Applied Mechanical Design

Fostering creativity

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Inspired by
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Conceptual Design Phase

- Consists in finding a viable and promising concept
- Idea is to fill morphological matrix with several working principles for each function
- A working principle represents physical effect and its embodiment
- Find maximum number of working principles by creativity, searches and analysis of known systems → Ideation tools

Ideation Techniques & Tools

- It is all about guided idea generation
- Techniques provide systematic framework for generating ideas
- Systematic procedures force designers to explore alternatives
- Implementation of structure and experience build confidence in success of results

Terminology

- “Ideation” is generation of ideas
- “Creativity” is ability to generate new ideas and concepts that are useful
- “Innovation” is application of creative output

http://uncideation.tumblr.com/

Creativity

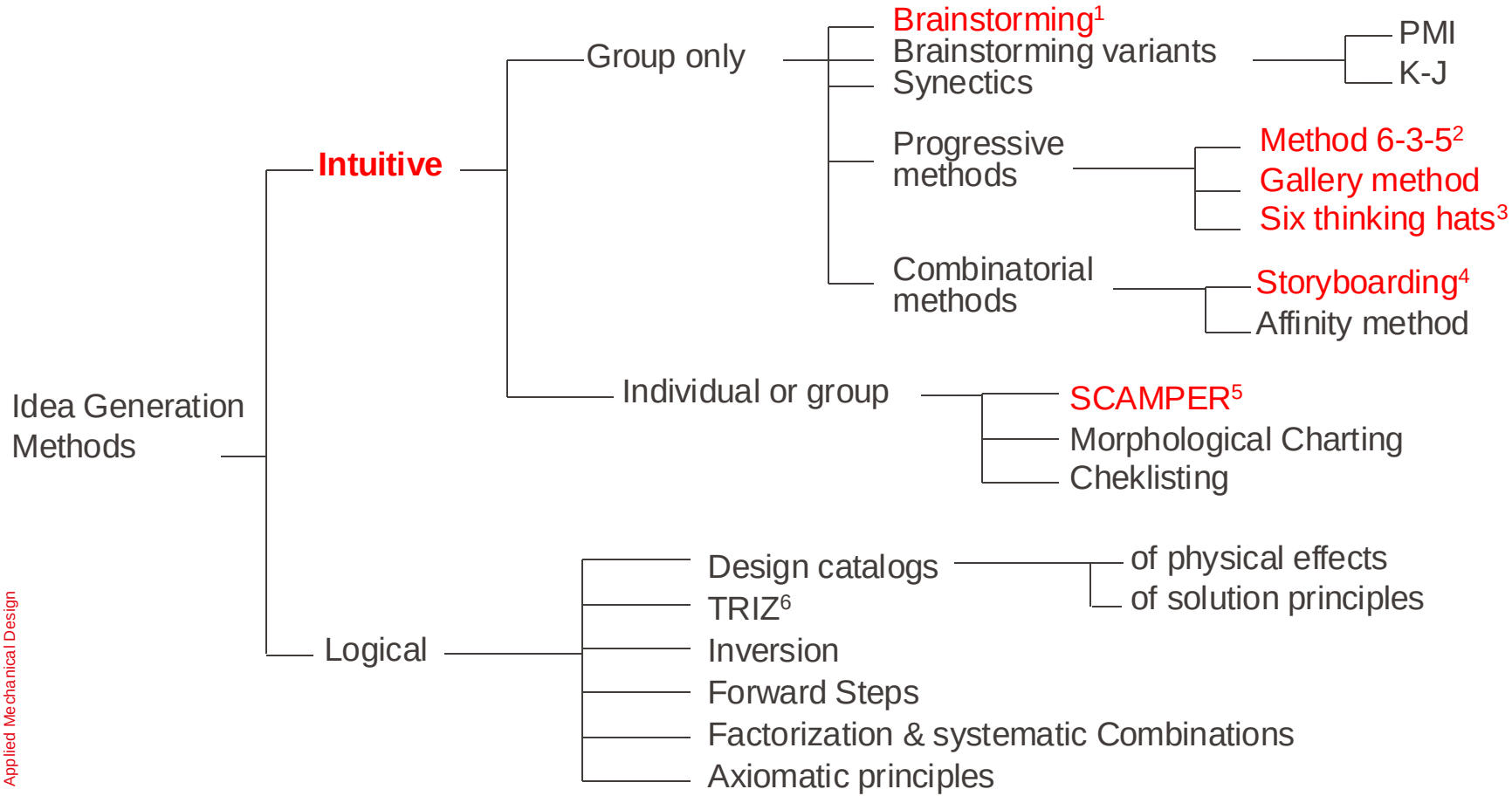
- Can creativity be enhanced?
  - Yes, through practice
  - Yes, through tools
- Surrounding and mindset affect creativity
  - Environment
  - Concentration
  - Attitude
  - Independence of thought

