Теория Решения Изобретательских Задач

TRIZ@UPM

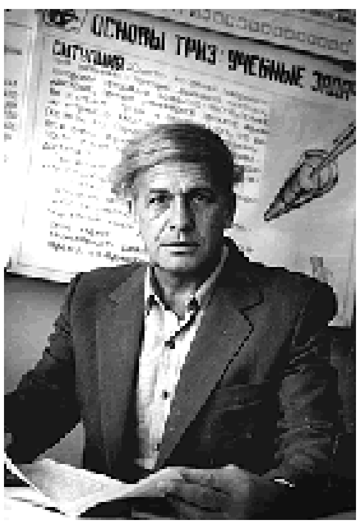
Theory of Inventive Problem Solving

Innovation

all innovations emerge from the application of a very small number of inventive principles and strategies.

What is TRIZ?

- TRIZ is the Russian acronym for the “Theory of Inventive Problem Solving”.
- It is a systematic problem solving method based on logic and data, not intuition or spontaneous creativity of individuals or groups



- Developed by Genrich Altshuller and his colleagues from 1946 through to 1985 in the former Union of Soviet Socialist Republics (USSR)
- It is based on the study of patterns of problems and solutions
- TRIZ provides repeatability, predictability, and reliability due to its structure and algorithmic approach
- It improves individual or team’s ability to solve problems

Key Discoveries

Initial analysis of patents (worldwide)

200,000

Synthesized down to just innovative patents

40,000

Are mined for…

* Today >2.8M patents have been analyzed & investigated

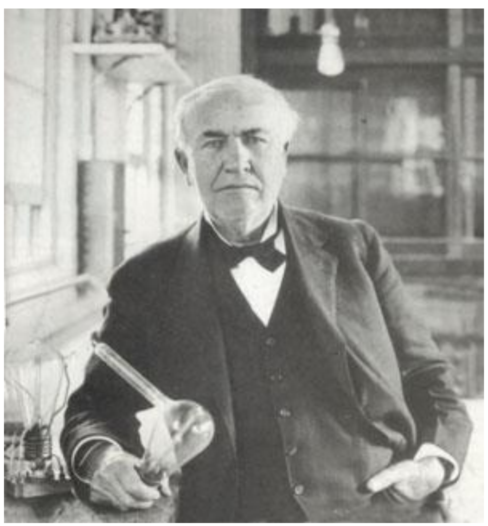
TRIZ is a statistically based family of <u>principles and strategies</u> enabling engineers to identify potential solution paths of technical problems

1. Problems and solutions were repeated across industries & sciences → 40 Inventive Principles for solving Problems
2. Patterns of technical evolution were repeated across industries & sciences → Technology Trends to evolve a technical system to the next generation
3. Innovations used scientific effects outside the field from where the original problem was found → Scientific Effects can be used to solve problems in unique ways

Why TRIZ?

Trial and error problem solving approach → Structured and systematic problem solving approach

Increase efficiency and speed of innovation



Thomas Alva Edison (1847 – 1931)
"Genius is one percent inspiration, ninety-nine percent perspiration"

In 1879, after spending $40,000, and performing 1,200 experiments with 5,000 researchers, Edison succeeded in making a light bulb using carbonized filaments from cotton thread. The light bulb burned for two days. The electric light took the greatest amount of time and required the most complicated experiments of all his experiments.

TRIZ Proliferation

methodology embraced by many corporations

- siemens
- samsung
- whirlpool
- lg
- christian dior
- intel
- boeing
- motorola
- procter & gamble
- delphi automotive

BusinessWeek

TECHNOLOGY December 25, 2008, 12:01AM EST

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Tech Innovations for Tough Times

How GE and others are using alternative techniques such as TRIZ to make R&D more efficient

By Steve Hamm

These days, TRIZ is coming on strong at corporations hungry for new ways to improve innovation and productivity beyond what they've already achieved with the widely adopted Six Sigma and Lean techniques. In addition to GE, TRIZ fans include Intel (INTC), Samsung, and Procter & Gamble (PG), as well as smaller companies like FuelCell Energy (FCEL), a Danbury (Conn.) leader in power-generation fuel cells. The company employed TRIZ to evaluate the expensive flanges it uses to join pipes in its generators. After weighing the component costs, effectiveness, and complexity of assembly, FuelCell switched to a new clamping technique that will slash costs by 50%.

