ASQ-LA
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Accelerate Innovation with TRIZ

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Session Outline

- What is TRIZ
- Five Pillars of TRIZ
- Additional Examples /Case Studies
  - Pharma
  - Microprocessor Testing
  - Ink Jet Cavitation Damage (exercise)
  - Hospital OR Utilization (exercise)

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What is TRIZ?

TRIZ is a problem solving toolkit derived from the study of patterns of invention in the global patent literature that can be used to rapidly generate plausible concepts that solve problems in technical and non-technical domains.

Теория Решения Изобретательских Задач

Teorija Reshnija Izobretatelskih Zadach

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Why Is Problem Solving Part of Innovation?

- If the customer has the problem, the solution is called ??

- If the company has the problem, the solution is called ??

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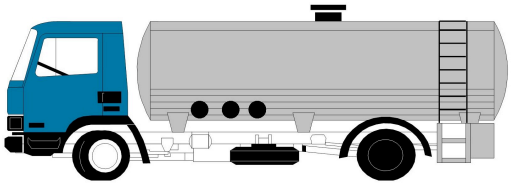
Several Simple Examples
What is the trick?

1. Chocolate candy bottles filled with syrup/liquor.
    1. How are they filled?
    2. Challenges?

2. There is a patent! Need to drill holes in it.
    1. Challenges?

3. What kind of detectives are they? Shortage of oil in tanker.



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Additional Examples
Technical Contradictions

- Machines make welded steel pipes of a large diameter.

- Breaking glass sheets

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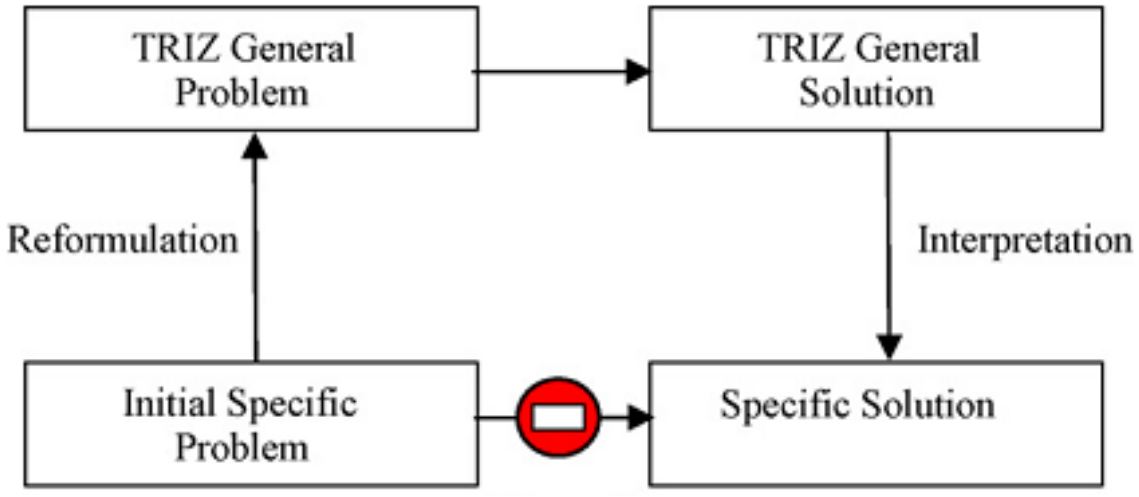
Think for Yourself

- Methods so far
  - Do it inversely
  - Change the state of the physical property
  - Do it in advance
  - Do a little less
  - Separate in Time

TRIZ: The Basic Model

- The TRIZ methodology claims that, 'Inventive problems can be codified, classified and solved methodically, just like other engineering problems'.[1]



Trial –and- Error

[1] Stratton, R., Mann, D., & Otterson, P. (2000, April). The Theory of Inventive Problem Solving (TRIZ) and Systematic Innovation-a Missing Link in Engineering Education?

Two Culturally-Shocking, Underlying TRIZ Concepts

- **Don't accept compromises**. Eliminate them.
- **Somebody, someplace, has already solved your problem or one similar to it.** Creativity means finding that solution and adapting it to the current problem.
  - Pharmaceutical industry needed a way to deal with excess foam from a pharmaceutical process, solution came from the beer industry

