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Stimulating creativity by dealing with conflicts and contradictions (Triz)
Can we teach creativity?

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School of
Engineering

No.1 UNIVERSITY
IN GREATER MANCHESTER FOR STUDENT SATISFACTION
NATIONAL STUDENT SURVEY 2017

TEF Silver Teaching Excellence Framework

CAN WE TEACH PEOPLE TO CREATE AND TO INNOVATE?

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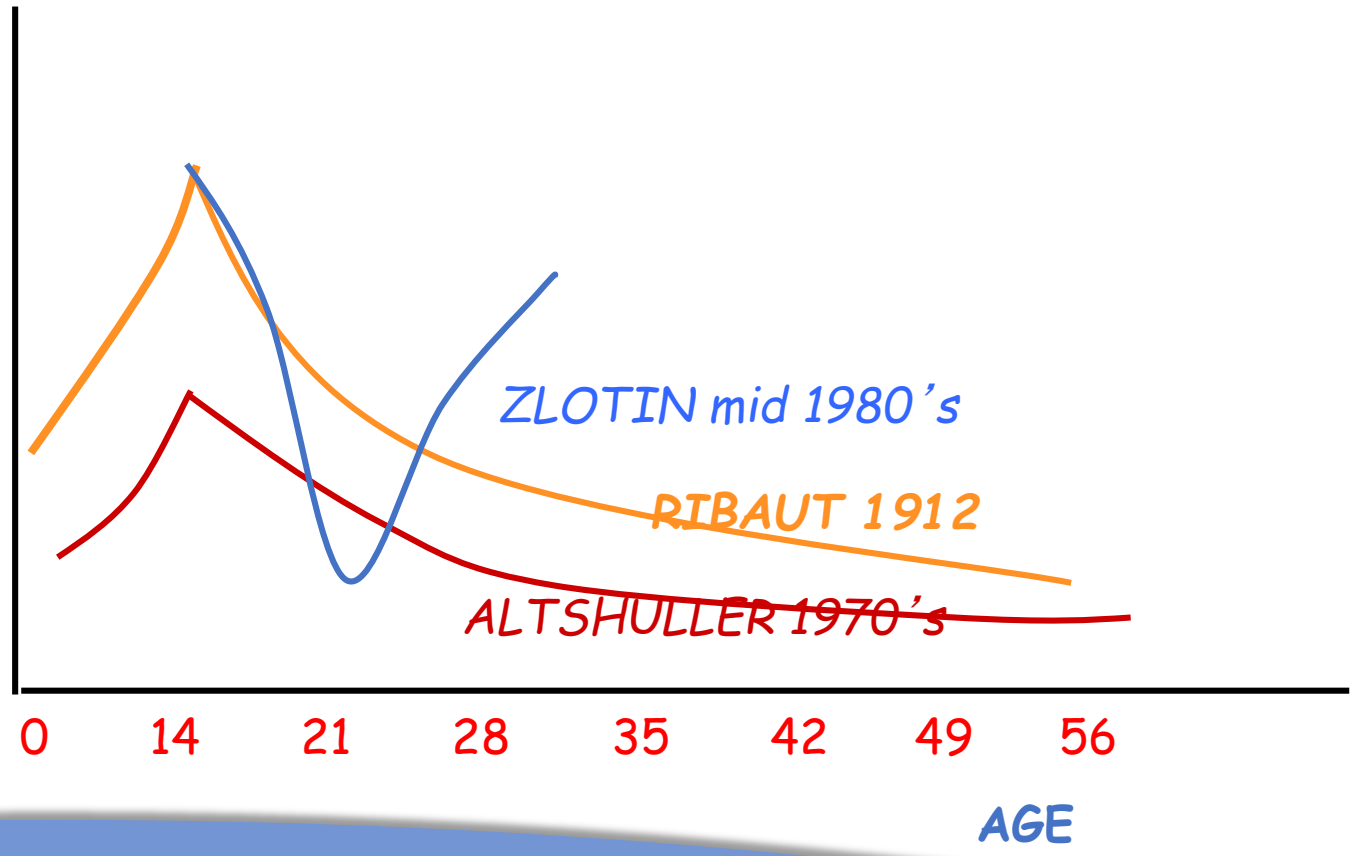
- Many tools and theories available
- Almost all involve teamwork and breaking down psychological barriers to thinking
- Creativity and innovation involves:
  - Finding unique solutions to problems
  - Seeing solutions which are not obvious to others but often delightfully simple
  - Broadening the mind beyond the scope of the present problem
  - Harnessing an organisations intrinsic innovative talent
  - Thinking laterally
  - Exploiting new ideas

