Problem Solution Generation Options

by Duke Okes

Limitations of Traditional Brainstorming

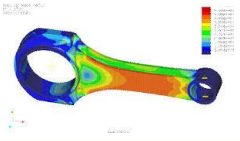
- Not optimum for people who don't like to speak up in groups
- Group activity can limit individual creativity
- It's a random search of a large potential solution space
- Structured, round robin and/or brain-writing can help

PSG Options

- Engineering Analysis
- Creative Thinking
- Benchmarking
- Mistake Proofing
- Biomimicry
- TRIZ

Engineering Analysis

- Analyzing properties regarding relevant scientific principles and laws of physics
- Looking at component-system relationships
- Mathematical/statistical modeling
- Computer or physical simulations
- Material sciences
- Task analysis
- e.g., finite element analysis, stack-up analysis



Creative Thinking

- Looking at things from another angle
- Going outside conventional boundaries
- Often uses techniques such as:
  - *Scale up or scale down*
  - *Forced relationships/associations/analogies*
  - *Reverse or morph*
  - *WWXD*
  - *No limits*
  - *Mind map*

- Opens up ideas that may not be possible, but can be adapted or will trigger other thoughts

Informal Benchmarking

- Someone, somewhere, has solved the same or a similar problem
- Could be product or process focus
- Google search, industry resources, conferences, technical journals
- Use findings to generate your own solutions

Examples

- Wrinkles in wound flexible packaging film
- Equipment changeover and pit stops
- Hospital LOS for knee surgery
- Data from Industry Week Best Plant award winners
- Reverse engineering customer's product

Formal Benchmarking

1. Identify what you want to benchmark
2. Find a benchmark partner (company, industry, best in class)
3. Do your homework
4. Swap visits, data, etc.
5. Identify gaps to close and develop action plans
6. Implement and revisit original purpose

Some Example Resources

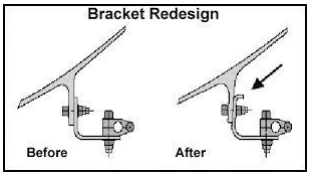
- American Productivity and Quality Center
- Baldrige Award winners
- Florida Benchmarking Consortium (local government)
- Industry Benchmarking Consortium (capital projects)
- Western States Benchmarking Consortium (K-12)
- ARC Benchmarking Consortium (automation, controls, plant assets)
- Accounting and Finance Benchmarking Consortium
- Transportation Industries Benchmarking Consortium

Mistake Proofing

- Also called Poka-yoke, developed by Shigeo Shingo
- Designed to prevent or detect defects, especially in low occurrence situations
- Accomplished through control (e.g., jigs or software) or detection (e.g., light curtains or timing) and alarms in mechanical systems
- Often provides low-cost solutions to problems
- More difficult to apply in human-oriented situations, so barriers (checklists, second checks, etc.) often used
- Need detailed understanding/diagram of product or process

Examples

- Size of gasoline vs. diesel nozzles and fill opening
- Interlock on microwave oven door
- Auto water faucet shutoff
- Doors on ATL train, hotel elevators



Human Mistake Proofing (with TRIZ concepts)

- Prevent it
  - Eliminate tasks or risks: Trim, self eliminate, prior action
  - Replace functions required: Automate, prior action, combine
  - Facilitate functions: Trim, standardize, copy, prior action, color, combine
- Minimize it
  - Detect abnormalities: Count, self eliminate, standardize, unique geometry, automate
  - Mitigate effects: Trim, copy, prior action, standardize

Source: NC State

Examples

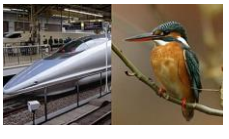
- Counting sponges used during surgery
- Drop down menus vs. key data into field
- Auto spell check
- Mirror & diagram at entry-way for checking PPE

Grout, 2007.