TRIZ: Five Pillars

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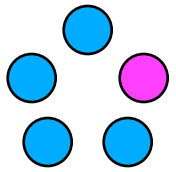
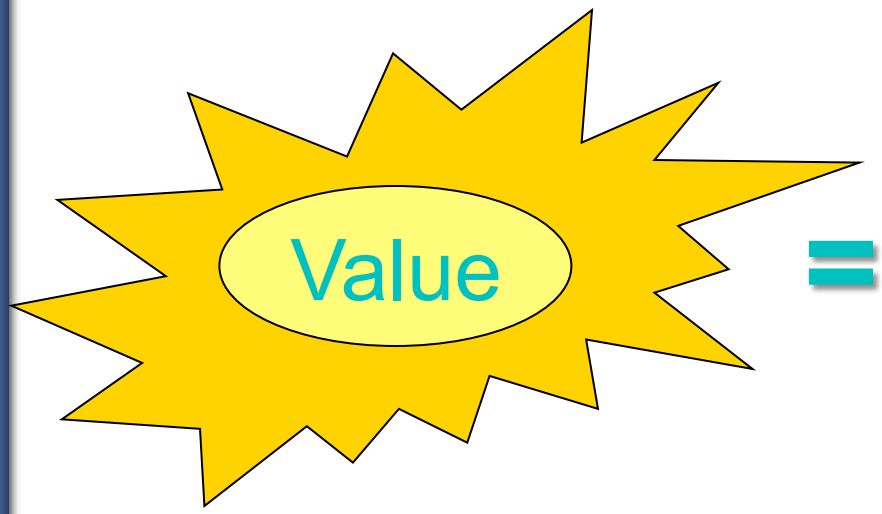
TRIZ Ideality Approach



IFR



$$\text{Value} = \frac{\textit{Benefits}}{\textit{Cost + Harm}}$$

- The ideal system performs a required function without actually existing.
- Start by focussing on solutions not problems, then ask how can we use the resources to achieve this?
- Helps in 3 ways: Psychological, Technical, Assessment

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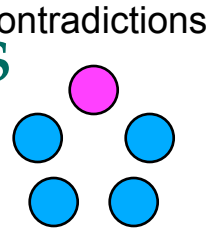
Contradictions: Traditional Tradeoffs

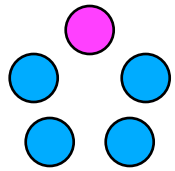


- **Technical Contradictions**: something gets better, something else gets worse
  - Stronger at cost of additional weight
  - Greater bandwidth requires more power
  - Faster airbag deployment requires greater force

- **Physical Contradictions**: one object has contradictory requirements
  - Coffee hot enough to enjoy but not so hot as to burn
  - Software powerful features but easy to use
  - A pen tip should be sharp to draw fine lines, but blunt to avoid tearing paper

TRIZ Dissolution Constraints

Contradictions



Improved Parameter ↓	Damaged Parameter → 1	2	3	4	5	6	7	8	9	10
1			15, 8 19, 34		29, 17 38, 34		29, 2 40, 28		2, 8, 15, 38	8, 10, 18, 37
2				10, 1, 29, 35		35, 30, 13, 2		5, 35, 14, 2		8, 10, 19, 35
3	8, 15, 29, 34				15, 17, 4		7, 17, 4, 35		13, 4, 8	17, 10, 4
4		35, 28, 40, 29				17, 7, 10, 40		35, 8, 2,14		28, 10
5	2, 17, 29, 4		14, 15, 18, 4				7, 14, 17, 4		29, 30, 4, 34	19, 30, 35, 2
6		30, 2, 14, 18		26, 7, 9, 39						1, 18, 35, 36
7	2, 26, 29, 40		1, 7, 4, 35		1, 7, 4, 17				29, 4, 38, 34	15, 35, 36, 37
8		35, 10, 19, 14	19, 14	35, 8, 2, 14						2, 18, 37
9	2, 28, 13, 38		13, 14, 8		29, 30, 34		7, 29, 4			13, 28, 15, 19
10	8, 1, 37, 18	18, 13, 1, 28	17, 19, 9, 36	28, 10	19, 10, 15	1, 18, 36, 37	13, 9, 12, 37	2, 36, 18, 37	13, 28, 15, 12	

Principles to use ↑

- Technical contradictions solved through 40 elimination principles
- Physical contradictions solved through 4 basic principles to look at supersystems, subsystems, separation of time and space.

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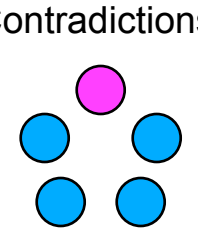
TRIZ: Contradiction Matrix



The matrix tells you among the 40 principles which ones have been used most frequently to solve a problem that involves a particular technical contradiction.

