

TRIZ 40 Design Principles

(Adapted from Slides Developed by Darryl Mann, Creax)



Principle 3. Local Quality

A - Change an object's structure from uniform to non-uniform

- Reduce drag on aerodynamic surfaces by adding riblets or 'shark-skin' protrusions
- Moulded hand grips on tools
- Drink cans shaped to facilitate stable stacking
- Material surface treatments/coatings - plating, erosion/corrosion protection, non-stick, etc

B - Change an external environment (or external influence) from uniform to non-uniform

- Use a temperature, density, or pressure gradient instead of constant temperature, density or pressure
- Introduce turbulent flow around an object to alter heat transfer properties

C - Make each part of an object function in conditions most suitable for its operation

- Freezer compartment in refrigerator
- Different zones in the combustion system of an engine

D - Make each part of an object fulfil a different and/or complementary useful function.

- Swiss-Army knife
- Combined can and bottle opener
- Hammer with nail puller



Principle 5. Merging

A - Bring closer together (or merge) identical or similar objects or operations in space

- Automatic rifle/machine gun
- Multi-colour ink cartridges
- Multi-blade razors
- Bi-focal lens spectacles
- Double/triple glazing
- Strips of staples
- Catamaran/trimaran



B - Make objects or operations contiguous or parallel; bring them together in time

- Combine harvester
- Manufacture cells
- Grass collector on a lawn-mower
- Mixer taps
- Pipe-lined computer processors perform different stages in a calculation simultaneously
- Vector processors perform the same process on several sets of data in a single pass
- Fourier analysis – integration of many sine curves

Principle 7. Russian Dolls “Nested Doll”

A - Place one object inside another

- Place a safe inside a wall or under floorboards
- Retractable aircraft under-carriage
- Introduce voids into 3D structures
- Injected cavity-wall insulation
- Paint-brush attached to inside of lid of nail-varnish, etc
- Lining inside a coat

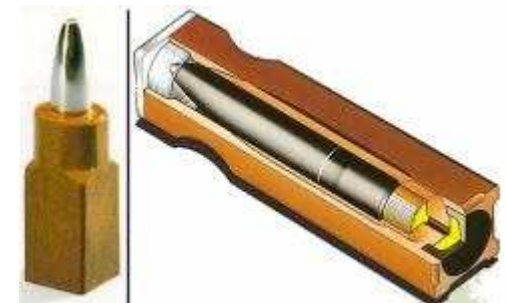


B - Place multiple objects inside others

- Nested tables
- Telescope
- Measuring cups or spoons
- Stacking chairs
- Multi-layer erosion/corrosion coatings

C - Make one part pass (dynamically) through a cavity in the other.

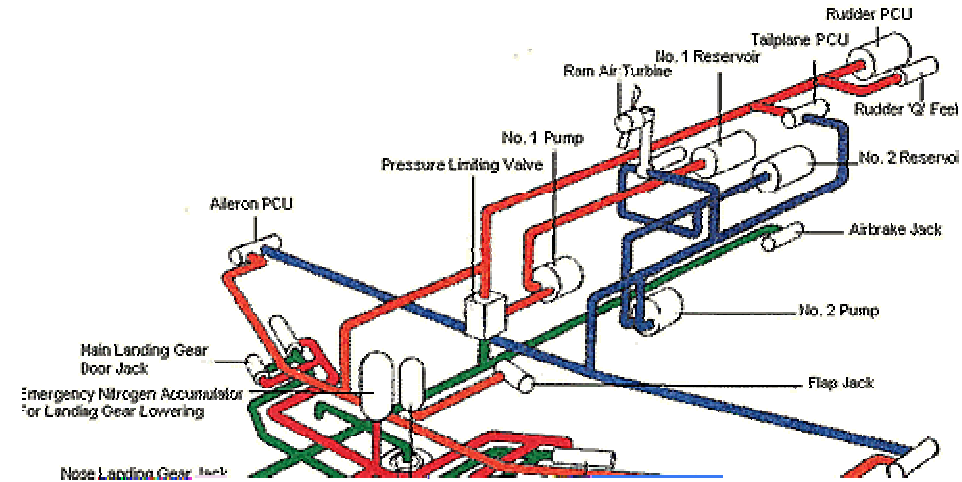
- Telescopic car aerial
- Retractable power-lead in vacuum cleaner
- Seat belt retraction mechanism
- Tape measure
- Stacked charge ammunition



Principle 9. Preliminary Anti-action

A - If it will be necessary to perform an action with both harmful and useful effects, this action should be replaced with anti-actions to control harmful effects

- Make clay pigeons out of ice or dung in order that they do not have to be collected afterwards.
- Masking objects before harmful exposure: Use a lead apron on parts of



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)

- To loosen stuck parts, cool the inner part instead of heating the outer part.
- Vacuum casting
- Test pressure vessel by varying pressure outside rather than inside the vessel
- Test seal on a liquid container by filling with pressurised air and immersing in liquid; trails of bubbles are easier to trace than slow liquid leaks
- Place nuts in a vacuum to get them out of their shells
- “Upside-down” motorcycle forks



