Concepts in Engineering Design

SCAMPER

Reference: http://www.designorate.com/a-guide-to-the-scamper-technique-for-creative-thinking

SCAMPER

SCAMPER

Creative thinking and problem-solving are essential parts of the design process to turn ideas into innovation and break the barriers against creativity.

One of the successful methods used in creative thinking is the SCAMPER technique.

While there are different creative thinking and problem-solving techniques such as reversed brainstorming, Hurson's thinking model, the six hats of critical thinking and Lego Serious Play, SCAMPER is considered one of the easiest and most direct methods.

The SCAMPER technique is based very simply on the idea that what is new is actually a modification of existing old things around us.

SCAMPER was first introduced by Bob Eberle to address targeted questions that help solve problems or ignite creativity during brainstorming meetings.

The name SCAMPER is acronym for seven techniques; (S) substitute, (C) combine, (A) adapt, (M) modify, (P) put to another use, (E) eliminate and (R) reverse. These keywords represent the necessary questions addressed during the creative thinking meeting.

How do SCAMPER technique work?

During the need for critical thinking either alone or inside a group, forcing the mind to think in a specific flow can help emerging innovative ideas that won't be possible to reach using a regular thinking flow.

The SCAMPER technique aims to provide seven different thinking approaches to find innovative ideas and solutions.

There are two main concepts to keep in mind before starting the brainstorming using the SCAMPER technique; yet there is no sequential flow to follow while moving from each of the seven thinking techniques.

Unlike Disney's creative strategy method, SCAMPER facilitators can move between different techniques without restricted to a specific flow.

Secondly, the principle of force fitting should be adapted during the thinking sessions.

For example, any response to the SCAMPER technique is welcomed no matter how non-logical is it. The seven SCAMPER techniques include the following:

SCAMPER - Substitute

The substitute technique focuses on the parts in the product, service or solution that can be replaced with another. During this part of the discussion the meeting attendees focus on making decisions to substitute part of the process with another. Questions asked during this part are:

- What part of the process can be substituted without affecting the whole project?
- Who or what can be substituted without affecting the process?
- What part in the process can be replaced with better alternatives?
- Can the project time or place be replaced?
- What will happen when we replace part of the project with another?
- Where else could you sell the product?
- Could we use another alternative of X?
- Can we substitute the current device with another better one?
- Can we replace the process with simpler one?

The substitute technique tends to provide alternative solutions for decision makers to evaluate different solutions in order to reach the final action.

SCAMPER - Combine

The combine technique tends to analyze the possibility of merging two ideas, stages of the process or product in one single more efficient output.

In some cases, combining two innovative ideas can lead to a new product or technology which leads to market strength.

For example, merging phone technology with digital camera produced a new revolutionary product in the telecommunications industry.

The combine technique discussion can include the following questions:

- Can we merge two steps of the process?
- Can we apply two processes at the same time?
- Can our company combine resources with another partner in the market?
- Can we mix two or more components together?
- Can we combine X and Y technologies?

SCAMPER - Adapt

Adapt refers to a brainstorming discussion that aims to adjust or tweak product or service for a better output.

This adjustment can range between minor changes to radical changes in the whole project.

Adaption is one of the efficient techniques to solve problems through enhancing the existing system.

The adapt technique brainstorming session can include the following questions:

- What would we need to change to reach better results?
- What else could be done in this specific task?
- How can we improve the existing process?
- How can we adjust the existing product?
- How can we make the process more flexible?

SCAMPER – Modify/minify/magnify

The modify technique refers to changing the process in a way that unleashes more innovative capabilities or solves problems.

This change is more that just adjustment as it focuses on the overall process.

For example, it can target reducing the project's process or change our perspective of how to look at the problem.

The questions asked under this rubric include:

- How will modifying the process improve results?
- What if we had a double consumer base?
- If the market was different, what would the process look like?
- Can we change the process to work more efficiently?
- What if the product is double the current size?

SCAMPER – Put to another use

This technique concerns how to put the current product or process in another purpose or how to use the existing product to solve problems.

For example, this technique can be used to learn how to shift an existing product to another market segment or user type.

