

Midlands Engine and Energy Research Accelerator's Green Innovation Network

12th January 2023

Innovation Techniques: Thinking Inside the Box

Some innovation techniques that I have found to be powerful, including:

- TRIZ
- Effective Objectives Setting
- Biomimicry

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Innovation Techniques: Thinking Inside the Box

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Innovation Techniques

TRIZ: Russian acronym "...problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature..." or "*Theory of Inventive Problem Solving*"

Pioneered by **Genrich Altshuller**

Example of one of Altshuller's early successes:



Lunar lander surface proximity system:

Essential component: a light source

Lunar module landing tests repeatedly led to bulb failure

Solution Process

1. Establish failure mode: glass breaking
2. Break problem down to fundamental requirements:
 - a. Glowing filament

Solution

On moon, no air/oxygen to burn the filament.
Therefore, a glass bulb envelope not required.

Therefore, just use a filament on its own with no glass bulb. Problem solved

An example of deleting a feature to improve the design.

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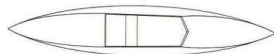
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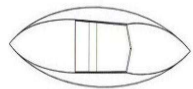
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Use of Contradictions or Conflicts to help with innovation and invention

Example: **Boat design**



Long, narrow boats → Less drag, but less stable

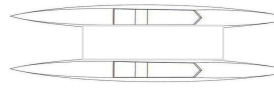


Short, wide boats → More stable, but more drag

Conflict ↑↓

This conflict can stimulate or drive innovation

e.g. a possible solution or 'innovation':



Twin hull, catamaran → Low drag and stable

1. Clearly state the conflicts
2. Resolve the conflicts
3. Result: invention/innovation



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Genrich Altshuller found from looking at >40,000 patents

40 Inventive Principles:

1. Segmentation
2. Taking out
3. Local Quality
4. Asymmetry
5. Merging
6. Universality
7. "Nested doll"
8. Anti-weight
9. Preliminary anti-action
10. Preliminary action
11. Beforehand cushioning
12. Equipotentiality
13. The other way around
14. Spheroidality
15. Dynamics
16. Partial or excessive actions
17. Another dimension
18. Mechanical vibration
19. Periodic action
20. Continuity of useful action
21. Skipping
22. "Blessing in disguise"
23. Feedback
24. 'Intermediary'
25. Self-service
26. Copying
27. Cheap short-living
28. Mechanics substitution
29. Pneumatics and hydraulics
30. Flexible shells and thin films
31. Porous materials
32. Color changes
33. Homogeneity
34. Discarding and recovering
35. Parameter changes
36. Phase transitions
37. Thermal expansion
38. Strong oxidants
39. Inert atmosphere
40. Composite material films

See: <https://www.slideserve.com/iria/what-is-triz> (last accessed 26-11-2022)

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40 Inventive Principles:

https://commons.wikimedia.org/wiki/File:40_inventive_principles_of_TRIZ_method_2006en.jpg



40 Inventive principles of TRIZ (Genrich Altshuller found from looking at >40,000 patents):

Principle 1 Segmentation

see <http://www.triz.co.uk>

A. Divide an object into independent parts

- Socket spanners
- Large truck replaced by truck and trailer
- Multi-pin connectors
- Multiple pistons in an internal combustion engine
- Multi-engined aircraft
- Stratification of different constituents inside a chemical process vessel



B. Make an object sectional - easy to assemble or disassemble

- Rapid-release fasteners for bicycle saddle/wheel/etc.
- Quick disconnect joints in plumbing and hydraulic systems
- Single fastener V-band clamps on flange joints
- Loose-leaf paper in a ring binder



C. Increase the degree of fragmentation or segmentation

- Multiple control surfaces on aerodynamic structures
- Multi-zone combustion system
- Build up a component from layers (e.g. stereo-lithography, welds, etc.)



Google: "40 Inventive Principles With Examples" to find .pdf document



40 Inventive principles of TRIZ (Genrich Altshuller found from looking at >40,000 patents):

Principle 2 Taking-Out

A. Extract the disturbing part or property from an object

- Use fibre optics or a light pipe to separate the hot light source from the location where light is needed.