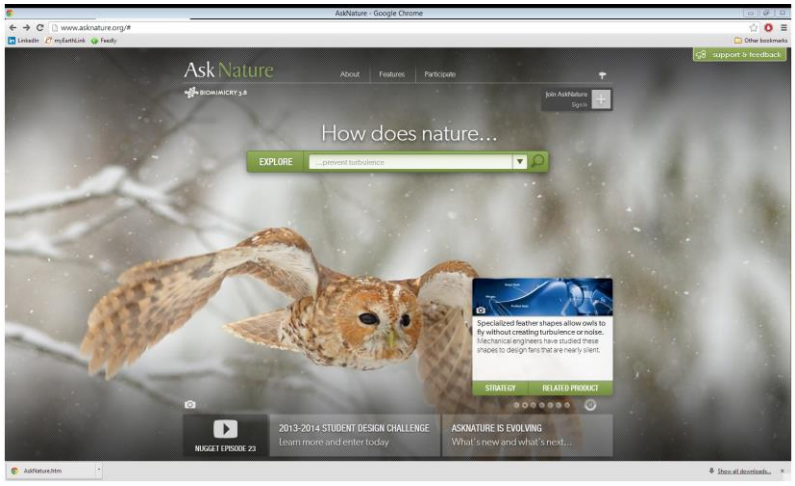
Basics of Biomimicry

- Learning from biology … nature
- Dog and burrs on coat > Velcro

- Termite mounds and building cooling systems
- Woodpecker head and bicycle helmets
- Butterfly wings and display technology
- Kingfisher and bullet train
- Lotus flower and windows



Using a Biomimicry Search



Partial List of TRIZ Techniques

- Ideal final result (IFR)
- Resources
- Smart little people (SLP)
- Functional analysis
- Contradictions

Ideal Final Result (IFR)

- Get maximum benefit with minimum cost and/or harm; IFR = Benefit/(Cost+Harm)
- Problem solves itself for free, or activity doesn't need to be done due to changes at higher level of system
- Can benefit from Why-Why analysis, but in the upward direction
- Examples:
  - Grass that doesn't need to be mowed
  - Glass that is self cleaning
  - Seamless bags (vs. testing seams for leaks)
  - No-beam carport design

Resources

- What resources are available to help solve the problem?
  - Human, materials, space, time, function, information, energy
- Look for free/cheap resources already available, others that could perhaps be made available
- Resources could be within or outside the system

Smart Little People (SLP)

- Sometimes called Many Little People or Smart Little Creatures
- Shifts thinking to a different level of system
- Example – Testing plastic bags for leaks:
  - They would be in the adhesive and let us know about quality of seal – color change as it seals?
  - They would inspect seam – acoustic, capacitive?

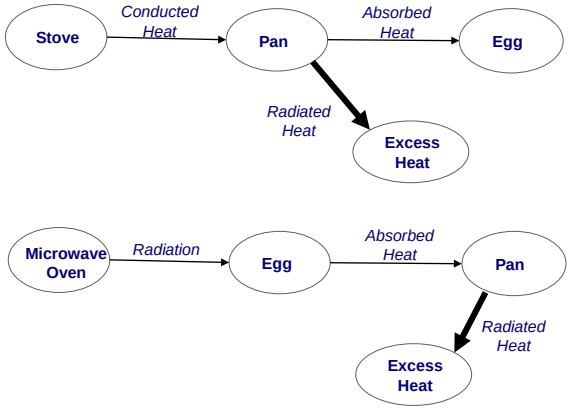
Functional Analysis (+Su-field & Scientific Effects)

- Looks at the functional relationships of components of the system (Subject – Action – Object)
- Evaluates quality of the relationships per:
  - Useful 
  - Harmful 
  - Insufficient 
  - Excessive 
  - Absent 
- Scientific effects can then be analyzed to develop alternatives through changes to the subject, object or field (Su-field) that provides the action