The questions in this technique can include the following:

What other parts in the company can use the product?

What are the benefits for the product if used elsewhere?

What if we target another market segmentation for the current product?

Can we add a specific step into the process to replace another?

What are other ways can we use it?

Can we recycle the waste for another use?

SCAMPER – Reverse

Finally, the reverse or rearrange technique aims to explore the innovative potential when changing the order of the process in the production line.

Reversing the process or part of it can help solving problems or produce more innovative output.

The questions in this part include:

- What would happened if we reverse the process?
- How can we rearrange the current status for better output?
- What if we consider it backwards?
- Can we interchange elements?

SCAMPER – Reverse

Finally, the reverse or rearrange technique aims to explore the innovative potential when changing the order of the process in the production line.

Reversing the process or part of it can help solving problems or produce more innovative output.

The questions in this part include:

- What would happened if we reverse the process?
- How can we rearrange the current status for better output?
- What if we consider it backwards?
- Can we interchange elements?

The SCAMPER technique is one of the easiest and direct methods for creative thinking and problem-solving through a number of techniques or question types; (S) substitute, (C) combine, (A) adapt, (M) modify, (P) put to another use, (E) eliminate and (R) reverse. These types can be used to explore problems from seven perspectives. This holistic technique of study helps reaching the best decision which fuels innovation and creativity.

Concepts in Engineering Design

TRIZ

Reference: https://spaceflightsystems.grc.nasa.gov/pmwg/htmls/TRIZ.ppt

Improving Innovation Through TRIZ

Why Innovation???

Who remembers what our Quality Policy is and what is says?

Our commitment to continuous improvement and innovation ensures quality products, excellent services, and satisfied customers.

This is an easy answer today with current programs getting cut and OExS looking to be the mega program of the future.

In our full cost environment and the strong emphasis to contract out, we must be innovative if we want to stay relevant and keep funding coming in.

What is TRIZ (pronounced trees)?

TRIZ stands for:

"Teorija Rezbenija Izobretatelskih Zadach"

Translated means"

"Theory of Inventive Problem Solving"

So why are we talking about a problem solving methodology using a Russian name?

- TRIZ originated in former USSR where it was developed by Genrich Altshuller (1926-1998). He began developing this method after WWII and continued till he died.
- At the close of WWII, the Soviet Government agreed to give the German Patent Library to the US in exchange for various pieces of industrial equipment. Altshuller claimed equipment will be worthless in 20 years, but the patents would remain valuable.
- He was critical of this decision and sent a letter to Stalin stating so. He was arrested by the KGB and sentenced to 25 years for anti-soviet propaganda.
- He was imprisoned in Siberia for 4 years in the early 50's where he would have died had Stalin not died first. Many including Atshuller were released from prison. He continued the development for 40 years. But not till the collapse of the iron curtain did the method see the outside of the USSR when TRIZ experts immigrated or lectured.

- TRIZ is considered an Algorithm. It is considered a empirical method of innovation, because it is a step by step process that can lead to innovation. It is based upon an exhaustive patent search that was conducted by Altshuller.
- Its premise is that innovation can be taught.
- This goes contrary to popular opinion, because most feel innovation is emotionally based. It happens when we get a Eureka! moment. It cannot be structured. You must be gifted with a creative mind.
- TRIZ is catching on in many companies and throughout the world. Most companies involved in development know that innovation is critical to their bottom line.
- TRIZ works to reduce the number of trial and error iterations by circumventing much of the solution set thereby getting to the solution quicker.

Why TRIZ?

There are several methods for increasing innovation.

- Brainstorming
- Synectics
- Lateral Thinking
- Neurolinguistic Programming
- Mind Mapping

These are all emotionally based.

TRIZ is empirically based!!

It is designed to overcome Psychological Inertia. Psychological Inertia is based upon habits, our education, paradigms, internal processes, past successes, past failures and "we have always done it that way".

TRIZ directs the solution path based on an empirical approach to the problem resolution.

From CAD/CAM Monthly email newsletter.

