GE105: Introduction to Engineering Design

Creativity in Engineering Design

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Do you know Creativity when you see it?

Are these creative new product concepts?

What about these?

Or these?


BUTTER


Duster Slippers For Cats
• For feline assistance with tedious housework

Creative Thinking Techniques

Creative designer must:

- Have an extensive memory store.
  - Expansion of memory store may be via observation, group activities, and access to recording and information retrieval system.
- Have an effective search technique to be able to manipulate with memory so that new patterns fall into place.

Creative Thinking Techniques

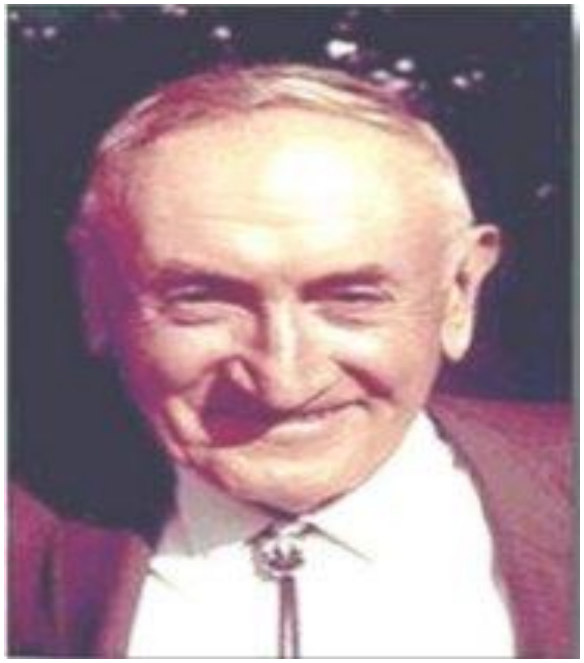
Techniques for creative thinking are classified according to the way in which they assist the memory scan.

The techniques can be grouped as:

- Problem Recognition
  - Morphological Analysis
- Idea Stimulation
  - Analogy
- Group Activity
  - Brainstorming

Morphological Analysis

- Systematically structuring and investigating the total set of relationships contained in multi-dimensional, usually non-quantifiable, problem complexes. (1966-1969)
- **Fritz Zwicky** (1898 – 1974)
  - He wrote a book on the MA subject in 1969, and claimed that he made many of his discoveries using this method.
  - Fields.
    - Classification of astrophysical objects.
    - Development of jet and propulsion systems.
    - Legal aspects of space travel.
    - Later on 100's of projects carried out using MA.



Morphological Analysis

Organizing Functions/Key Features and Means to Generate Designs that Work

- Morphological Analysis - Important Alternative Development tool
  - Chart or Matrix
    - Functions or Key Features are listed in the first column
    - Alternate Means of achieving each function are given in that function's row
  - Generating the Means for each function can be a highly creative process
    - Means do not have to be words – some designers use sketches or thumbnails to show some alternative means

Morphological Analysis

- The Morphological Analysis can be used to generate Complete Alternatives
  - Leftmost column lists ALL functions/key features
  - Selecting a means from EACH row guarantees that the solution satisfies all required functionality
    - Will NOT, however, guarantee that
      - Alternatives will WORK
      - Or even be internally consistent
    - Judgement is still required
- This approach can result in a HUGE number of alternatives

Morphological Analysis - Example 1

Design of a beverage container

Morph Chart/Matrix showing one means for each function which can be combined to form one complete alternative that looks feasible

MEANS FEATURE/ FUNCTION	1	2	3	4	5	6
Contain Beverage	Can	Bottle	Bag		Box	••••
Material for Drink Container	Aluminum	Plastic	Glass	Waxed Cardboard	Lined Cardboard	Mylar Films
Mechanism to Provide Access to Juice	Pull Tab	Inserted Straw	Twist Top	Tear Corner	Unfold Container	Zipper
Display of Product Information	Shape of Container	Labels	Color of Material	••••	••••	••••
Sequence Manufacture of Juice, Container	Concurrent	Serial	••••	••••	••••	••••