B - Make movable parts (or the external environment) fixed, and fixed parts movable)

- Hamster wheel
- Rotate the part instead of the tool.
- Wind tunnels
- Moving sidewalk with standing people

C - Turn the object (or process) 'upside down'

- Clean bottles by inverting and injecting water from below; the water then drains by itself.
- Turn an assembly upside down to insert fasteners
- Open tinned beans from the bottom to get out beans that would otherwise have stuck to the bottom due to storage

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 conditionA

- Adjustable steering wheel (or seat, or back support, or mirror position...)
- Gel fillings inside seat allow it to adapt to user
- Shape memory alloys/polymers.
- Racing car suspension adjustable for different tracks and driving techniques
- Telescopic curtain rail allows for "one size fits all"



B - Divide an object into parts capable of movement relative to each other

- Articulated lorry
- Folding chair/mobile phone/laptop/etc
- Brush seals

C - If an object (or process) is rigid or inflexible, make it movable or adaptive

- Bendy drinking straw
- Flexible joint

D - Increase the degree of free motion

- Use of different stiffness fibres in toothbrush – easily deflected at the edges to prevent gum damage, hard in the middle
- Loose sand inside truck tyre gives it self-balancing properties at speed

Principle 19. Periodic Action

A - Instead of continuous action, use periodic or pulsating actions

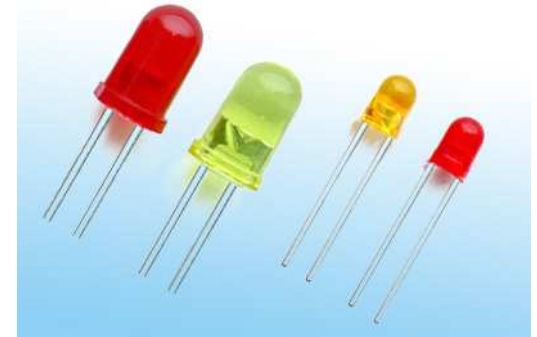
- Hitting something repeatedly with a hammer
- Pile drivers and hammer drills can exert far more force for a given weight
- Replace a continuous siren with a pulsed sound.
- Pulsed bicycle lights make cyclist more noticeable to drivers
- Pulsed vacuum cleaner suction improves collection performance
- Pulsed water jet cutting

B - If an action is already periodic, change the periodic magnitude or frequency

- Replace a pulsed siren with sound that changes amplitude and frequency.
- Washing machine/dish-washer water injection operates uses different cycles for different load types.
- Dots and dashes in Morse Code transmissions
- Use AM, FM, PWM to transmit information

C - Use pauses between actions to perform a different action

- Clean barrier filters by back-flowing them when not in use.
- Inkjet printer cleans heads between passes
- Brush between suction pulses in vacuum cleaner.
- Multiple conversations taking place along the same telephone transmission line.
- Use of energy storage means – e.g. batteries, fly-wheels, etc



Principle 21. Skipping

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

- Use a high speed dentist's drill to avoid heating tissue.
- Laser eye surgery
- Cut plastic faster than heat can propagate in the material, to avoid deforming the shape.
- Break toffee with an impulsive blow from a hammer
- Drop forge
- Flash photography
- Super-critical shaft – run through resonant modes quickly



Principle 23. Feedback

A - Introduce feedback (referring back, cross-checking) to improve a process or action

- Automatic volume control in audio circuits
- Signal from gyrocompass is used to control simple aircraft autopilots.
- Engine management system based on exhaust gas levels more efficient than carburettor
- Thermostat controls temperature accurately
- Statistical Process Control - Measurements are used to decide when to modify a process
- Feedback turns inaccurate op-amp into useable accurate amplifier

B - If feedback is already used, change its magnitude or influence in accordance with operating conditions

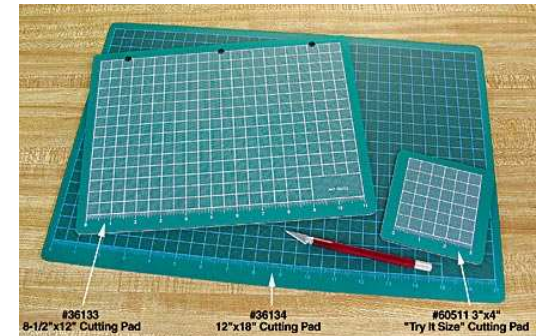
- Change sensitivity of an autopilot when within 5 miles of an airport.
- Change sensitivity of a thermostat when cooling vs. heating, since it uses energy less efficiently when cooling.
- Use proportional, integral and/or differential control algorithm combination



Principle 25. Self-service

A - Make an object serve or organise itself by performing auxiliary helpful functions

- A soda fountain pump that runs on the pressure of the carbon dioxide that is used to "fizz" the drinks. This assures that drinks will not be flat, and eliminates the need for sensors.
- Halogen lamps regenerate the filament during use--evaporated material is redeposited.
- Self-aligning/self-adjusting seal
- Self-locking nut
- Self-cleaning oven/glass/material
- Self-repairing structures
- Abradable materials used in engines such that initial running-in 'cuts' optimum seals into lining
- "Self-healing" cutting mat.



