GE105
Introduction to Engineering Design
College of Engineering
King Saud University

Lecture 9.

Creativity in Engineering Design

FALL 2016

Creativity and Engineering

- The professional life of engineers is devoted to the creative solution of problems
- Technology is the result of creativity with a purpose, or engineering design

  - Sending someone to the moon and to bringing him back to earth in 1968 required a number of technologies created by Engineers

Creative Engineers Have:

- Curiosity and tolerance of unknown
- Openness to new experiences
- Willingness to take risks
- Ability to observe details and see the "whole picture"
- No fear of problems
- Ability to concentrate and focus on the problem until it's solved

What some once said:

- This 'telephone' has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us. (*Western Union internal memo*, 1876)
- I think there is a world market for maybe five computers. (*Thomas Watson**, 1943)
- 640K [memory] ought to be enough for anybody (*Bill Gates*, 1981)

What you should hear:

- Great spirits have always encountered violent opposition from mediocre minds.

- Albert Einstein

- The person who says it cannot be done should not interrupt the person doing it.

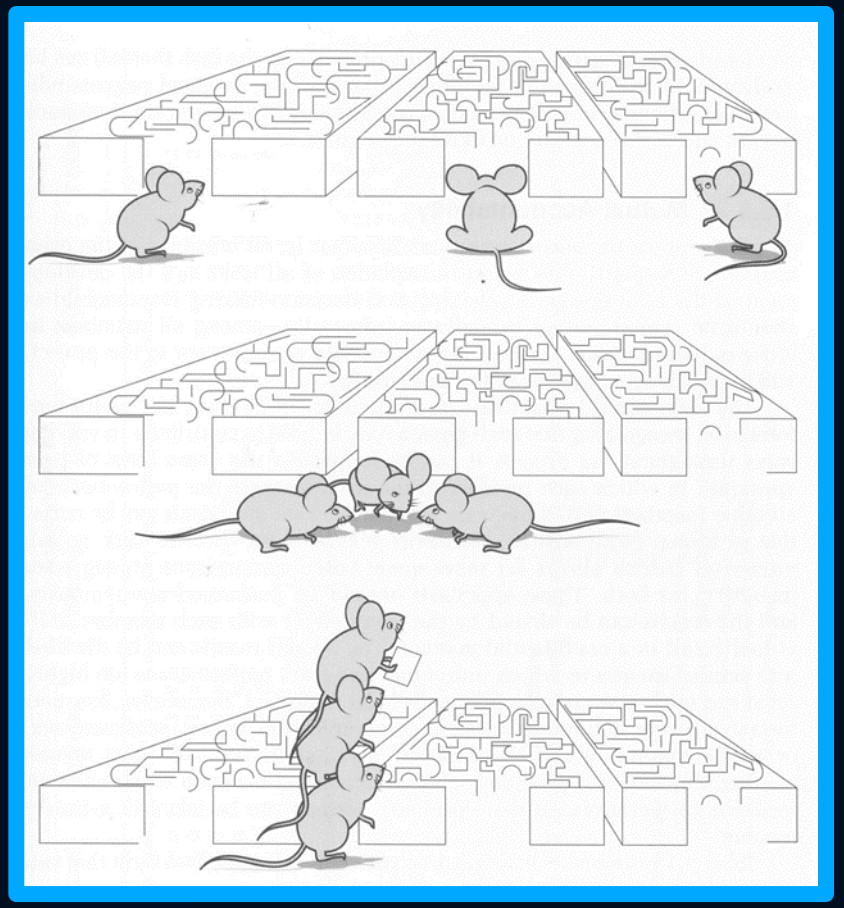
- Chinese Proverb

- Every really new idea looks crazy at first.

*- Alfred North Whitehead**

Teams and Creativity

- Teams combine the different backgrounds, experiences and thinking preferences of individuals
- Interaction among team members – other's ideas are used as stepping-stones to more creative ideas
- Willingness on the part of a team to take greater risks



Engineering Creative Methods

- **Evolution:** Incremental improvement; *Every problem that has been solved can be solved again in a better way.*
- **Synthesis:** Two or more existing ideas are combined into a third, new idea.
- **Revolution:** Completely different, new idea
- **Reapplication:** Look at something old in a new way.
- **Changing Direction:** Attention is shifted from one angle of a problem to another

Introduction to Creative Thinking , Robert Harris. Version Date: July 1, 1998

Engineering Creativity and Constraints

- In engineering, creativity is useful only if it fits into the realities of the physical world
  - A creative idea in engineering must conform to the established physical laws
  - A creative idea in engineering must conform to our present knowledge of the nature of matter, unless we invent or find a new form of matter.
- Creativity in engineering is constrained by feasibility and practicality.