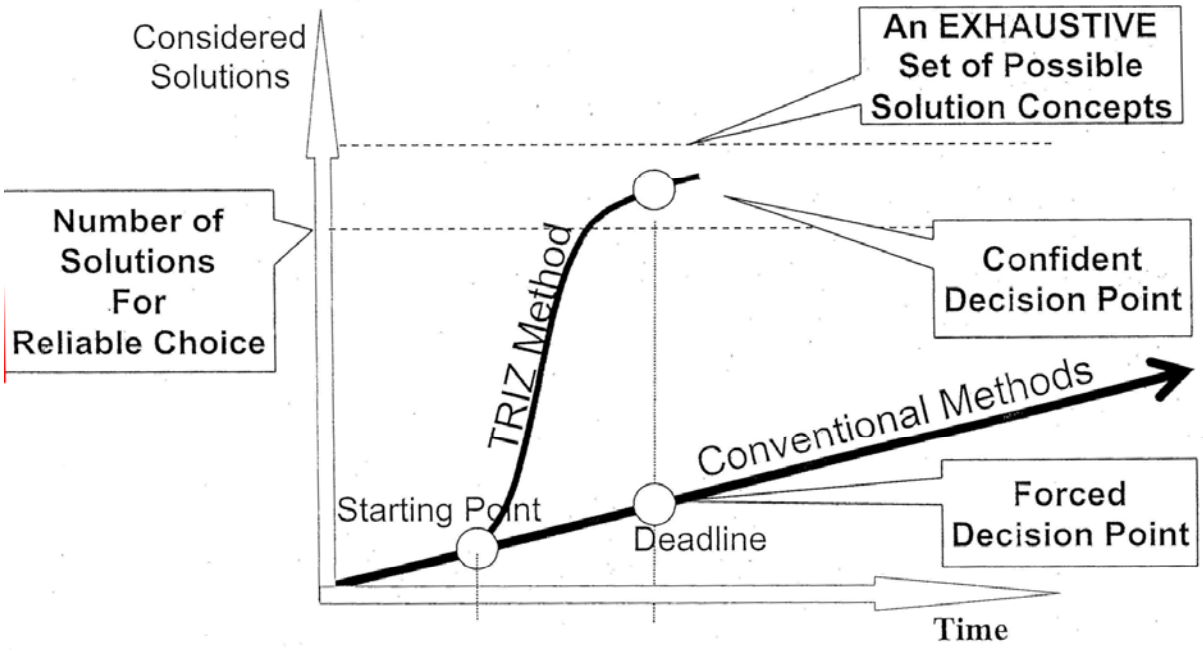
"It is astounding to think that the manufacturing industry averages only one product success for every 3,000 ideas generated. Even more astounding is the fact that this proportion has remained virtually unchanged over the past four decades. An upshot of this is that companies waste approximately half of their development budgets on products that never reach the consumer or that fail after commercialization.

These are incredible odds for manufacturers! The issue is not a lack of ideas. The dilemma is capitalizing on ideas.

Studies indicate that innovation is the key to product development success. It's innovation that enables a company to bring products to market that meet customer requirements.

TRIZ attempts to circumvent the many mediocre solutions to problems and get directly to the best solution faster.

Impact of TRIZ on an Organization



Benefits of TRIZ?

- Problem solving based on fixed algorithm

  Easy algorithm to follow, repeatable

- Better and more innovative solutions

  Enhances credibility, wins more proposals

- Reduces the number of trail and error solutions.

  Saves time, money and reduces risk

- Works on any type of problem

  New products, failure prediction, analysis

TRIZ's Basic Premise

- Problems may be coded, classified, and solved methodically.
- The evolution of technology is predictable using patterns and trends repeated many times.
- TRIZ uses knowledge engineering based upon over 200,000 patents searched in the former USSR.