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MAY 31, 2006

INNOVATION

By Reena Jana

BusinessWeek

The World According to TRIZ

Blue-chip American companies are embracing a 60-year-old innovation theory pioneered by a Russian inventor

Fast-forward to 2006. The list of American companies that have applied Altshuller's recipe for innovation includes Boeing (BA), Hewlett Packard (HPQ), IBM (IBM), Motorola (MOT), Raytheon (RTN), and Xerox (XRX), among others.

A Perpetual Crisis Machine

Samsung's VIP Center is home to a uniquely paranoid culture--and that's the way the boss likes it.

By PETER LEWIS

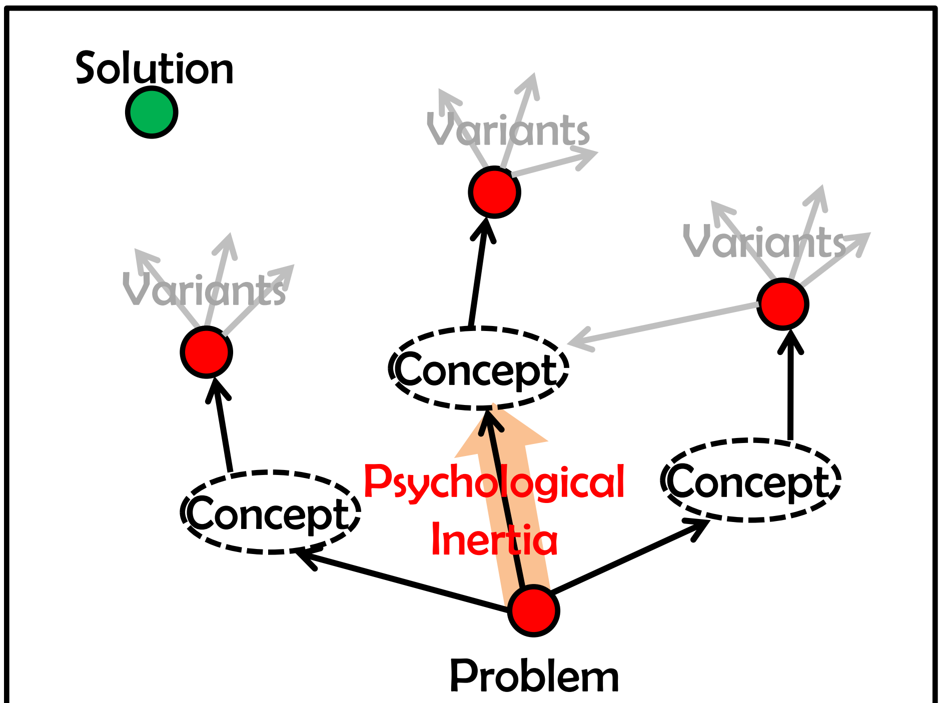
September 19, 2005

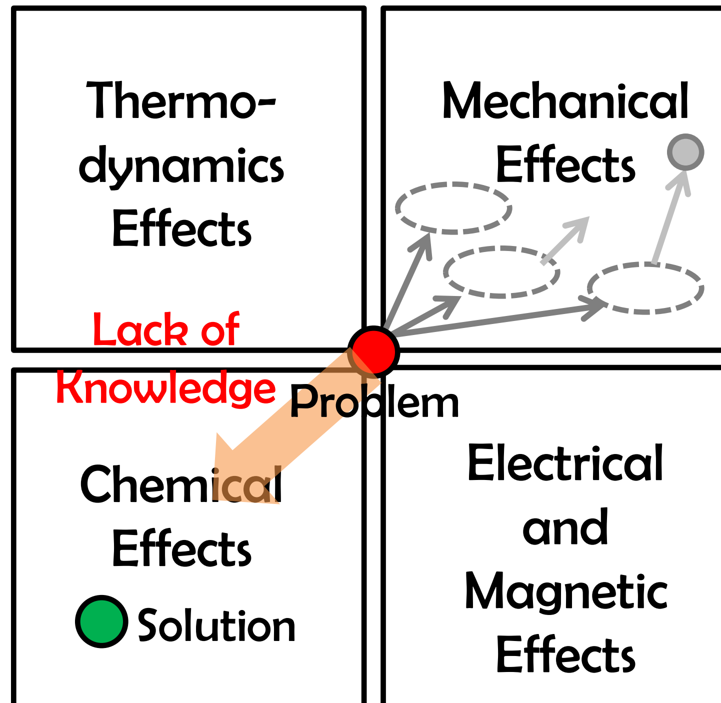
FORTUNE

In any event, TRIZ is by no means unique to Samsung; hundreds of companies--including competitors like Philips, LG, and Motorola--use it too. At the VIP Center, however, the goal is to train every engineer and researcher in the company in TRIZ think.

Limitation of usual problem solving methods

- Psychological inertia
- Lack of knowledge
- Wrong objective or goal
- Avoid conflict or contradiction
- Do not know actual root cause

