of one-storied arrangement a multi-storied arrangement can be achieved.
d. Tilt the object.
e. Use other side of the given area.

18. Mechanical Vibrations

a. Make your object or its part vibrate.
b. If the object is in oscillatory motion, increase the frequency of oscillations.
c. Use resonance frequencies.
d. Use ultrasonic frequencies.
e. Use piezoelectric vibrators instead of mechanical ones.
f. Use ultrasonic oscillations in combination with electromagnetic field.

19. Periodic Action

a. Instead of continuous action use pulse actions.
b. Vary periodicity according the conditions.
c. Use pauses between impulses to perform some other action.

20. Useful Action Continuity

a. All parts of the object must work continuously.
b. Eliminate all idle running.

21. Skip

a. If your object is subjected to harmful or hazardous actions within some process, conduct the process at a very high speed.

22. Turn the Harm to One's Good

a. Use harmful factors to achieve positive effects.
b. Eliminate a harmful factor by adding it with another harmful factor.
c. Amplify the harmful factor to such degree so that it would stop to bring harm to your object or environment.

23. Feedback

a. Introduce feedback.
b. If the feedback is available, vary it in accord with operating conditions.

24. Intermediary

a. Use an intermediate carrier to provide necessary actions if it is not possible to use existing objects or parts.
b. Temporarily merge your object with another one that will provide the required action and then decompose them.

25. Self-service

a. The object must serve itself by performing tuning, adjusting and repair operations itself.
b. Use available resources or waste resources.

26. Use of Copies

a. If you need to undertake some actions with respect to unavailable, fragile, complicated, or dangerous object, use its simpler and cheaper copy.
b. Instead of real objects, use their optical images (pictures, holograms).
c. Use infrared or ultraviolet copies.

27. Cheap Short-life Instead of Costly Long-life

a. Replace an expensive object with many cheap objects which deliver the same function.

28. Mechanical Principle Replacement

a. Replace mechanical principle behind your system or object with another physical principle: optical, acoustic, magnetic, electromagnetic, thermal, etc.

29. Pneumatic and Hydraulic Structures

a. Instead of a solid object or its parts, use gases or liquids: inflatable and filled with liquids, air cushion, hydrostatic and hydro-dynamic.

30. Flexible Shells and Thin Films

a. Instead of heavy three-dimensional structures use flexible shells and thin films.
b. Use flexible shells and thin films to isolate the object or its part from environment.

31. Porous Materials

a. Make your object porous.
b. Use porous coating.
c. Use porous inserts.
d. If the object is porous, fill the pores with other substance, liquid or gas to achieve positive effect.

32. Changing Color

a. Change the color of the object, its part or environment.
b. Change transparency of the object, its part or environment.

33. Homogeneity

a. Make interacting objects of the same material or the material with identical properties.

34. Reject and Regeneration of Parts

a. If a part of an object that has delivered its function had become unnecessary or undesired, eliminate it by dissolving, evaporating, etc. or modify so that the interfering property will cease to exist.
b. Restore consumable parts of the object during operation.

35. Change of Physical and Chemical Parameters

a. Change the object's aggregate state.
b. Change concentration or composition of the object.
c. Change the degree of flexibility of the object.
d. Change the temperature of the object or environment.

36. Phase transitions

a. Use physical phenomena accompanied by phase transitions: change of volume, emission or absorption of heat, etc.

37. Thermal Expansion

a. Use thermal expansion or contraction of materials.
b. Merge two materials with different coefficients of thermal expansion.

38. Strong Oxidizers

a. Replace regular air with enriched air.
b. Replace the enriched air with pure oxygen.
c. Ionize air or oxygen.
d. Use ozonized oxygen.
e. Use ozone.

39. Inert Atmosphere

a. Use inert gases instead of usual ones.
b. Add neutral parts or additives to the object.

40. Composite materials

a. Replace homogeneous materials with composite ones.