https://designschool.canva.com/blog/creative-learning/

What we know about creativity

- Everyone, regardless of age, gender, education, possesses creative potential
- Creative performance is influenced by attitude, emotion, environment
- Some factors may present barriers that block creativity
- Creative ability can be taught, developed, and generally enhanced and encouraged

Idea Generation Methods



Brainstorming[1]

- Systematic, group-oriented technique for producing large number of ideas
- Rules & guidelines
  - No critique or judgment
  - Wild ideas are encouraged
  - Modifying, combining, and improving upon the ideas of others is promoted
- Quantity as opposed to quality of ideas is emphasized

Method 6-3-5²

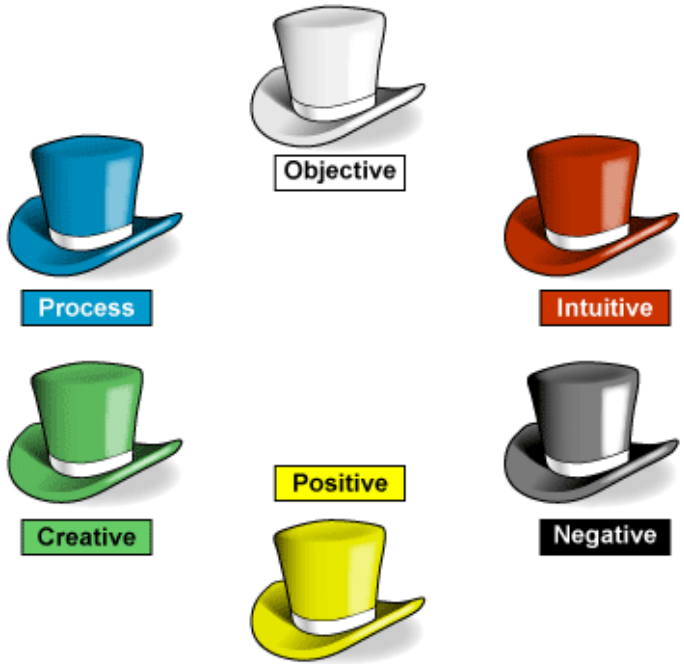
- Methodology
  - Identify ideation task
  - Form group of six
  - Each participant writes down three solution keywords
  - Sheet with keywords are passed to neighbor, who records three further solutions or developments
  - Ideas are passed a total of five times
  - Often used after brainstorming session
  - Clocking and rigid ruling might inhibit creativity

Gallery Method

- Methodology
  - Identify ideation task
  - Form group
  - Individuals sketch solutions
  - Group reviews all sketches exposed in a gallery
  - Individuals further develop and refine ideas
  - Group finalizes ideas and selects promising ones
  - Extension to other methodologies
  - Requires significant amount of time
  - Graphical, ordered and iterative brainstorming

Six Thinking Hats[3]

- Discussion in group with given roles
- All aspects / views of a problem are taken into account
- Efficient discourse on complex problem
- Role play may suppress individual creativity