Definition 1

IFR – Ideal Final Result

It is the imagined ultimate solution

- Eliminates the deficiencies of the original system
- Preserves the advantages of the original system
- Does not make the system more complicated
- Does not introduce new disadvantages

Create using imagination not knowledge

Change the problem to an assertion

- Declare the future possibility without proof

Definition 2

Ideality

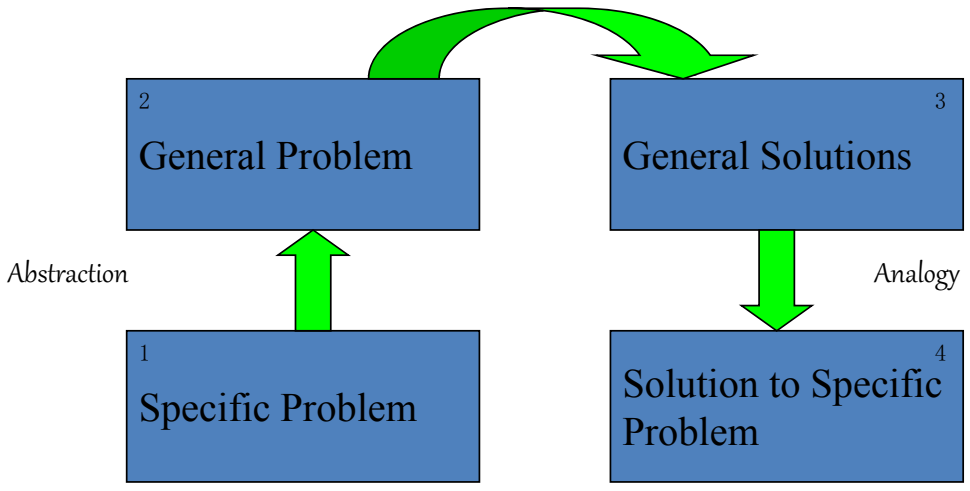
A metric to measure progress towards the IFR

$$Ideality = \frac{\sum Benefits}{\sum Cost + \sum Harm}$$

Improvement is to increase Ideality

- increasing benefits
- decreasing costs
- decreasing harm

Fundamentals of TRIZ



Algorithm for Problem Solving

1) Define the problem
   - List all requirements and constraints
   - We want this but we can't because of this. We get this because of this.

2) Create Ideal Final Result (IFR)
   - Eliminate the deficiencies
   - Preserve the advantages
   - Not more complicated
   - No new disadvantages

3) Determine the differences
   - Compare original system with IFR

4) Create Ideality Equation
   - List differences as Benefit, Cost, Harmful

5) Determine Contradictions
   - Technical or Physical contradictions

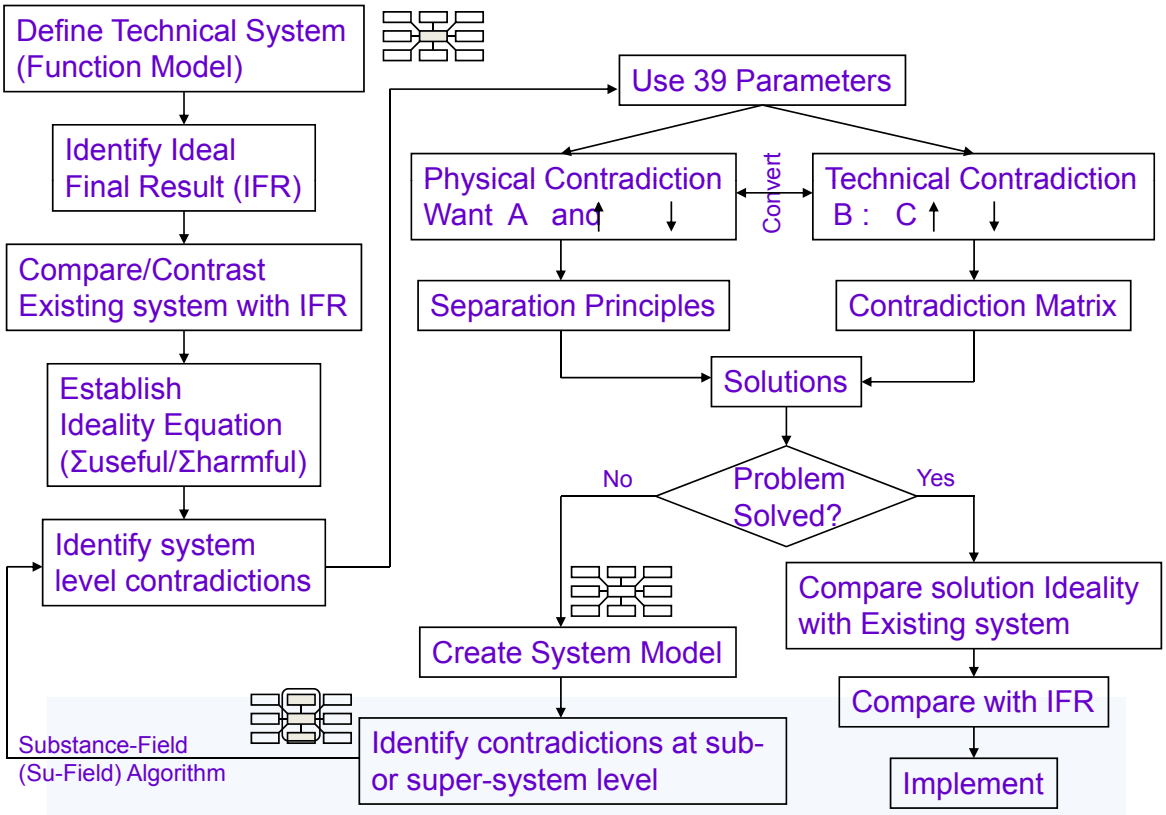
6) Determine Input Parameters
   - Use 2 of 39 or other parameters