Creativity versus Age



TRIZ

- Russian Acronym – TEORIYA RESHENIYA IZOBRETATELSKIKH ZADATCH - which translated means Theory of Inventive Problem Solving:
- Genrich Altshuller – Started work in TRIZ in 1946 when employed as a Russian Patent Agent

http://www.xtriz.com/BriefHistoryOfTRIZ.pdf

TRIZ - FUNDAMENTAL CONCEPT

THE LIKELIHOOD IS THAT SOMEONE SOMEWHERE IN THE WORLD HAS ENCOUNTERED YOUR PROBLEM AT SOMETIME AND FOUND A SOLUTION

History of TRIZ

- Altshuller began developing TRIZ methodology while working as a Patent Agent in Russia.
- By 1969 he had reviewed about 40,000 patent abstracts in order to find out in what way the innovation had taken place.
- He concluded
  - ONLY 40 Principles of invention (today over 2 million patents have been studied-but still only 40 principles) https://www.triz.co.uk/files/U48432_40_inventive_principles_with_examples.pdf
  - Creative inventions involve resolving technical and physical contradictions
  - The evolution of all technical systems follow a pattern
  - The concept of Ideality is an important step in defining a problem

40 Inventive Principles

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1. Segmentation	11. Prior Cushioning	21. Hurrying	31. Holes
2. Taking Out	12. Remove Tension	22. Blessing in Disguise	32. Colour Changes
3. Local Quality	13. The Other Way Around	23. Feedback	33. Homogenity
4. Assymmetry	14. Spheroidality/Curvature	24. Intermediary	34. Discarding and Recovering
5. Merging	15. Dynamics	25. Self- Sevice	35. Parameter Changes
6. Universality	16. Slightly Less/Slightly More	26. Copying	36. Paradigm Shift
7. Nested Doll	17. Another Dimension	27. Cheap Disposable	37. Relative Changes
8. Counter-Balance	18. Resonance	28. Another Sense	38. Enriched Atmosphere
9. Prior Counter-Action	19. Periodic Action	29. Fluidity	39 Inert Environment
10. Prior Action	20. Continuity of Useful Action	30. Thin and Flexible	40. Composite Materials

Principle 1
Segmentation

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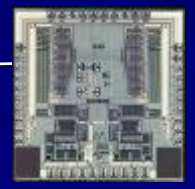
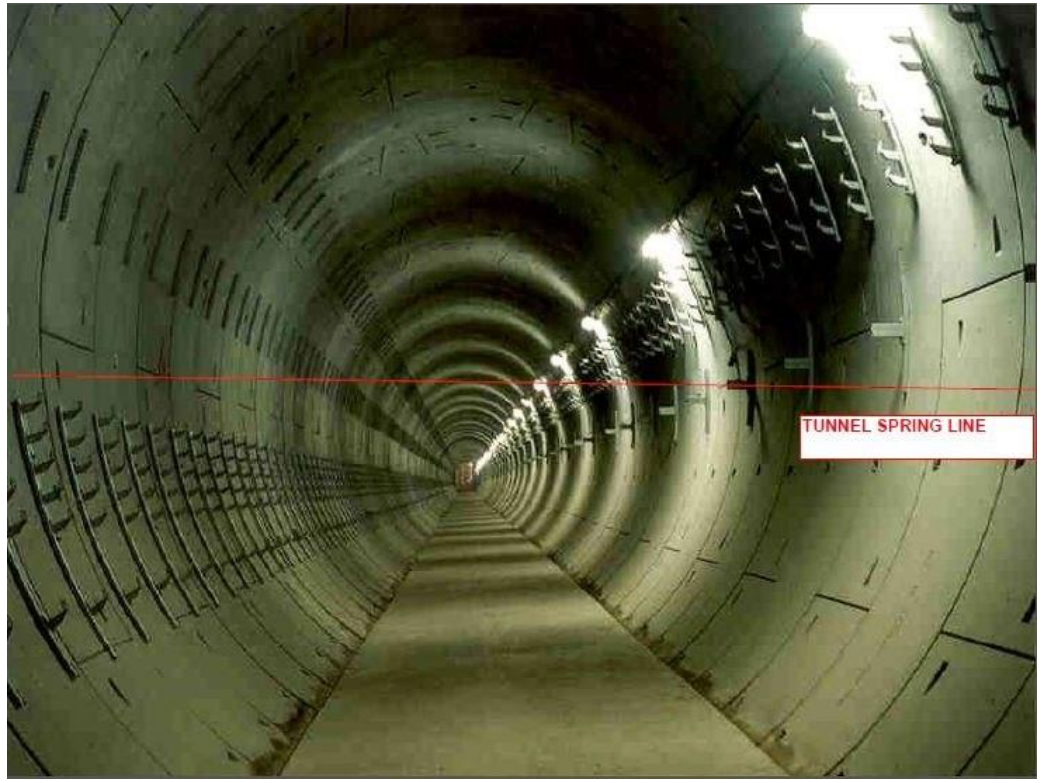
A. Divide an object into independent parts
- Integrated circuit
- Pocket-spring mattress
- Sieve