Morphological Analysis - Example 2

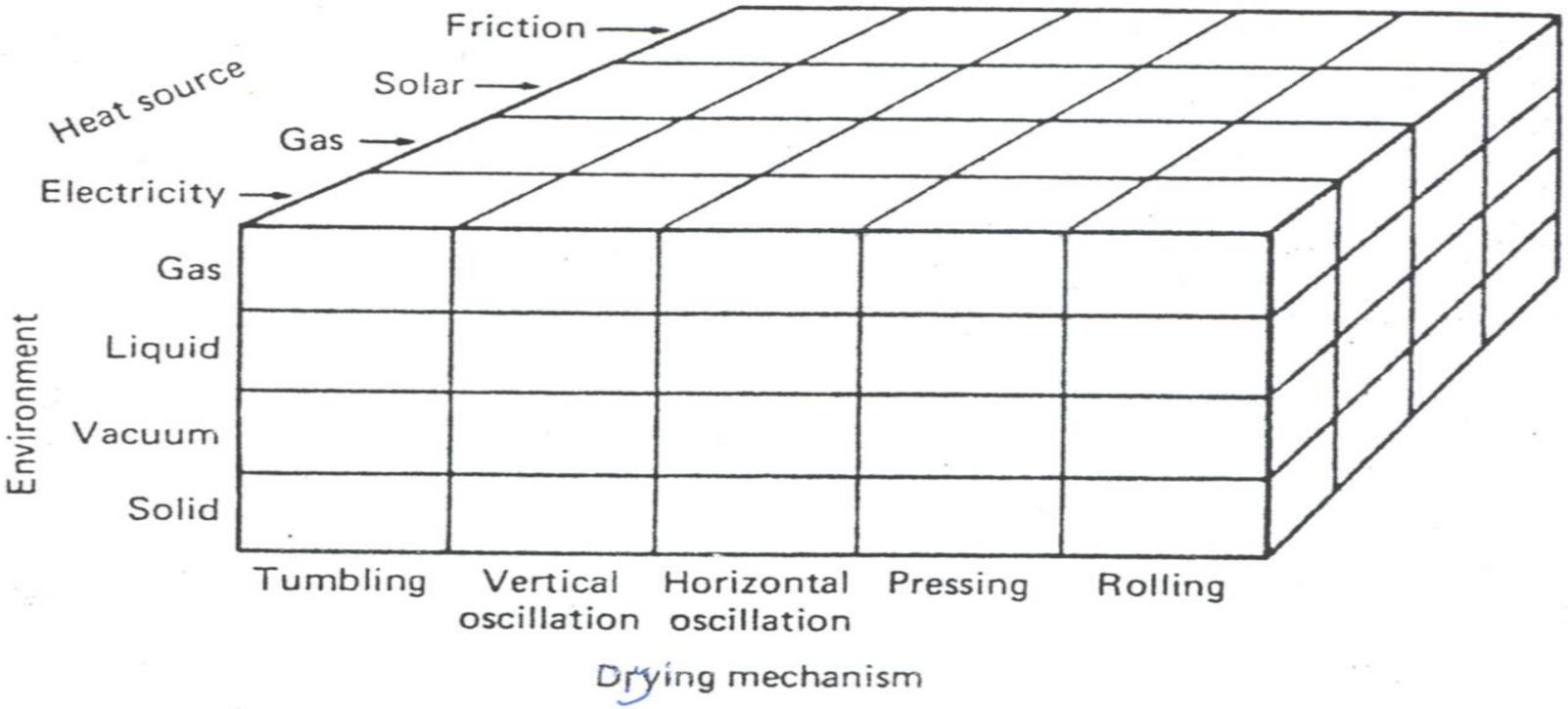
Design a device for picking, packaging, and transporting vegetables