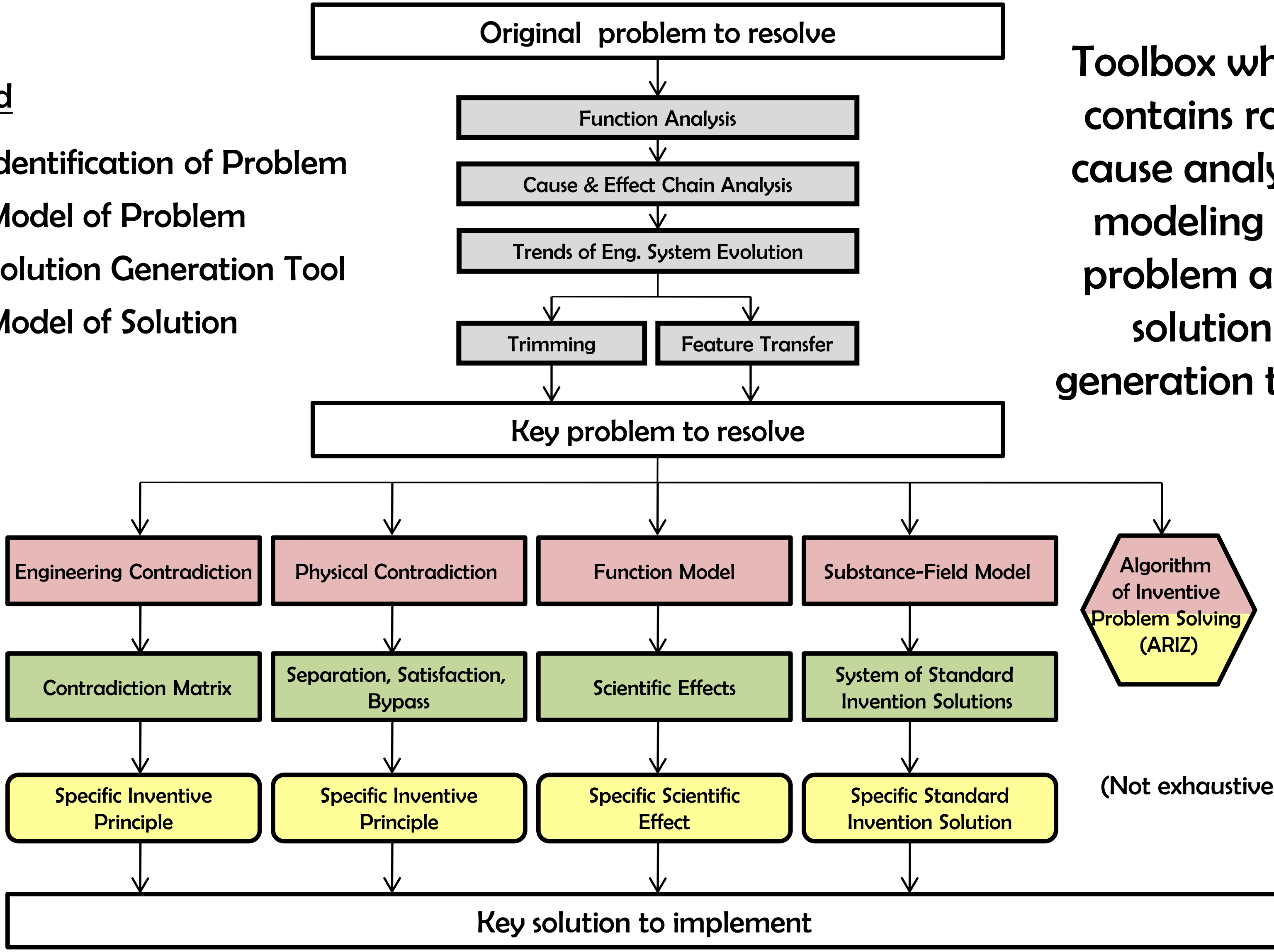




Structure of TRIZ tools

Legend

- Identification of Problem
- Model of Problem
- Solution Generation Tool
- Model of Solution



Toolbox which contains root cause analysis, modeling of problem and solution generation tools

(Not exhaustive list)

TRIZ Tool : Structured Problem Solving

Content

- What is Structured Problem Solving?
- Understanding Step-by-Step Process
- Know the advantage of TRIZ to complement Structured Problem Solving process

What is Structured Problem Solving?

Step by Step Process

1. Define Problem
2. Current Situation
3. Identify Causes
4. Develop Solutions
5. Implement Solutions
6. Standardize Solutions
7. Next Steps

Step 1 – Define Problem

1. Define Problem
2. Current Situation
3. Identify Causes
4. Develop Solutions
5. Implement Solutions
6. Standardize Solutions
7. Next Steps

Purpose

- Identify the problem and the importance of working on it

Output

- Establish a team
- Develop Problem Statement

Key questions

- Nature of problem?
- Symptoms quantified?
- Resources committed?

Step 2 - Current Situation

1. Define Problem
2. Current Situation
3. Identify Causes
4. Develop Solutions
5. Implement Solutions
6. Standardize Solutions
7. Next Steps

Purpose

- Clarify the problem areas as the situation exists today

Output

- Create a problem description

Step 3 - Identify Causes

1. Define Problem
2. Current Situation
3. Identify Causes
4. Develop Solutions
5. Implement Solutions
6. Standardize Solutions
7. Next Steps

Purpose

- Identify and verify the root causes of the problem

Output

- Isolate and verify the root cause of the problem

Step 4 - Develop Solutions

1. Define Problem
2. Current Situation
3. Identify Causes
4. Develop Solutions
5. Implement Solutions
6. Standardize Solutions
7. Next Steps

Purpose

- Develop and test solutions to eliminate the root cause

Output

- Fix the problem at the root cause level
- Generate no additional problems

Step 5 - Implement Solutions

1. Define Problem
2. Current Situation