B. Make an object sectional - easy to assemble or disassemble
- Rapid-release fasteners for bicycle saddle/wheel/etc
- Quick connect joints in plumbing systems
- Plugs and sockets for electrical connections
- 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)
- Modular study programmes
- Multiple choice exams

Principle 1 -Segmentation
Tunnel built in Segments



Principle 1 -Segmentaion

Principle 4-Assymetry
Sydney Opera House

Principle 13 – The Other Way Round

Floating Bridge
Principle 29 - Fluidity

Temporary Bridge Structure Principle 34 – Discarding/Recovering

The TRIZ Definition of an Inventive Problem

An inventive problem is one which consists of a harmful function (or the absence of a useful one) whose elimination is important because:

1. *The method of resolving the problem is unknown.*

OR

2. *Use of the known and generally accepted means of resolving a problem leads to the appearance of another problem.*

Basis of TRIZ

- Ideality – The ideal system is one without the system or with all harmful elements removed.
- Functionality – Focus on the main useful function of a system and remove all non useful or harmful functions.
- Thinking in Space and Time – Look into the past, the present, the future, the system
- Resources – Often we already have the resource to solve a problem.
- Contradictions – Almost all inventive problems involve a conflict or a contradiction:
  - One thing improves another thing gets worse
  - We want something for one reason. We don't want it for another reason.