	Option 1	Option 2	Option 3	Option 4
Vegetable picking device		Triangular plow	Tubular grabber	Mechanical picker
Vegetable placing device	Conveyor belt	Rake	Rotating mover	Force from vegetable accumulation
Dirt sifting device	Square mesh	Water from well	Slits in plow or carrier	
Packaging device				
Method of transportation		Track system	Sled	
Power source	Hand pushed	Horse drawn	Wind blown	Pedal driven

Concept 1

Morphological Analysis - Example 3

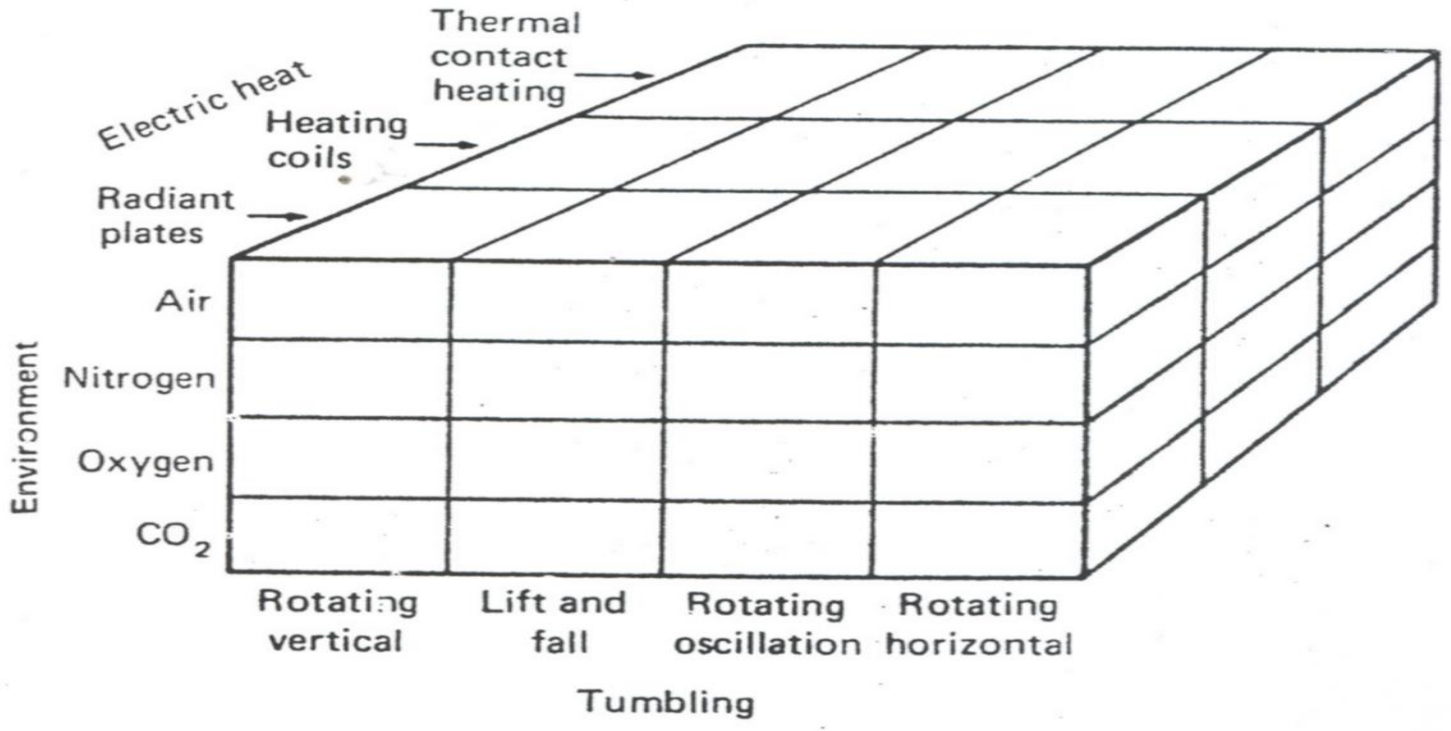
Design of Clothes Dryer



Morphological analysis of design of clothes dryer. (*After Alger and Hays.*)

Morphological Analysis - Example 4

Design of Clothes Dryer



Morphological box for design concepts of electric tumbler clothes dryer.