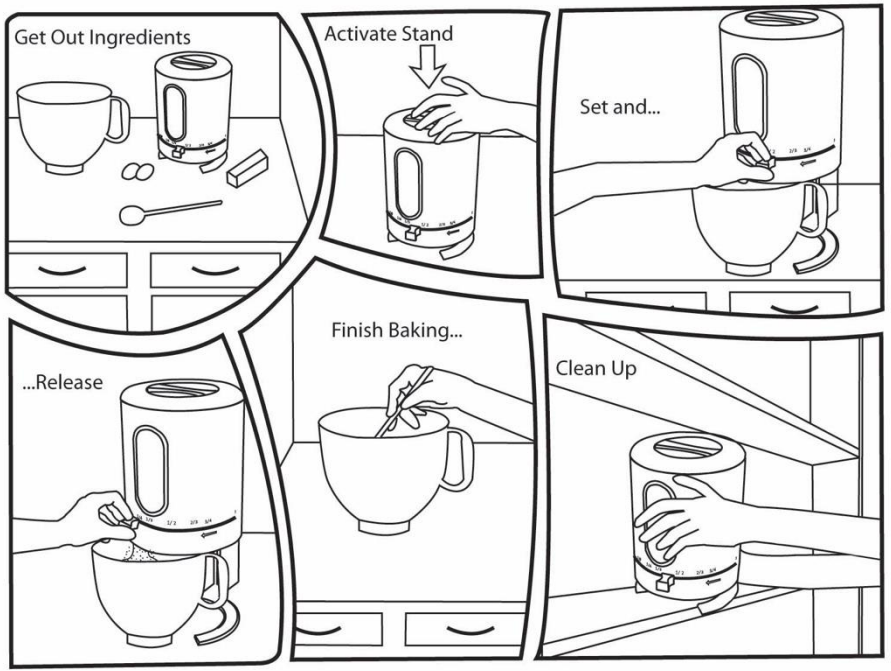


Six Thinking Hats[3]

- *White*: Analytical thinking. Focus on facts, available information and data base. Objective assessment. Pursue constructive approaches and solutions
- *Red*: Intuition and emotional thinking. Focus on feelings and personal opinions. Little need for logic and rational justifications
- *Black*: Critical thinking, judgment, caution, constructive skepticism. Strictly logical, pointing out why a proposal does not fit the facts, experience or conditions; what could go wrong; what is the worst-case scenario, etc.
- *Yellow*: Optimistic thinking. Envisaging of what could be achieved; positive speculation about the best-case scenario, benefits, value-creation, etc.
- *Green*: Creative, associative thinking. Introducing novel and provocative ideas; creative, constructive, alternative and unorthodox approaches
- *Blue*: Keeps process overview, puts ideas into order, moderates discussion

Storyboarding[4]

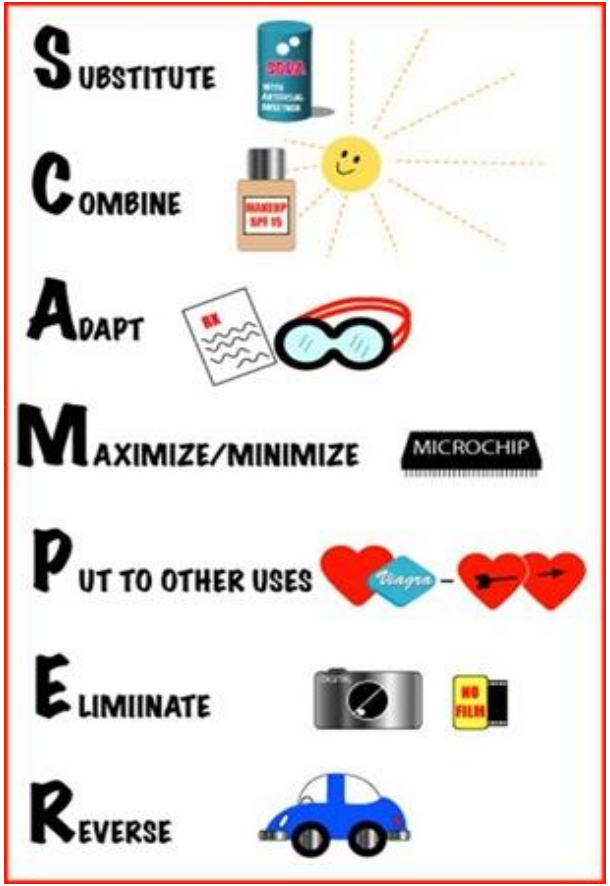
- Extensively used in film industry
- Popularized by W. Disney
- Used in defense and aerospace industry
- Suited for identifying use cases of product
- May be used to identify hidden specifications
- Documentation is part of creative process



http://web.mit.edu/2.009/www/resources/illustrator/crash-course/storyboard.html

SCAMPER[5]

- Collection of useful techniques to unblock creative thinking
- Helps in shifting perspective
- A collection of successful creativity tools
- No systematics to cover full solution space