Some Useful Links

www.creax.com

www.ideationtriz.com

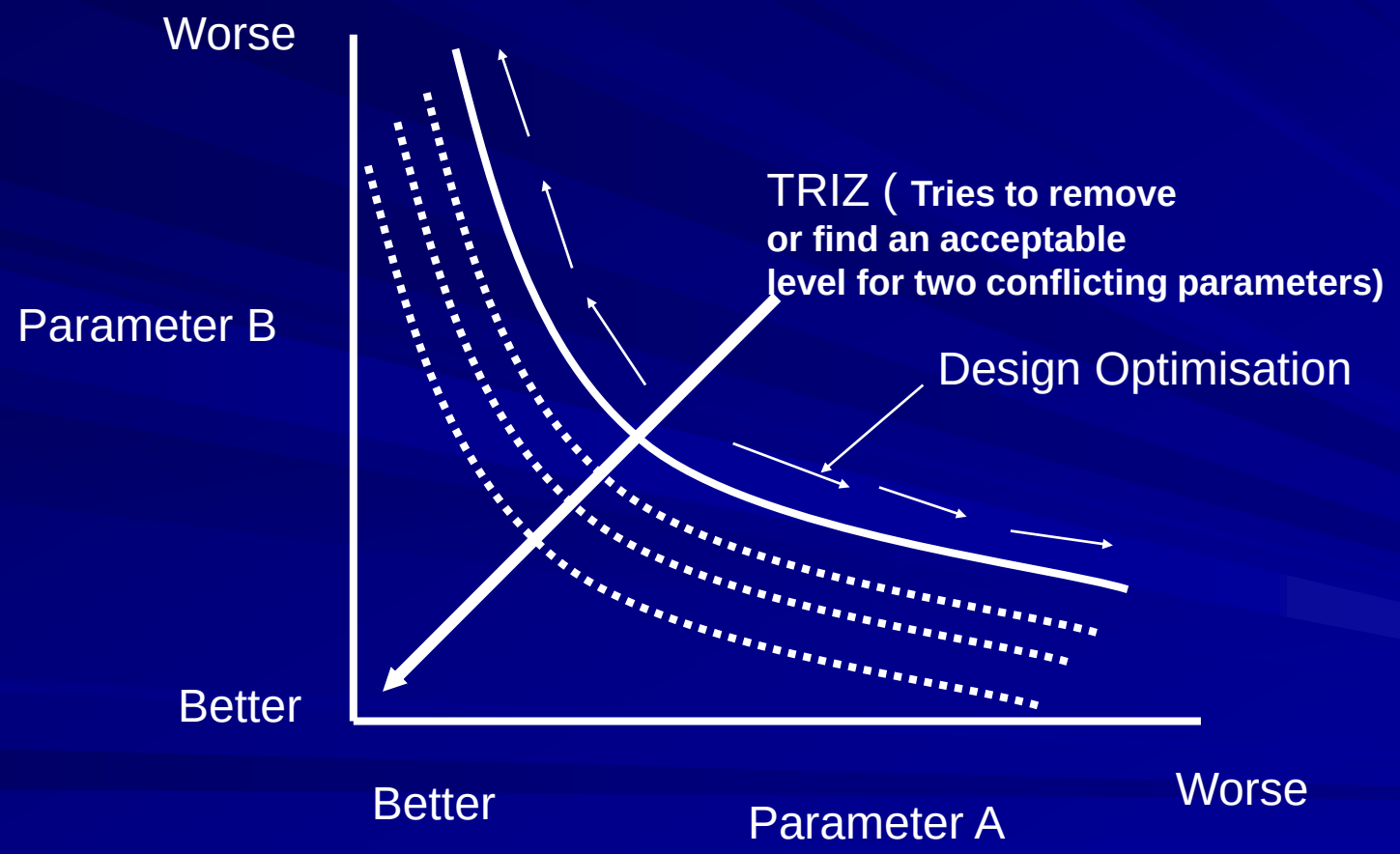
www.triz-journal.com

www.systematic-innovation.com

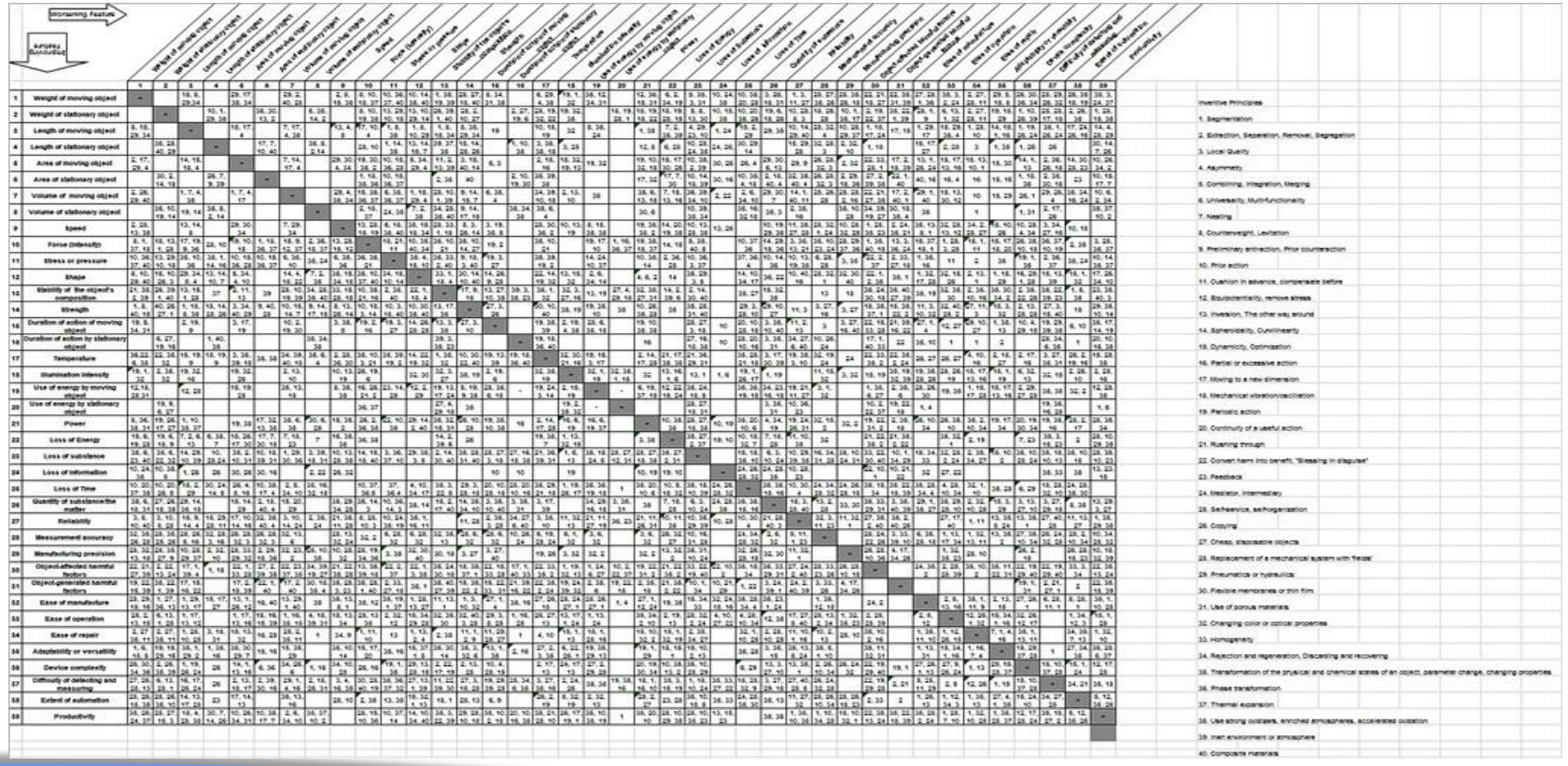
CONTRADICTIONS

- One of the principal concepts of TRIZ is based upon the fact that the solution to all inventive problems involves contradictions:
- Technical contradiction – a challenge to be overcome when known alternatives to improve one aspect of design do so at the expense of another aspect e.g. increasing a wall thickness improves strength but increases the weight of the wall
- Physical contradiction – a situation where we may want to increase or do something for one reason or decrease or do something opposite for another reason e.g. a window to let light in or to be obscure for privacy

TECHNICAL CONTRADICTIONS



CONTRADICTION MATRIX



Contradiction Matrix