3. Identify Causes
4. Develop Solutions
5. **Implement Solutions**
6. Standardize Solutions
7. Next Steps

Purpose

- Implement and validate corrective actions

Output

- Implementation plan, risks and barriers identified
- Validate that corrective action is working

Step 6 - Standardize Solutions

1. Define Problem
2. Current Situation
3. Identify Causes
4. Develop Solutions
5. Implement Solutions
6. **Standardize Solutions**
7. Next Steps

Purpose

- Ensure that improvements are sustained over time

Output:

- Solutions proliferated to similar equipment and processes

Step 7 - Next Steps

1. Define Problem
2. Current Situation
3. Identify Causes
4. Develop Solutions
5. Implement Solutions
6. Standardize Solutions
7. Next Steps

Purpose

- Evaluate accomplishments and lessons learned

Output:

- Document post-mortem
- Update documentation
- Publish report and findings

What is the hardest step in problem solving?

Structured Problem Solving Process & TRIZ

SPS	TRIZ
1 Define Problem	• TRIZ helps to define the real problem to be worked on vs. symptoms • Function Analysis of product or process • Ideality of Engineering Systems & focusing on Main Useful Function
2 Current Situation	• Cause and Effect Chain helps to see other potential causes of problems • Scientific Effects database - better understanding of potential causes
3 Identify Causes 4 Develop Solutions	• Substance-Field Modeling, 76 Standard Inventive Solutions • 40 Inventive Principles – identify potential solutions • Predictions (Trends of Engineering System Evolution) – identifies evolutionary potential of interaction between components • ARIZ (Algorithm of Inventive Problem Solving)
5 Implement Solutions	
6 Standardize Solutions	
7 Next Steps	

TRIZ complements Structured Problem Solving

TRIZ is a “power” tool to add to an innovator’s toolbox

TRIZ Tool : Engineering Contradiction

Content

- What is Engineering Contradiction?
- What are System Parameters?
- What are Inventive Principles?
- How to use Contradiction Matrix?