B - Use waste resources, energy, or substances

- Use heat from a process to generate electricity: "Co-generation".
- Use animal waste as fertilizer.
- Use food and lawn waste to create compost.
- Use pressure difference to reinforce seal action

Principle 27. Cheap Short-Lived Objects

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

- Disposable nappies/paper-cups/plates/cameras/torches/etc
- Matches versus lighters
- Throw-away cigarette lighters
- Industrial diamonds used in cutting tools
- Sacrificial coatings/components
- Post-Its
- Discarding-sabot armour piercing round.



Principle 29. Pneumatics and Hydraulics

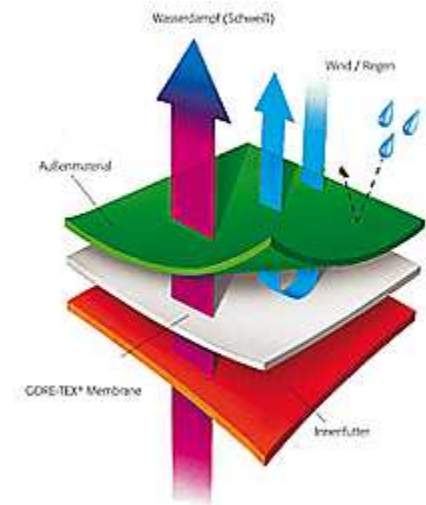
A - Use gas and liquid parts of an object instead of solid parts (e.g. inflatable, filled with liquids, air cushion, hydrostatic, hydro-reactive)



Principle 31. Porous Materials

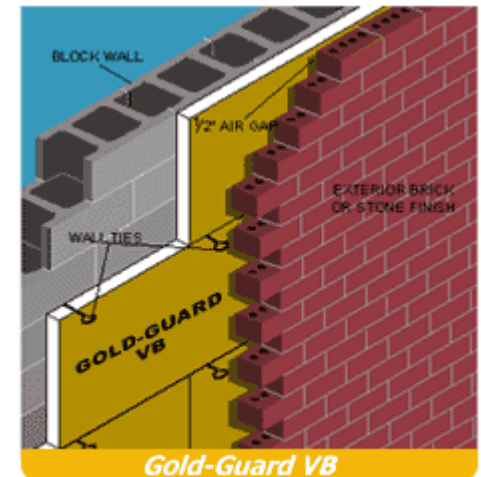
A - Make an object porous or add porous elements (inserts, coatings, etc.)

- Drill holes in a structure to reduce the weight.
- Cavity wall insulation
- Transpiration film cooled structures
- Foam metals
- Use sponge-like structures as fluid absorption media
- Goretex fabric



B - If an object is already porous, use the pores to introduce a useful substance or function

- Use a porous metal mesh to wick excess solder away from a joint.
- Store hydrogen in the pores of a palladium sponge. (Fuel "tank" for the hydrogen car--much safer than storing hydrogen gas)
- Dessicant in polystyrene packing materials
- Medicated swabs/dressings



Principle 33. Homogeneity

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

- Make the container out of the same material as the contents, to reduce chemical reactions.
- Friction welding requires no intermediary material between the two surfaces to be joined.
- 'Liquid paper' for correcting mistakes when writing
- Temporary plant pots made out of compostable material
- Human blood transfusions/transplants, use of bio-compatible materials
- Make ice-cubes out of the same fluid as the drink they are intended to cool
- Join wooden components using (wood) dowel joints
- Graphite "solid" pencil.



Principle 35. Parameter Changes

A - Change an object's physical state (e.g. to a gas, liquid, or solid)

- Transition from mechanical to fluid or electrical drives
- Vaporise (or freeze) mercury to ease placing of very small amounts into fluorescent light-bulb

B - Change the concentration or consistency

- Liquid versus bar or powder detergents.
- Abradable linings used for gas-turbine engine seals

C - Change the degree of flexibility

- Use adjustable dampers to reduce the noise of parts falling into a container by restricting the motion of the walls of the container.
- Compliant brush seals rather than labyrinth or other fixed geometry seals

D - Change the temperature

- Raise the temperature above the Curie point to change a ferromagnetic substance to a paramagnetic substance.
- Lower the temperature of medical specimens to preserve them for later analysis

E - Change the pressure.

- Pressure cooker cooks more quickly and without losing flavours.
- Electron beam welding in a vacuum.

F - Change other parameters

- Shape memory alloys/polymers
- Use high conductivity materials – e.g. carbon fibre