Feature → / Improving Feature ↓	Weight of moving ol	Weight of stationa object	Length of moving ol	Length of stationa object	Area of moving obj	Area of stationary ol	Volume of moving o	Volume of stationa object	Speed	Force (Intensity)	Stress or pressur	Shape
	1	2	3	4	5	6	7	8	9	10	11	12
Weight of moving object	+	-	15, 8, 29,34	-	29, 17, 38, 34	-	29, 2, 40, 28	-	2, 8, 15, 38	8, 10, 18, 37	10, 36, 37, 40	10, 14, 35, 40
Weight of stationary object	-	+	-	10, 1, 29, 35	-	35, 30, 13, 2	-	5, 35, 14, 2	-	8, 10, 19, 35	13, 29, 10, 18	13, 10, 29, 14
Length of moving object	8, 15, 29, 34	-	+	-	15, 17, 4	-	7, 17, 4, 35	-	13, 4, 8	17, 10, 4	1, 8, 35	1, 8, 10, 29
Length of stationary object		35, 28, 40, 29	-	+	-	17, 7, 10, 40	-	35, 8, 2,14	-	28, 10	1, 14, 35	13, 14, 15, 7
Area of moving object	2, 17, 29, 4	-	14, 15, 18, 4	-	+	-	7, 14, 17, 4		29, 30, 4, 34	19, 30, 35, 2	10, 15, 36, 28	5, 34, 29, 4
Area of stationary object	-	30, 2, 14, 18	-	26, 7, 9, 39	-	+	-		-	1, 18, 35, 36	10, 15, 36, 37	
Volume of moving object	2, 26, 29, 40	-	1, 7, 4, 35	-	1, 7, 4, 17	-	+	-	29, 4, 38, 34	15, 35, 36, 37	6, 35, 36, 37	1, 15, 29, 4