Exercise

- Inventive Principle Case Study

What is a Contradiction?

An improvement in one characteristic of a system results in the degradation of another characteristic

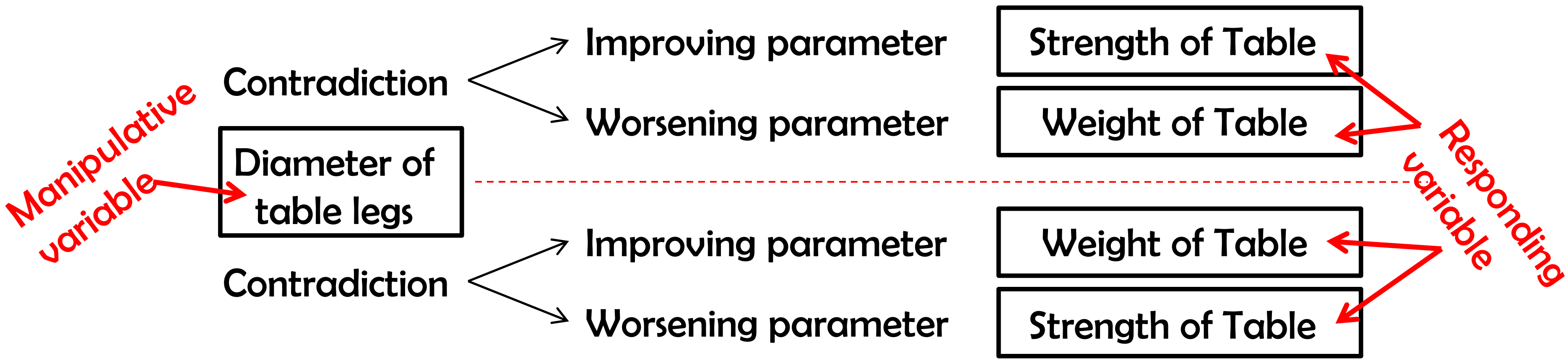
"As one characteristic gets better another characteristic gets worse"

- If I add heat, then productivity goes up, but it consumes more energy
- If I make the lift larger, then it is better to carry more loads, but it adds more weight
- If I increase the power of the car, then the speed will be improved, but the fuel consumption will go up

Traditionally the problem is addressed by compromise, sacrifice or trade-off

Resolving Engineering Contradictions

- Identifying, understanding and resolving Engineering Contradictions within a system is a powerful way to improve the system
- It is possible to eliminate the Engineering Contradictions rather than looking for trade offs
- Use "If … (manipulative variable changes) … then … (responding variable #1 improves) …, but … (responding variable #2 worsens) …"



If we increase the diameter of the table legs, then the table can carry a heavier load, but the table becomes heavier

If we increase the diameter of the table legs, then the strength of the table improves, but the weight of the table gets worse