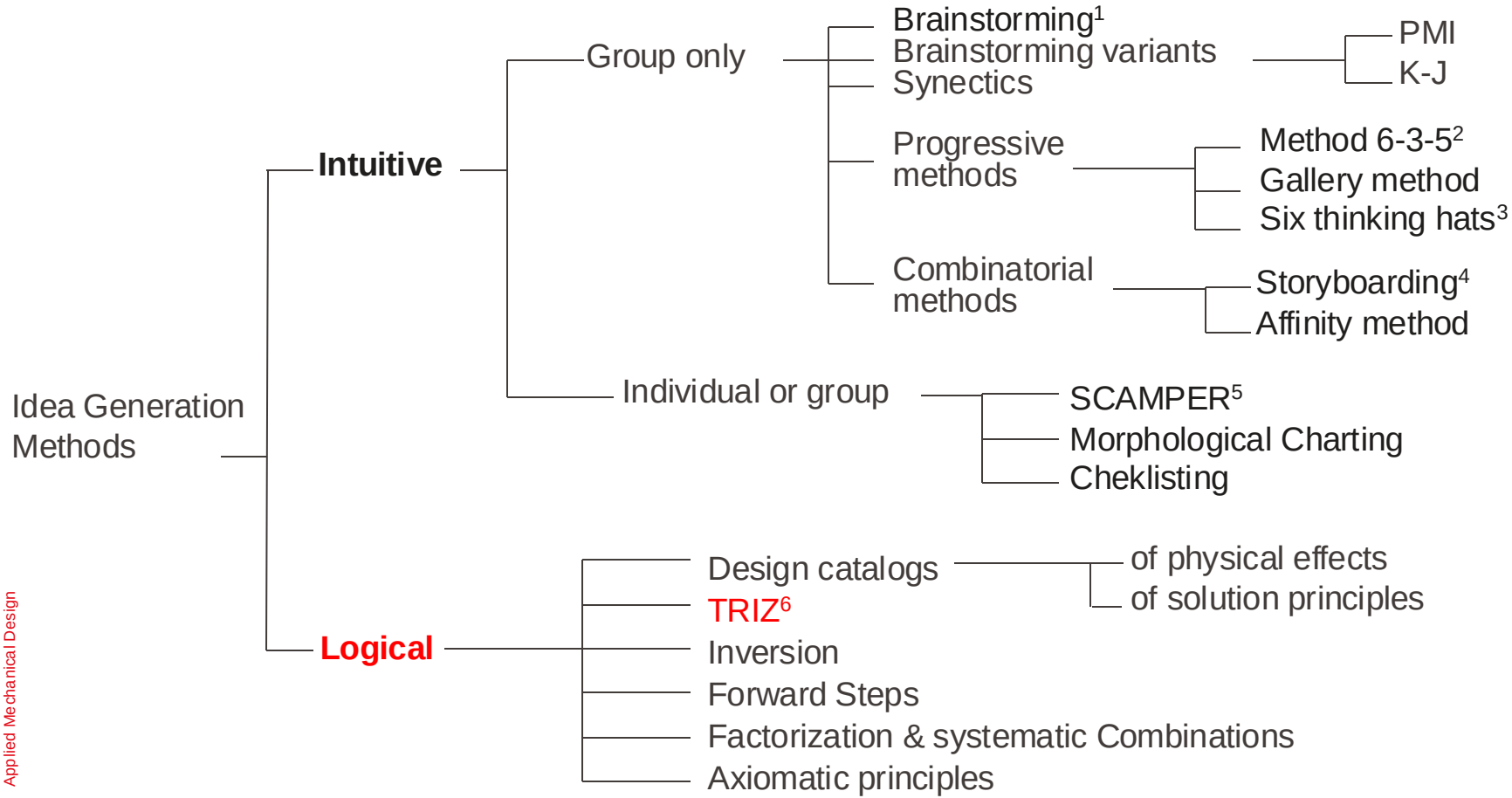
SCAMPER[5]

- Substitute
  - Components or sub-systems, objects/process/problem with others. Materials, people, time, use environment…
- Combine
  - Combine parts, by mixing functionality, materials, features, components, services to create synergies
- Adapt
  - Change functions, use parts of other component, vary characteristics and use, exchange sub-systems, vary haptics, adapt acoustics, exchange colors…

SCAMPER[5]

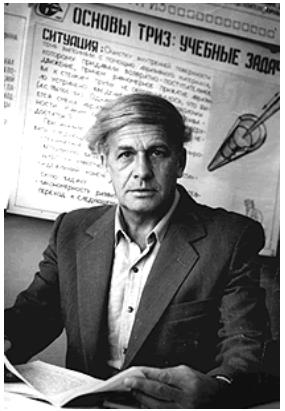
- Maximize / minimize
  - Change size, distort geometrical aspects, exaggerate properties or features of objects / processes / services / problems…
- Put to other use
  - Find other uses of current solution, identify different relationships with intended users or markets, to whom could your solution / product / process also of value…
- Eliminate
  - Remove parts from current solution, reduce functionality to the minimum, simplify use…
- Reverse
  - Turn problem upside-down, move it inside-out, find contrary uses, inverse sequences…