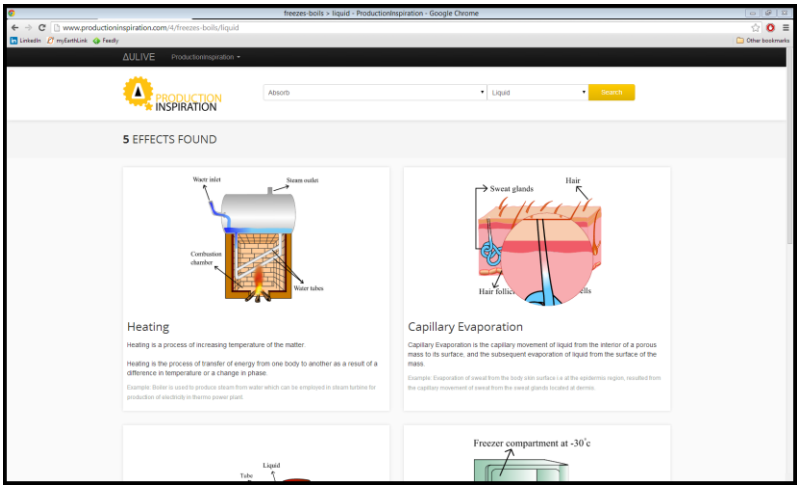
Simple Example

- Frying an egg
- Stove heats pan, pan cooks egg, egg sticks to pan
- Look at change to pan, change to heat, or change to egg
- Change to pan = no stick type or spray, change to heat = microwave, change to egg = temperature of egg prior to cooking?

Partial Functional Diagram of the Cooking System



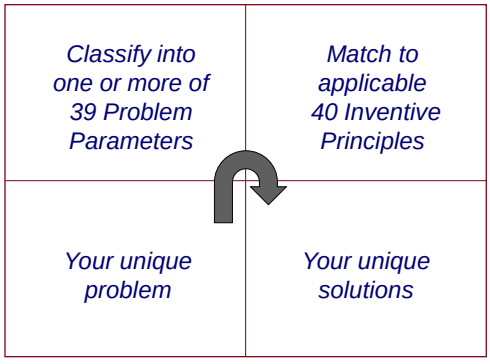
Example Effects Search



Contradictions

- Technical contradictions are problems where there are tradeoffs required (e.g., improving one thing causes another to get worse)
- Physical contradictions exist when the same parameter needs to be both high and low
- 39 Problem Parameters & 40 Inventive Principles
- The contradiction matrix allows determining best options

The Cycle for Contradictions



Example Technical Contradiction

- Manual data entry is expensive and often leads to errors in database
- Want to speed up data entry process (improve speed), but doing so will result in more errors (degrade quality)
- How to improve both simultaneously?
- Steps to follow:
  - Look up both factors in 39 Problem Parameters (will usually fall into more than one)
  - Look up intersection of the two to find relevant 40 Inventive Principles; Note: Use Rows for Improve, and Columns for Degrade)
  - Focus on the principles that repeat

The Lookup Process

- Improve Speed Problem Parameters (rows)
  - 9 – Speed
  - 26 – Amount of substance
  - 33 – Convenience of use
  - 38 – Level of automation
  - 39 - Productivity
- Degrade Quality Problem Parameters (columns)
  - 24 – Loss of information
  - 27 - Reliability
  - 29 – Accuracy of manufacturing
- Intersection of the two yields many numbers, with the following repeats = #'s 13, 22, 27, 23, 35, 10, 28 Inventive Principles