7) Physical or Technical Contradiction
   - Convert between the two contradictions
   - If Technical then use Contradiction Matrix

8) Determine General Solution
   - Use 40 Inventive Principles

9) Examime Solutions
   - Convert generic solutions to specific
   - Does solution increase Ideality?
   - No – go to step 5
   - Does solution solve the problem?
   - Yes – IMPLEMENT

Solving a Problem with TRIZ



39 Parameters

1. Weight of moving object
2. Weight of stationary object
3. Length of moving object
4. Length 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
11. Stress, pressure, or tension
12. Shape
13. Stability of the object's composition
14. Strength
15. Duration of action by a moving object
16. Duration of action by a stationary object
17. Temperature
18. Illumination intensity, brightness, light quality, etc.
19. Energy used by moving object
20. Energy used by stationary object
21. Power
22. Loss or waste of Energy
23. Loss of substance
24. Loss of Information
25. Loss of Time
26. Amount of substance/matter
27. Reliability
28. Measurement accuracy
29. Manufacturing precision
30. External harm affects the object
31. Object-generated harmful factors
32. Ease of manufacture
33. Ease of operation Simplicity
34. Ease of repair
35. Adaptability or versatility
36. Device complexity
37. Complexity of control
38. Extent of automation
39. Productivity

40 Inventive Principles

1. Segmentation
2. Taking out (Extraction)
3. Local quality or conditions
4. Asymmetry
5. Combining or merging
6. Universality
7. Nesting
8. Counterweight
9. Preliminary counter-action
10. Preliminary action
11. Cushion in advance
12. Equipotentiality
13. Inversion or ‘the other way round'
14. Spheroidality - Curvature
15. Dynamics
16. Partial or excessive actions
17. Moving to another dimension
18. Mechanical vibration
19. Periodic action
20. Continuity of useful action
21. Rushing through or skipping
22. "Blessing in disguise" or "Turn Lemons into Lemonade"
23. Feedback
24. Mediator or intermediary
25. Self-service
26. Copying
27. Cheap short-lived object instead of expensive durable one
28. Replace mechanical system
29. Pneumatics or hydraulics
30. Flexible shells or thin films
31. Porous materials
32. Change the color
33. Homogeneity
34. Rejecting and regenerating parts
35. Transformation of physical or chemical states of an object
36. Phase transitions
37. Thermal expansion
38. Strong oxidants
39. Inert atmosphere
40. Composite materials