Contradiction Matrix

39 Worsening Parameters

39 Improving Parameters

Worsening Feature → / Improving Feature ↓	Speed	Shape	Loss of Time	Reliability	Measurement accuracy	Ease of operation	Adaptability or versatility	System complexity	Measurement Difficulty	Productivity
Speed	+	35, 15, 18, 34		11, 35, 27, 28	28, 32, 1, 24	32, 28, 13, 12	15, 10, 26	10, 28, 4, 34	3, 34, 27, 16	
Shape	35, 15, 34, 18	+	14, 10, 34, 17	10, 40, 16	28, 32, 1	32, 15, 26	1, 15, 29	16, 29, 1, 28	15, 13, 39	17, 26, 34, 10
Loss of Information	26, 32		24, 26, 28, 32	10, 28, 23		27, 22			35, 33	13, 23, 15
Loss of Time		4, 10, 34, 17	+	10, 30, 4	24, 34, 28, 32	4, 28, 10, 34	35, 28	6, 29	18, 28, 32, 10	
Measurement accuracy	28, 13, 32, 24	6, 28, 32	24, 34, 28, 32	5, 11, 1, 23	+	1, 13, 17, 34	13, 35, 2	27, 35, 10, 34	26, 24, 32, 28	10, 34, 28, 32
Ease of operation	18, 13, 34	15, 34, 29, 28	4, 28, 10, 34	17, 27, 8, 40	25, 13, 2, 34	+	15, 34, 1, 16	32, 26, 12, 17		15, 1, 28
Ease of repair	34, 9	1, 13, 2, 4	32, 1, 10, 25	11, 10, 1, 16	10, 2, 13	1, 12, 26, 15	7, 1, 4, 16	35, 1, 13, 11		1, 32, 10
Adaptability or versatility	35, 10, 14	15, 37, 1, 8	35, 28	35, 13, 8, 24	35, 5, 1, 10	15, 34, 1, 16	+	15, 29, 37, 28	1	35, 28, 6, 37
System complexity	34, 10, 28	29, 13, 28, 15	6, 29	13, 35, 1	2, 26, 10, 34	27, 9, 26, 24	29, 15, 28, 37	+	15, 10, 37, 28	12, 17, 28
Productivity		14, 10, 34, 40		1, 35, 10, 38	1, 10, 34, 28	1, 28, 7, 10	1, 35, 28, 37	12, 17, 28, 24	35, 18, 27, 2	+

39 System Parameters

1. Weight of Moving Object
2. Weight of Stationary Object
3. Length (or Angle) of Moving Object
4. Length (or Angle) of Stationary Object
5. Area of Moving Object
6. Area of Stationary Object
7. Volume of Moving Object
8. Volume of Stationary Object
9. Speed
10. Force (a.ka. Torque)
11. Pressure or Stress
12. Shape
13. Stability of the Object's Composition
14. Strength
15. Duration of Action of Moving Object
16. Duration of Action of Stationary Object
17. Temperature
18. Illumination Intensity
19. Use of Energy by Moving Object
20. Use of Energy by Stationary Object
21. Power
22. Loss of Energy
23. Loss of Substance
24. Loss of Information
25. Loss of Time
26. Quantity of Substance
27. Reliability (Robustness)
28. Measurement Accuracy
29. Manufacturing Precision (Consistency)
30. Object Affected Harmful Factors
31. Object Generated Harmful Factors
32. Ease of Manufacture (Manufacturability)
33. Ease of Operation
34. Ease of Repair (Repairability)
35. Adaptability or Versatility
36. Device Complexity
37. Difficulty of Detecting and Measuring
38. Extent of Automation
39. Productivity