CONTRADICTIONS IN PRACTICE

- *As the length of a stationary object increases - **IMPROVES***
- *Its Shape - **GETS WORSE***
  - ***Example – We want a long bridge but its weight causes it to sag.***

The Contradiction Matrix shows:

Inventive Principles – 13 (The Other Way Round)
14 (Spheroidality – Curvature)
15 (Dynamics)
7 (Nested Doll)

Kingston-Rhinecliff Bridge-USA
Principle 13-The Other Way Round

Principle 14-Spheroidality/Curvature Double Helix Bridge - Singapore

Clifton Suspension Bridge Principle 15 - Dynamisation

Roller-mounted "saddles" at the top of each tower allow movement of the chains when loads pass over the bridge.

Principle 7 Nested Doll Telescopic Bridge

Physical Contradictions

- The 4 principles used for separating physical contradictions are:
- Separation in SPACE (Where?)
- Separation in TIME (When ?)
- Separation ON CONDITION (What ?)
- Separation by TRANSITION TO AN ALTERNATIVE SYSTEM

Physical Contradictions

- Physical contradictions are those situations where we desire different properties of a certain parameter
- e.g.
- Big and Small
- Hot and Cold
- Transparent and opaque
- Rich and poor
- Such contradictions can be solved by separating the two properties

SEPARATION IN SPACE

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⑩ Inventive Principle:

1. Segmentation
2. Taking out
3. Local quality
17. Another Dimension
13. Other Way Around
14. Curvature
7. Nested Doll
30. Flexible shells/Thin Films
4. Asymmetry
24. Intermediary
26. Copying

Gatorgrip Socket

Collapsible Cup

Incidentally the two examples we have given require separation both in space and in time

SEPARATION IN TIME

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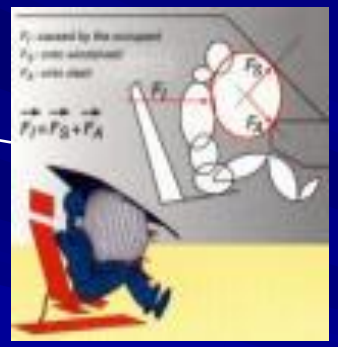
Inventive Principle:
15. Dynamics
10. Prior Action
19. Periodic Action
11. Beforehand Cushioning
16. Partial or Excessive Action
21. Skipping
26. Copying
18. Mechanical Vibration
37. Thermal Expansion
34. Discarding and Recovering
9. Prior Counter-Action
20. Continuity of Useful Action



SEPARATION ON CONDITION

- Inventive principle:
- 35 Parameter changes
- 32 Colour changes
- 31 Phase transition
- 38 Strong oxidants
- 39 Inert atmosphere
- 28 Mechanics substitution
- 29 Pneumatics and hydraulics

Reactolite sunglasses

Aerosol spray

TRANSITION TO AN ALTERNATIVE SYSTEM

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- 1. Transition to sub system
  - 1 Segmentation
  - 25 Self service
  - 40 Composite materials
  - 33 Homogeneity
  - 12 Equi-potentiality
- 2. Transition to super system
  - 5 Merging
  - 6 Universality
  - 23 Feedback
  - 22 Blessing in disguise
- 3. Transition to alternative system
  - 27 Cheap/short living
- 4. Transition to inverse system
  - 13 Other way round
  - 8 Counter weight

Functionality

- Every system has a Main Useful Function.
- Anything which does not contribute towards this Main Useful Function is essentially harmful.
- The functional relationship between every element of the system and every other element which either IMPROVES or HARMS the system is an important process in understanding the nature of the problem and is core to the TRIZ methodology.