Contradiction Matrix

	Improving Feature \ Worsening Feature	Weight of moving object	Weight of stationary object	Length of moving object	Length of stationary object	Area of moving object	Area of stationary object	Volume of moving object
		1	2	3	4	5	6	7
1	Weight of moving object	+	-	15, 8, 29,34	-	29, 17, 38, 34	-	29, 2, 40, 28
2	Weight of stationary object	-	+	-	10, 1, 29, 35	-	35, 30, 13, 2	-
3	Length of moving object	8, 15, 29, 34	-	+	-	15, 17, 4	-	7, 17, 4, 35
4	Length of stationary object		35, 28, 40, 29	-	+	-	17, 7, 10, 40	-
5	Area of moving object	2, 17, 29, 4	-	14, 15, 18, 4	-	+	-	7, 14, 17, 4
6	Area of stationary object	-	30, 2, 14, 18	-	26, 7, 9, 39	-	+	-
7	Volume of moving object	2, 26, 29, 40	-	1, 7, 4, 35	-	1, 7, 4, 17	-	+

Kathy Schubert's Example Problem – How do you create a partial gravity field, i.e. lunar or Martian within the zero-g drop tower?

Phrase the problem as follows:

"I want to create a partial gravity field in the zero-g drop tower, but I can't because it relies on the earth gravity field which is constant"

General Problem: Develop technical contradictions. Find pairs of the 39 Parameters. One must increase while the other decreases.

Improving	Worsening	Contradiction Matrix General Solutions
10: Force	1: Weight of Moving Object	8, 1, 37, 18
35: Adaptability	36: Device Complexity	15, 29, 37, 28
3: Length Moving Object:	24: Loss of Information	1,24

Contradiction Matrix Yields:
8: Counterweight
37: Thermal Expansion

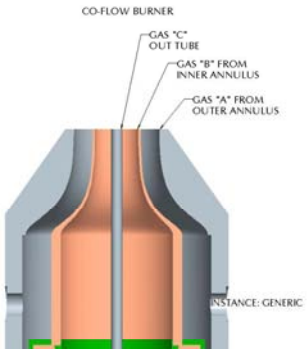
Develop the Specific Solution

Ken Gregg's Example Problem – Gas A & B are constantly flowing creating a steady flame front established about 10mm past the nozzle face. A puff of Gas C is sent into flame to visualize possible flame extinction.

Phrase the problem as follows:

"I want to create a uniform flow with Gas A & B, but I can't because GAS C will contaminate it when it is blown in to visualize flame extinction.

This uses Physical Contradiction rather than the Technical Contradiction just described.



1. Use of a barrier	• Check valve • One-way film/membrane • Dissolution of lid covering tube by application of current • Film of soapy water on tube
2. Separation of space	• Bring in tube with Gas C when needed. • Flow Gas B in tube followed by plug of Gas C when required.
3. Separation of time	• Splitting flow
4. Scale	• Bleed Gas C from tube with high flow when required
5. Upon condition	• No specific solution
6. Prevent interaction	• Ionize or polarize Gas C, but not B.

Ken Gregg's Example Problem – Continued

BEST SOLUTION

Introduce tube just prior to puff. Have Gas C flowing at bleed rate out of tube until puff occurs.

BENEFIT TO CUSTOMER

- Well defined problem statement.
- Defined generic solution sets focus effort to where solutions are likely to be found and directs the group to explore options that may not have been considered.
- Large number of possible solutions generated
- Ranking of solutions by experienced professionals increases confidence.
- Group allowed me to leverage my time effectively

TRIZ Timeline
1956 First TRIZ paper published by Altshuller
1980 First TRIZ Conference
1993 TRIZ becomes known outside of USSR
1996 TRIZ Journal founded

Reference Books on TRIZ
The Innovation Algorithm, Genrich Altshuller
Simplified TRIZ, Kalevi Rantanen

Some TRIZ Websites of Interest

TRIZ Journal:	http://www.triz-journal.com
European TRIZ:	http://www.etria.net
Altshuller Institute for TRIZ Studies	http://www.aitriz.org
Technical Innovation Center:	http://www.triz.org
International TRIZ Association	http://matriz.karelia.ru