- Air Conditioning in the room where you want it with the noise of the system outside the room

(The contradiction here is noise vs coolness: the cooler it gets the noisier it gets. This solves the contradiction by putting the noise elsewhere)

B. Extract the only necessary part (or property) of an object

- Sound of a barking dog (with no dog) as a burglar alarm
- Economy class on planes or budget airlines (travel but no frills)
- Scarecrow



- Porsche: deleted features for light weight (but more expensive!)

Google: "40 Inventive Principles With Examples" to find .pdf document

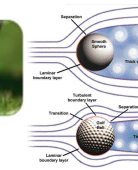


40 Inventive principles of TRIZ (Genrich Altshuller found from looking at >40,000 patents):

Principle 3 Local Quality

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

- Reduce drag on aerodynamic surfaces by adding riblets or 'shark-skin' protrusions; or golf balls
- Moulded hand grips on tools
- Drink cans shaped to facilitate stable stacking
- Material surface treatments / coatings – plating to prevent corrosion



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

- 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
- Night-time adjustment on a car rear-view mirror

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

- Sharp and blunt end of a drawing pin
- Rubber on the end of a pencil
- Hammer with nail puller



40 Inventive principles of TRIZ (Genrich Altshuller found from looking at >40,000 patents):

Principle 17 Another Dimension

A. Move into an additional dimension - from one to two - from two to three

- Coiled telephone wire
- Pizza-box with ribbed (as opposed to flat) base
- Helical staircase uses less floor area
- Introduction of down and up slopes between stations on railway reduces overall power requirements



B. Go from single storey or layer to multi-storey or multi-layered

- Stacked or multi-layered circuit boards
- Multi-storey office blocks or car-parks



C. Incline an object, lay it on its side

- Cars on road transporter inclined to save space

D. Use the other side

- Mount electronic components on both sides of a circuit board
- Print text around the rim of a coin
- Paper clip - works by pressing both sides of paper together



Google: "40 Inventive Principles With Examples" to find .pdf document



...and the 39 TRIZ Features (found from initially looking at >40,000 patents):

39 TRIZ Features:

1: Weight of moving object	14: Strength	27: Reliability
2: Weight of stationary object	15: Durability of moving object	28: Measurement accuracy
3: Length of moving object	16: Durability of non moving object	29: Manufacturing precision
4: Length of stationary object	17: Temperature	30: Object-affected harmful
5: Area of moving object	18: Illumination intensity	31: Object-generated harmful
6: Area of stationary object	19: Use of energy by moving object	32: Ease of manufacture
7: Volume of moving object	20: Use of energy by stationary object	33: Ease of operation
8: Volume of stationary object	21: Power	34: Ease of repair
9: Speed of object	22: Loss of Energy	35: Adaptability or versatility
10: Force (Intensity)	23: Loss of substance	36: Device complexity
11: Stress or pressure	24: Loss of Information	37: Difficulty of detecting
12: Shape	25: Loss of Time	38: Extent of automation
13: Stability of the object	26: Quantity of substance	39: Productivity

See: <https://slideplayer.com/slide/8454683/> (slide 16) (last accessed 26-11-2022)



If you wish to try TRIZ out...

1. Spend 15 minutes in pairs or threes writing down some "contradictions" or "conflicts" related to company products, processes or services – i.e. like the boat example. (If you can, try to establish initial **key questions**).

X, Y causes A, B
Long, narrow boats → Less drag, but less stable
Short, wide boats → More stable, but more drag



Or, if you prefer, think of "conflicts" in the design or operation of everyday objects, devices or processes.

- Don't try to think of solutions initially.

2. Then choose some of these and see if, as a larger group, you can **innovate/invent** to try to solve some of these conflicts; or at least establish the **key questions** that need addressing.

If you need to, Google: "40 Inventive Principles With Examples" to find .pdf document with examples



Innovation Techniques

Effective Objectives Setting:

1. Defining the 'box'
2. Thinking inside the box

Think about what resources we have got at our disposal – in total



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Some further thoughts:

- ❑ A **change of perspective** can be powerful
- ❑ Key task: **defining the question(s)**
- ❑ Sometimes useful to think of the **5 human senses** and/or the **many of forms of energy:** mechanical, chemical, electrical, etc. and/or use of **biomimicry** when looking for a solution

Archer Fish:
Targeted jets

Duck Leg:
Controlled counterflow heat exchangers

Flagellum Bacterium: Actuators; motors

Box Fish:
Mercedes low drag car

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