40 Inventive Principles

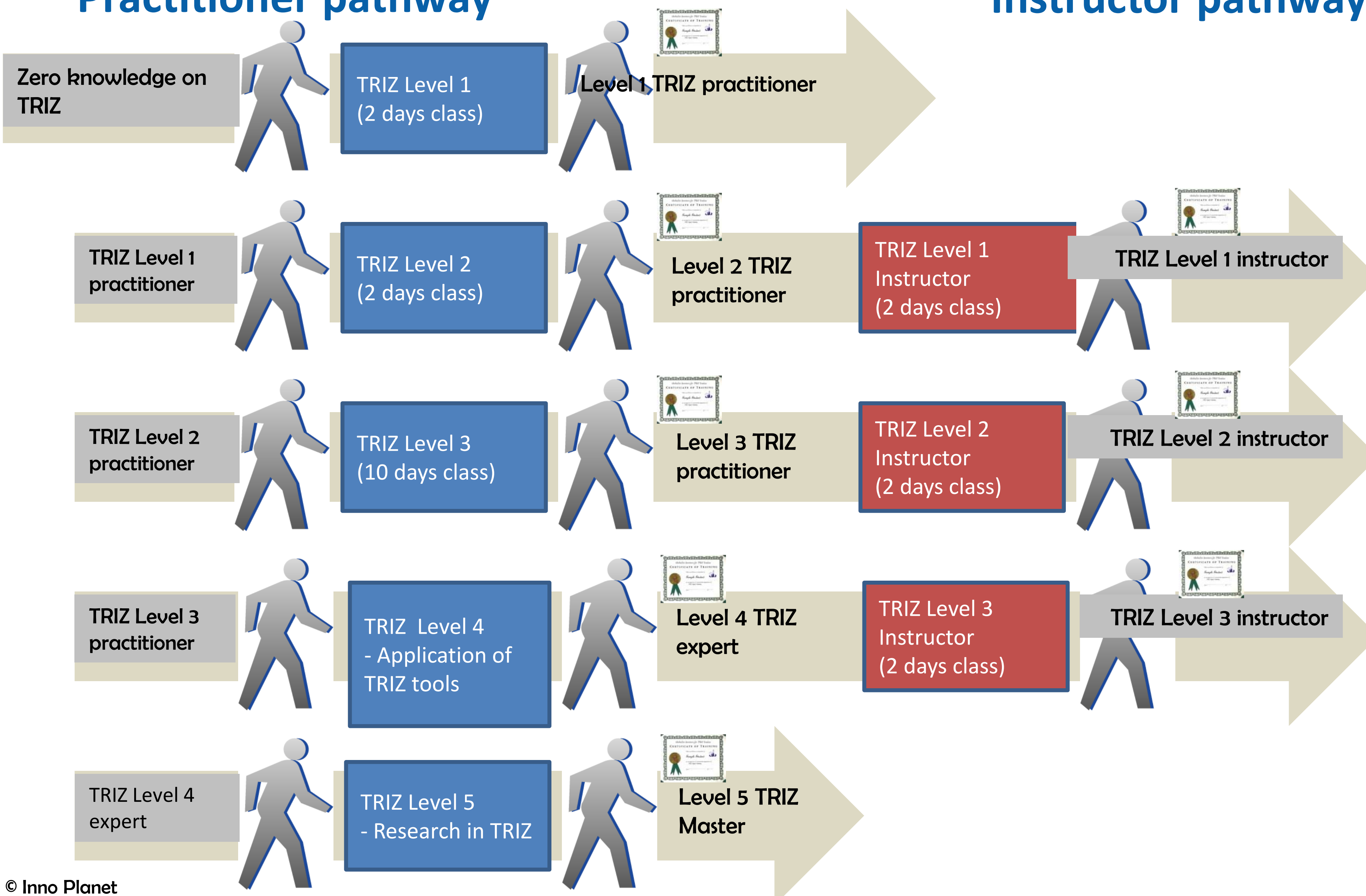
1. Segmentation
2. Taking Out or Extraction
3. Local Quality
4. Asymmetry
5. Merging or Combination
6. Universality
7. Nested Doll
8. Anti-weight or Counter weight
9. Preliminary anti action/Prior counter action
10. Preliminary action/Prior action
11. Beforehand cushioning/Prior Cushioning
12. Equipotentiality/Remove tension
13. The other way around
14. Spheroidality-Curvature
15. Dynamics
16. Partial or excessive actions
17. Another dimension
18. Mechanical vibration
19. Periodic action
20. Continuity of useful action
21. Skipping/Hurrying
22. Blessing in Disguise
23. Feedback
24. Intermediary
25. Self-service
26. Copying
27. Cheap/Short Living
28. Mechanics substitution/Another sense
29. Pneumatics and hydraulics/Fluidity
30. Flexible shells and thin films/Thin & flexible
31. Porous Materials/Holes
32. Color changes
33. Homogeneity
34. Discarding and recovering
35. Parameter changes
36. Phase transitions
37. Thermal expansion/Relative change
38. Strong oxidants/Enriched Atmosphere
39. Inert Atmosphere/Calmed Atmosphere
40. Composite materials/Composite structure

MyTRIZ path

MATRIZ = International TRIZ
MyTRIZ = Malaysia TRIZ Innovation Association
(http://mytriz.com.my)

Practitioner pathway

Instructor pathway



Summary, Wrap up

- Reviewed TRIZ philosophy, methodology and tools. TRIZ has ~25 tools which are able to be customized based on needs (e.g. patent circumnavigation, forecast future trends, solve old & chronic problems)
- Effective in identification of problem and generation of innovative solutions
  - Structured brainstorming of ideas. Complements other innovation process/methods e.g. Blue Ocean Strategy , Lean, Six Sigma,
- Follow the process flow, no shortcuts

"You can wait a hundred years for enlightenment,
or you can solve the problem in 15 minutes with these principles"
--- Genrich Altshuller, TRIZ