Steps for Morphological Brain-storming

Seeds for Morphological Brain-storming

Functionality;

Operational Method;

Power Source {Gasoline, Diesel, Electrical (battery), Electrical (mains), Chemical};

Components;

Areas of Use;

Capacity (by function, units of capacity, range of function, by performance indicators)

Material (Steel, Iron, Wood, Plastic, Ceramics, Nano-material, Fibers);

Styling and Finishing;

Systems Included;

Method of Transportation (if applicable).

Variations Generation

- For each seed generated, provide various design options.

Remaining Steps

Remaining Process

- Create a grid (matrix) of all the possibilities.
- Begin eliminating impossible combinations.
- Eliminate un-reasonable combinations.
- Eliminate useless combinations.
- Eliminate expensive combinations.
- What is left should give you a number of design features and alternatives.
- Morph these designs. This is done by creating a combination of these working features with one another to produce, say, three or more concepts.
- Weight and Rate these various concepts using good criteria to reach an optimal design! (next lecture)

During Eliminations, Remember:

- Some ideas are crazy and un-applicable for various reasons.
- Some combinations are a must.
- Some combinations are impossible.
- Some ideas are expensive.
- Some ideas are just not available for implementation at this day and age.

Idea Stimulation: Method of Analogy

- Copy ideas from nature, wild life, etc... The solution of problems by analogy is done when the designer has an interest in everything around him. This interest implies an **inquisitive nature**.

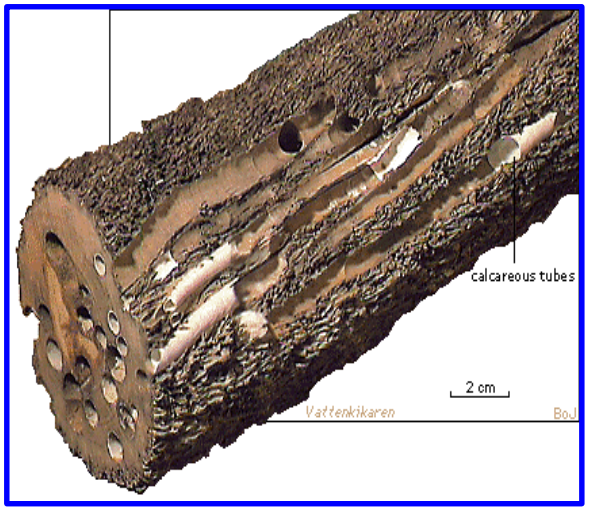
(Why, How)??

- Problem solving, by analogy, needs development of an interest intensity enabling one to understand the notions involved with observation.

Idea Stimulation: Method of Analogy

Marc Isambard Brunel

shipworm



Idea Stimulation: Method of Analogy

- Marc Isambard Brunel observed that a shipworm tunneling through timber (wood) constructed a tube for itself. The construction of a tunnel under the Thames by the use of caissons was the result of the observation.

Idea Stimulation: Method of Analogy

- The failed development of flapping wing aircraft is an attempt to copy the birds. Flying of birds depends on the configuration of feathers, the relative motion , and the shape of wings and flapping.

- The use of high aspect ratio wings on flying aircraft and gliders is the result of observations of the seagull (bird) who can have long gliding flight.

- Other Examples:
  - Bats
  - Octopus
  - Fish
  - …….

Group Activity: Brainstorming

- Group of people are gathered to stimulate the development of ideas.
- The group activities provide greater range of memory store.
- The development of search technique is improved upon the interaction between individuals.
- The basic "rules of the game" are:

1. Define the problem to be solved.
2. Do not criticize or pass judgment during the ideation phase.
3. All ideas are welcomed and listed.
4. Develop as many ideas as possible.
5. Combination and development of ideas is encouraged.

Quiz-2 on next class

Tutorial-3
due next week

Methods to clean and preserve a creational small lake from lettering, dead woods, used tires, etc.

Ways to raise the Titanic (300 m below the sea level).