Idea Generation Methods



TRIZ

- Theory of inventive problem solving
- Introduced by G. Altshuller
- Objective is algorithmic approach to invention



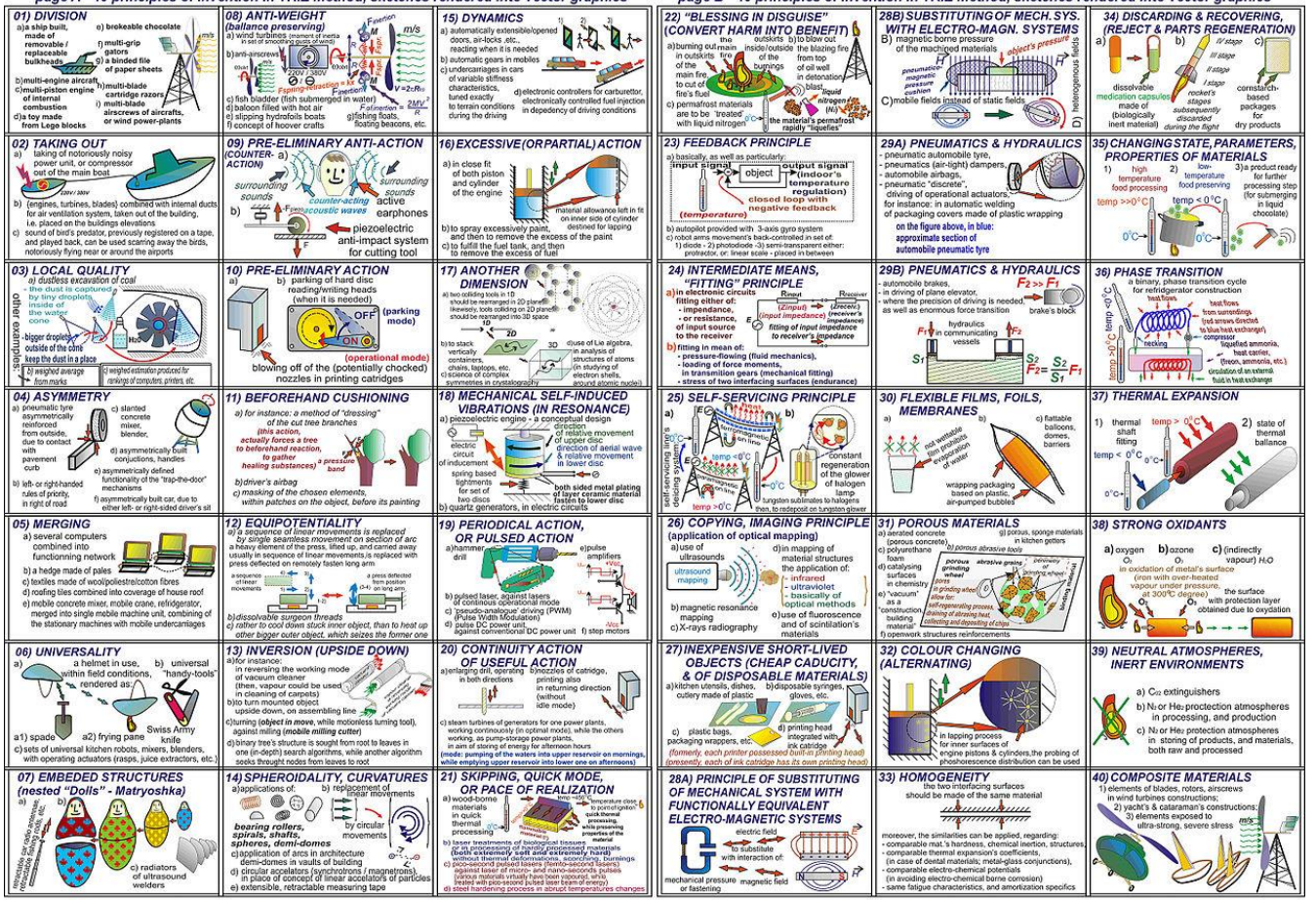
Researchgate.net

TRIZ

- Research produced following findings
  - Problems and their solutions are repeated across industries and science
  - Patterns of technological evolution are repeated across industries and science
  - Most innovations are transpositions of known solutions into other fields
  - Same solutions often overcome similar dilemma or contradiction