Using the Matrix

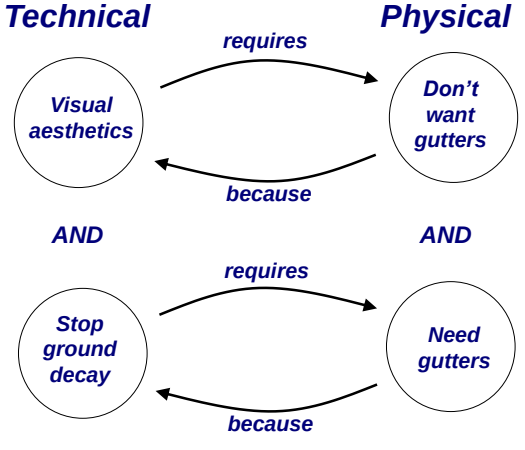
- / +		Weight of moving object	Weight of stationary object	Length of moving object	Length of stationary object	Area of moving object	Area of stationary object	Volume of moving object	Volume of stationary object	Speed	Force (Intensity)	Stress or pressure	Shape	Stability of the object's composition	Strength	Duration of action of moving object	Duration of action of stationary object	Temperature	Illumination intensity	Use of energy by moving object	Use of energy by stationary object	Power	Loss of Energy	Loss of Substance	Loss of Information	Loss of Time
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	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	1, 35, 19, 39	28, 27, 18, 40	5, 34, 31, 35		6, 29, 4, 38	19, 1, 32	35, 12, 34, 31		12, 36, 18, 31	6, 2, 34, 19	5, 35, 3, 31	10, 24, 35	10, 35, 20, 28
2	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	26, 39, 1, 40	28, 2, 10, 27		2, 27, 19, 6	28, 19, 32, 22	19, 32, 35		18, 19, 28, 1	15, 19, 18, 22	18, 19, 28, 15	5, 8, 13, 30	10, 15, 35	10, 20, 35, 26
3	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	1, 8, 15, 34	8, 35, 29, 34	19		10, 15, 19	32	8, 35, 24		1, 35	7, 2, 35, 39	4, 29, 23, 10	1, 24	15, 2, 29
4	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	39, 37, 35	15, 14, 28, 26		1, 10, 35	3, 35, 38, 18	3, 25			12, 8	6, 28	10, 28, 24, 35	24, 26,	30, 29, 14
5	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	11, 2, 13, 39	3, 15, 40, 14	6, 3		2, 15, 16	15, 32, 19, 13	19, 32		19, 10, 32, 18	15, 17, 30, 26	10, 35, 2, 39	30, 26	26, 4
6	Area of stationary object		30, 2, 14, 18		26, 7, 9, 39		+				1, 18, 35, 36	10, 15, 36, 37		2, 38	40		2, 10, 19, 30	35, 39, 38				17, 32	17, 7, 30	10, 14, 18, 39	30, 16	10, 35, 4, 18
7	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	28, 10, 1, 39	9, 14, 15, 7	6, 35, 4		34, 39, 10, 18	2, 13, 10	35		35, 6, 13, 18	7, 15, 13, 16	36, 39, 34, 10	2, 22	2, 6, 34, 10
8	Volume of stationary object		35, 10, 19, 14	19, 14	35, 8, 2, 14				+		2, 18, 37	24, 35	7, 2, 35	34, 28, 35, 40	9, 14, 17, 15		35, 34, 38	35, 6, 4				30, 6		10, 39, 35, 34		35, 16, 32 18
9	Speed	2, 28, 13, 38		13, 14, 8		29, 30, 34		7, 29, 34		+	13, 28, 15, 19	6, 18, 38, 40	35, 15, 18, 34	28, 33, 1, 18	8, 3, 26, 14	3, 19, 35, 5		28, 30, 36, 2	10, 13, 19	8, 15, 35, 38		19, 35, 38, 2	14, 20, 19, 35	10, 13, 28, 38	13, 26	
10	Force (Intensity)	8, 1, 37, 18	18, 13, 1, 28	17, 19, 9, 36	28, 10	19, 10, 15	1, 18, 36, 37	15, 9, 12, 37	2, 36, 18, 37	13, 28, 15, 12	+	18, 21, 11	10, 35, 40, 34	35, 10, 21	35, 10, 14, 27	19, 2		35, 10, 21		19, 17, 10	1, 16, 36, 37	19, 35, 18, 37	14, 15	8, 35, 40, 5		10, 37, 36

For a downloadable file of the matrix go to: http://www.triz-journal.com/archives/1997/07/matrix.xls

Solution Ideas

- 13 – Other Way Round:
  - Verbal vs. finger input
  - Standardize/change order in which is data entered
- 32 – Color Changes:
  - Use colored text on paper and match on screen
  - Color of lighting in work area
- 23 – Feedback:
  - Audio feedback for what was typed in
- 10 – Preliminary Action:
  - Design of forms and screens (e.g., same layout)
- 28 – Mechanical Substitution:
  - Audio entry
  - Scan forms

Converting Physical Contradictions to Technical Contradiction



Some Resources

- Books:
  - TRIZICS by Gordon Cameron
  - Insourcing Innovation by Silverstein, DeCarlo & Slocum
  - Simplified TRIZ by Rantanen & Domb
- Websites
  - www.biomimicry.com
  - www.asknature.org
  - www.productioninspiration.com
  - http://www.triz.co.uk/cp12.php
  - www.bmgi.com
  - http://triz40.com
  - www.triz-journal.com
  - www.mistakeproofing.com
  - http://archive.ahrq.gov/about/annualmtg07/
  - http://www.tx.ncsu.edu/departments/texed/professional_education_course_detail.cfm?courseid=137

Contact Information

Duke Okes
423-323-7576
dokes@earthlink.net
www.aplomet.com

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