Grenfell Tower

IDEALITY

- IDEALITY = $\frac{\text{(PERCIEVED) BENEFITS}}{\text{(COST + HARM)}}$
-

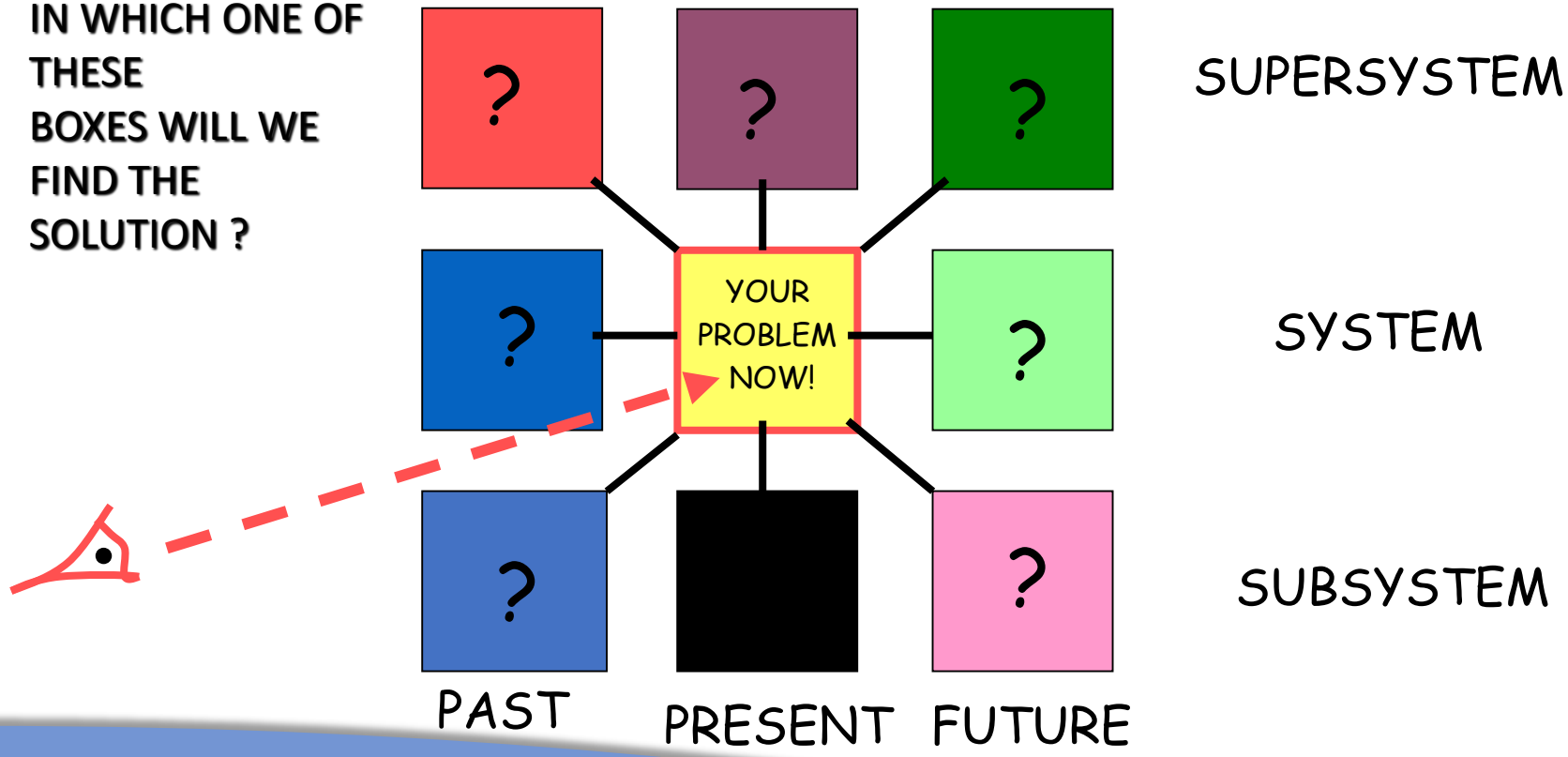
- As a system evolves it delivers more and more of the benefits and progressively less of the "bad things" until eventually we get to the state where the system is ideal and doesn't have any "bad things" – The IDEAL FINAL RESULT (IFR)

- ELIMINATE HARM OR CHANGE THE HARMFUL RESOURCES INTO USEFUL ONES !

- AN IDEAL SYSTEM IS ONE IN WHICH THE FUNCTION IS PERFORMED WITHOUT THE SYSTEM

Thinking in SPACE, TIME

IN WHICH ONE OF THESE BOXES WILL WE FIND THE SOLUTION ?



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