Creativity Stimulation Techniques

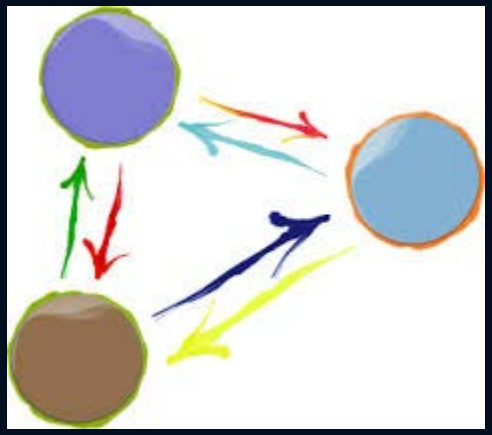
1. Inversion
2. Morphological Analysis
3. Analogy
4. Brainstorming

Many others

Techniques: 1. Inversion

- Inverting the problem to view it from a different angle
- If you would like to save energy, explore wasting energy
- The crow example: Water too low in the jug. Instead of trying to explore how to go to the water, explore how the water can get to the crow. Solution, put stones!

Techniques: 2. Morphological Analysis



- The problem is divided into smaller sub-problems.
- Concepts are generated to satisfy each smaller problem.
- A four-step process
  1. List the functions and features required
  2. Identify as many ways as possible for each feature or function
  3. Draw a table with functions listed vertically and features or concepts listed horizontally
  4. Identify all practical combinations

Techniques: 2. Morphological Analysis (Example)

Design a means of transportation for disabled persons*

Feature	Concept 1	Concept 2	Concept 3	Concept 4
Body Support	armchair	under arm	leg support	sofa
Ground Support	rollers	tracks	wheels	skids
Power Supply	Battery	solar	human	air
Speed Control	automatic	manual	on-off	-
Direction Control	side thrust	one side lock	reverse	Steering

Design 1: Armchair + Rollers + Solar + Automatic + Side-thrust

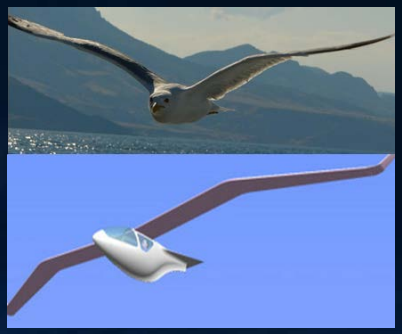
Design 2: Armchair + Wheels + Human + Manual + Steering

2. Morphological Analysis (contn'd)

- This approach is very powerful
- It generates "too many" combinations
- Many obviously will not make sense and can be quickly eliminated
- However, you often find a new idea by looking at the possible combinations of concept pieces
- Remember, this is an iterative process, you may have to go back to square one often

Techniques: 3. Analogy

- **Personal analogy** (imagine yourself in the situation, e.g., if designing a product, imagine yourself as the product itself or one of its functions)
- **Direct analogy** (Copy ideas from nature, wild life)



Techniques: 4. Brainstorming

Rules (within a comfortable/friendly environment):

- Define the problem to be solved
- No criticism allowed during the session
- Large quantity of ideas wanted (quantity over quality)
- Crazy ideas are welcome
- Keep ideas short and snappy
- Combine and improve on others' ideas "laterally" (new categories) and "vertically" (new ideas in categories)

Idea Selection

- Creative sessions lead to many ideas, how to select the best one?
- Do some clustering first (merge similar ideas under one heading)
- Then, apply one or more of the following options:

1. Questions Options Criteria (QOC)
2. Voting
3. SWOT Analysis

Selection: 1. Questions Options Criteria (QOC)

- Determine important criteria beforehand
- Judge each option (idea) based on the criteria
- Criteria may have a different weighting!

	Criteria 1	Criteria 2	Criteria 3
Option 1			
Option 2			
Option 3			
Option 4			

Selection: 2. Voting

- Members are given a fixed number of colored stickers (virtual money)
- Voting for good ideas (criteria) is by putting a sticker next to it
- For very good ideas, multiple stickers can be put
- This could be used to reduce the list of alternative ideas

Selection: SWOT

Strengths, **W**eaknesses, **O**pportunities, **T**hreats

- Often used to analyze business but can also be used to select ideas
- Specify each of these for each idea
- Can be applied to a reduced list of ideas
- Better suited to modify/improve existing designs

Final Thoughts

- For every good idea, expect to have tens of bad or wrong or useless ideas
- You don't have to be a mathematical genius. But you should be competent in mathematics.
- Evaluate and improve the extent of your hands-on and laboratory skills.
- Visualize how the work could be accomplished (spread sheets, flow charts, drawing)
- Imagination is also crucial. Begin at the science fiction level, then apply the constraints gradually.
- Keep a design notebook*