- Analysis of patterns therefore lead to systematic innovation processes
  - 40 principles of invention

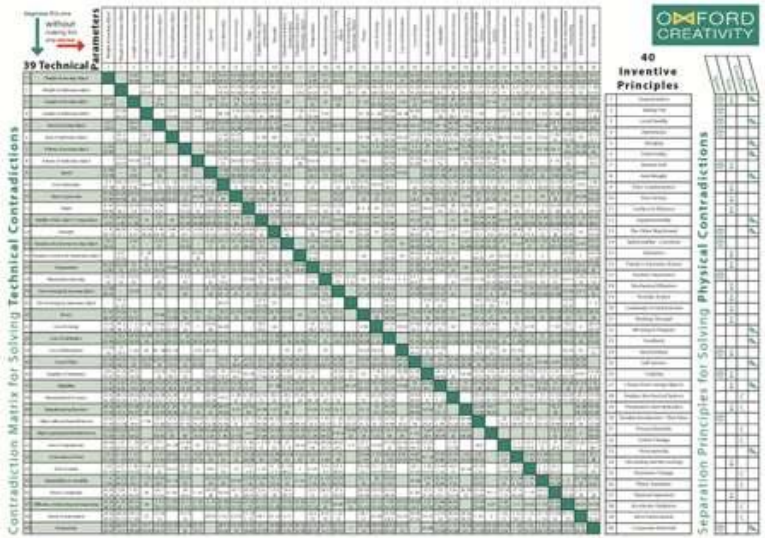
- 40 principles of invention



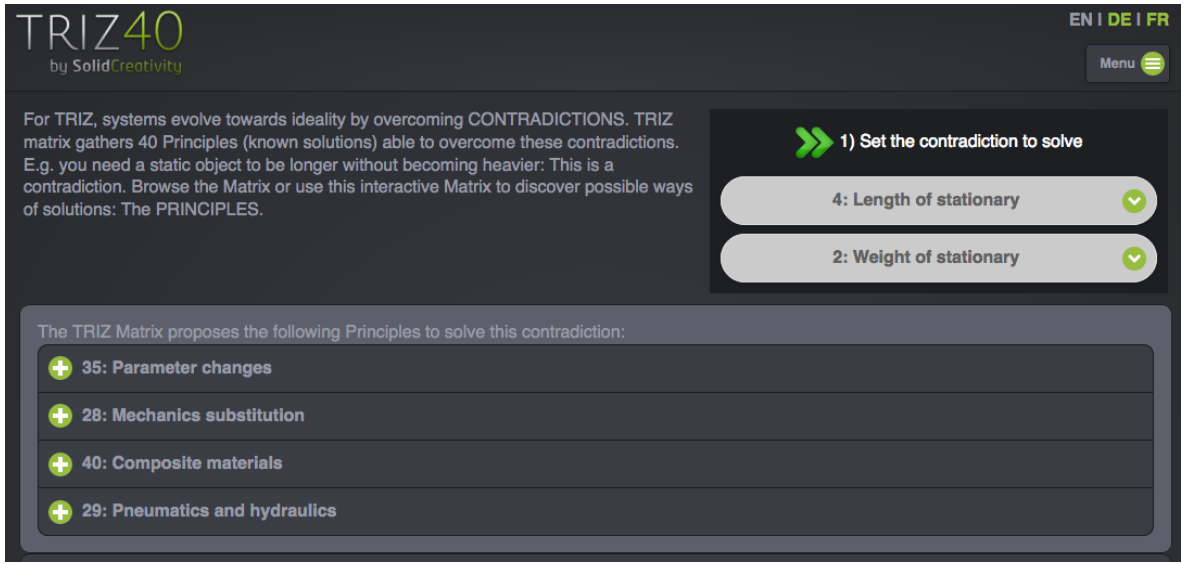
TRIZ

- Analysis of contradictions and their solution principles allows to establish contradiction matrix and associate solution principles

- Methodology
  - Abstraction of issue to be solved
  - Identify contradiction(s)
    - Conflict between two effects
    - Conflict between properties
  - Introduce contradiction pairs into matrix



- Example
  - Static object needs to be longer without impacting its mass
  - http://www.triz40.com/TRIZ_GB.php



Some Comments on Ideation Tools

- There is no such thing as a best tool
- Outcome is dependent on individuals and team dynamics
- Test different tools and identify most suitable for your environment
- Combine different methodologies to maximize output
- The different methodologies need training

References

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6. http://www.triz40.com/TRIZ_GB.php
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