	Worsening Feature → / Improving Feature ↓	Weight of moving object	Weight of stationary object
		1	2
1	Weight of moving object		↓
2	Weight of stationary object		↓
3	Length of moving object		↓
4	Length of stationary object	→	35, 28, 40, 29

Consider Using Inventive Principles:
- 28 - Mechanics Substitution
- 29 - Pneumatics and Hydraulics
- 35 - Parameter Changes
- 40 - Composite Materials

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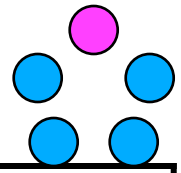
The 40 Principles (IP)

Contradictions



1. Segment*
2. Separate/Extract*
3. Localized Characteristics/ Quality
4. Asymmetry
5. Merge/Consolidate
6. Multi-Functionality/ Universality
7. Nesting Principle
8. Counterweight
9. Prior Counteraction
10. Prior Action*
11. Beforehand Compensation/ Preparation
12. Equi-Potentiality
13. Other Way Around/ Reverse
14. Curvature Increase/ Spheroidality
15. Dynamic Parts*
16. Partial or Excessive Action
17. Change or Move to a New Dimension
18. Mechanical Vibration
19. Periodic Action
20. Continuity of Useful Action
21. Hurrying/Rush Through or Skipping Over
22. Blessing in Disguise/ Convert Harm into Benefit
23. Feedback
24. Intermediary/Mediator
25. Self Service
26. Copying
27. Inexpensive and Short-Term (Instead of Expensive and Durable); Cheap Disposables
28. Interaction Substitute; Replacement of a Mechanical System*
29. Pneumatics and Hydraulics
30. Flexible Shells and Thin Membranes or Film
31. Porous Material
32. Optical Property Change/Changing Color
33. Homogeneity
34. Discarding and Recovering/Rejected and Regenerating Parts
35. Parameter Change/Transformation of the Physical-Chemical Properties of the System or Parts*
36. Phase Transition
37. Application of Heat Expansion (Thermal Expansion)
38. Using Strong Oxidants
39. 39. Inert Atmosphere/ Environment
40. Composite Materials

Most commonly used principles (J. Zhang)

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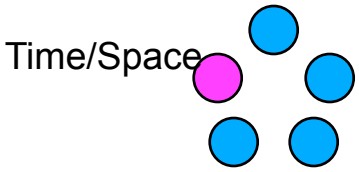
Separation principles



- Opposite physical states can be separated:
  - In Time
  - In Space
  - Between the system and its components

- A characteristic exists at the system level but not at the component level (or vice versa)
  - Kitchen sieve is solid at macro scale, porous at micro scale
  - Bicycle chain has rigid links but is flexible at system level

"Naturally creative people think in time & space"

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Air bag problem

Airbags need to inflate before contacting occupants to prevent forward motion. We would like to inflate the air bags faster while decreasing the adverse effects

- Principle 16: Partial or Excessive Action
  - Use a lower powered air bag. By using less power the acceleration of the bag is less, and injuries will be reduced.
  - Use smaller air bags with higher power. These bags will reach full inflation sooner.

Air bag problem

- Principle 21: Rushing Through / Skipping
  - Inflate the air bag faster than current practice.
- Principle 40: Composite materials
  - Airbag material that can't grab skin as it is deployed

Or:

  - Car intellectual system to avoid crashes
  - Social system that prevents small persons from front seat

We usually accept a compromise, but this is often not necessary. Powerful solutions are the ones that don't accept the trade-offs. Compromise when necessary.

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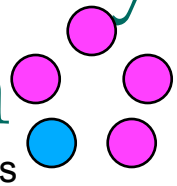
Using Resources Increases Ideality and Accelerates Innovation



- Reduce time for development
  - Same suppliers
  - No new regulatory approvals
  - No new training for employees, distributors or customers
- Increase Ideality
  - Reduce complexity
  - Reduce waste (energy and materials)

People

Energy

PROPERTIES

MATERIALS

Information

Change

Waste products

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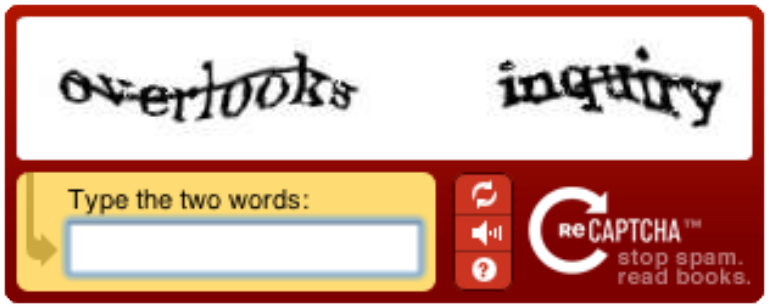
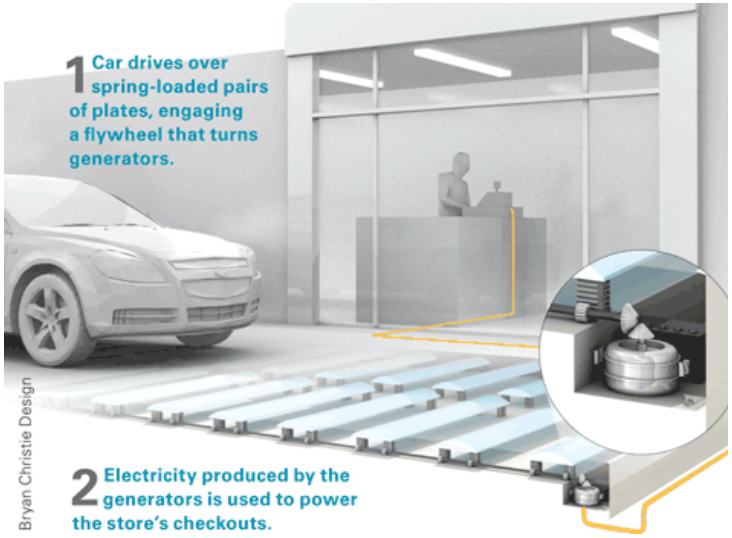
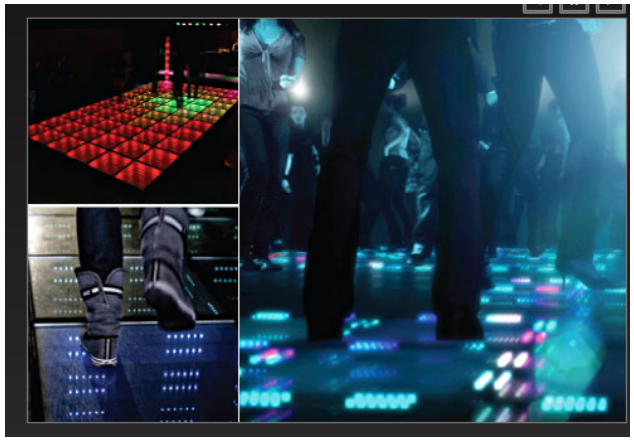
Using Customers as a Resource



Judgment

Energy





Rotterdam nightclub powered by dancers' energy

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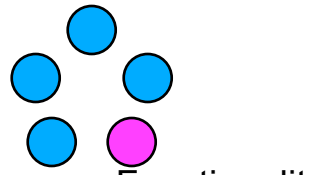
System Modeling and Analysis – Function Analysis



- TRIZ describes the system containing the problems in all its detail by listing all the components and all their interactions.
- TRIZ Function Analysis is different from other forms in that it includes all the negative, ineffective and excessive interactions in the system.
- All interactions are expressed as Subject-action-Object and it is important to use simple, clear language in order to be able to structure the problem correctly.

Additional Examples / Case Studies

- Pharma

- Case Studies *(projects conducted under guidance of one of our Principals, David Conley, and shared with permission from clients – with proprietary info removed.)*
  - Microprocessor Testing
  - Inkjet Cavitation Damage (exercise)
  - Hospital OR Utilization (exercise)

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Improve test models

- Eye medication and rabbits:
  - Rabbits have been used to test the irritation index of both medication and consumer products, but have a very different blink rate from humans, and a different pattern of eyelid shear during blinking. The diffusion flow cell has now replaced rabbits. Use of principles 17 and 27.

- Trans-follicular:
  - Because of the high variability of the number and size of hair follicles on human skin, it has been difficult to isolate the trans-dermal (skin) and trans-follicular (through the hair follicles) effects. Snake skin is an excellent model for the hairless skin. Use of principles 2 and 3.

Distribution

- Eye medication—assure correct time and dose:

  very easy to dispense the proper quantity when liquid, but, the drain into the cul de sac of the eye. The solution: liquid in the bottle and when being dispensed, but form a gel when it contacts the tears, and is activated by body temperature. Principle 35.

- Protect potency of proteins during shipment:

  The protein should be liquid (for easy use) but it should not be liquid (for easy handling and shipping). The solution is to freeze-dry the protein material, ship it in the dry powder form, and reconstitute it at the point of use. Principle 35, or principle of separation in time.

Scale up for full commercialization

- Avoid foam problems:
  - When liquids are shipped it can lead to the formation of foam. A very simple TRIZ solution does not solve the problem of foam creation, but it make foam not cause problems for downstream processes: apply Principle 13 and extract the liquid from the bottom of the tank, to get pure liquid without any foam.
- Improve medication uniformity by electrostatic deposition:
  - Although pill production by compressing powder is a well-established technology, there are many drugs that require higher accuracy and uniformity than the powder compression method can provide. Considerable improvement in uniformity has been achieved by electrostatically depositing the material on a continuous web of edible material. Principle 28

Current Usage in Industry

- **Systematic Innovation (TRIZ)**
  - System Development / Improvement / Revolution
  - Test Platform Development / Improvement / Revolution
  - Manufacturing Process Improvement
  - Technical & Business Problem Resolution
  - Computing System Application





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Summary

- TRIZ combines right-brain and left-brain techniques
- Reduces subjectivity
- Very effective methodology when appropriately applied
- Able to find solutions outside the field where they were developed
- Time and cost-effective
- Can be applied for many various purposes
- Flexible to environmental changes