Concept Generation

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What you’re going to learn today:

How to:

• generate 40% more ideas in a team
• identify 3x as many analogies
Agenda for Class

1. Idea Generation
2. “Rules” for Idea Generation
3. Brainstorming with Mind Maps
4. 6-3-5 (a brainwriting technique)
5. Morph Matrices
6. Checklist approaches
The Problem is Defined—Now What?

• Are you creative?
• Is it important for engineers to be innovative?
• How are concepts developed?
Brilliant Ideas take Time and Effort

OH, MAN, IT'S THE END OF THE DAY AND I HAVEN'T DONE ANYTHING!

THE ONLY WAY TO SALVAGE THIS IS TO COME UP WITH A SUPER BRILLIANT IDEA THAT MAKES UP FOR ALL THE TIME I WASTED.

C'MON! BRILLIANT IDEA! BRILLIANT IDEA! THINK...

I WONDER IF THIS IS HOW EINSTEIN CAME UP WITH E=MC²

PROBABLY NOT.
How to be a good idea generator (a.k.a. creative)

• Practice, practice, practice
• “Genius is 1% inspiration and 99% perspiration!”
  – Thomas Edison
• “The secret of creativity is knowing how to hide your sources”
  – Einstein
• “I use not only all the brains I have but all that I can borrow.”
  – Woodrow Wilson

• References your sources for this class and explain their connection to your results
• “Opportunity is missed by most people because it is dressed in overalls and looks like work.”
  – Thomas Edison
Starting Points for Concept Generation:
Parts of the design problem to solve

1. Individual functions
   (from a function structure)

2. Function groups (higher levels of a function tree, modules)

3. Product layout (concept variants)
Why Use Concept Generation Methods?

• Initial solutions are rarely the best

• Helps prevent design fixation

• Increase skills in concept generation

• Amplifies concept generation ability
Basic “Rules” of Idea Generation: Applies to all Idea Generation Methods

- Suspended judgment of ideas
- Present all ideas, including the bad or silly ones
- Wild and Crazy Ideas are good
- Build from others’ ideas
- Strive for quality and quantity
- Review the problem at the beginning of the session
Overview of Methods

Figure 10.3
Brainstorming Procedure

1. Select a facilitator
2. Review the problem ~10 minutes - (task clarification, CN’s, specifications, etc.)
3. Rapid idea generation
4. When ideas trickle, either stop or use idea generators (analogies, physical principles, etc.)
Recording a Brainstorm: Mind Maps

- Step 1: Write Problem in the center
- Step 2: Add ideas: cluster into hierarchical groupings

- Look for categories!!
- Groupings help lead to more ideas
- Documents brainstorming
- Power of technique – utilizes fact that ideas in memory are linked by association
Mind Maps

- Step 1: Write Problem in the center
- Step 2: Add ideas: cluster into hierarchical groupings
- Look for categories!!
Detect & display the location of a golf ball

- Bright colored ball
- Electronic Grid with ball emitter
- Sound horn in ball
- Exploding ball
- Golf lessons
- GPS System
- Scent-Human
- Scent-Dog
- Virtual golf
- Pressure sensitive ground
- String attached to ball

- Smoke trail
- Shorter golf course
- Putt-Putt golf
- Spotters paced every 10 m
- Colored golf course
- Trajectory calculation system
- Robotic arm hits ball
- Mini-camera in ball
- Light emitting ball
- Ball shoots flare
- Plexiglass side walls on golf course
- Funnel shaped golf course
- Speaker in ball; use microphone to call yourself

\[\textbf{Figure 10.5.}\]
Partial brainstorming list generated for the function of “detecting a golf ball.”
Software

• Mindmanager
• others
Include Pictures in Mind Maps

- PhotoElastic Beams
  - Measuring beam deflection and distributed loads using a 2X4, tape measure, ruler, and two bathroom scales.
  - Measuring the normal forces at the supports as the load is moved.

- Deformable Devices Under Bending Loads
  - Deformable rubber sheet.
  - Deformable Foam Shaft
  - Hands-on tube connected to a computer program that shows Mohr’s circle and the stresses.

- Stress Elements
  - Stress Transformations
  - Balloon
  - over-cooked hotdog

- Hands-on Activities
  - Thin walled Pressure Vessels (Hoop Stress Compared to Circumferential)

- Combined Loading
  - Visualization of a Stress Element using a Click Eraser
  - Visualizing Stress Concentrations
  - Observation of Failure Planes using Crayola Model Magic

- Statics
  - Statically equivalent loads produce equivalent motions.
  - Two different distinct, statically equivalent loads can both balance the spoon.

- Trusses and Method of Joints
  - Statically equivalent loads cause the same deformation.
  - Replace a part of a truss structure with a string and then load the structure.

- Activity: Find items under combined loading
A Sticky Note Mind Map
Generate 40% More Ideas!!!!
6-3-5 (brainwriting)

- Procedure
  6 – group members
  3 – ideas (sketches & keywords) per paper
  5 – exchanging papers

Guidelines
- Each rotation allows adding to and synthesizing (combining) ideas
- Avoid negative comments
- No talking! (Emphasizes sketching)
- Sketches with brief keywords
6-3-5 Illustration

- Avoid negative comments
- No talking!

10 Minutes
6-3-5:
Rotate sets of concepts, spend 7 minutes adding ideas and combining

7 Minutes More per exchange
6-3-5 Case Study: Power Driver

- **electricity, human force**
- **hand, bit**
- **direction, on/off**

**loosen/tighten screws**

- **torque, heat, noise**
- **hand, bit**
- **looseness (or tightness)**

**Energy flow**

**Material flow**

**Signal flow**

**Figure 5.14.**
A black box representation of a power screwdriver. The overall function
Morph Matrix Example

<table>
<thead>
<tr>
<th>Accept User (shape)</th>
<th>Cylindrical</th>
<th>Toroidal</th>
<th>Prism</th>
<th>Outer Handle</th>
<th>Deformable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dycem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(surface)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Clamping</td>
<td></td>
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<tr>
<td>Permanent Attach</td>
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<tr>
<td>Slot</td>
<td></td>
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<tr>
<td>Magnets</td>
<td></td>
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<tr>
<td>Accept Utensil</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eccentric Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Lever</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Button</td>
<td></td>
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<tr>
<td>Squeeze Tube</td>
<td></td>
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<tr>
<td>Photocells</td>
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<tr>
<td>Accept Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(User Energy)</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
# Morph Matrix Example: Ways to Store Energy

<table>
<thead>
<tr>
<th>Type of Energy Principle</th>
<th>Mechanical</th>
<th>Hydraulic</th>
<th>Electrical</th>
<th>Thermal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flywheel</td>
<td>Hydraulic Reservoir: a. Bladder, b. Piston, c. Membrane (pressure energy)</td>
<td>Battery</td>
<td>Mass $m$, $s$, $\Delta \theta$</td>
</tr>
<tr>
<td>2</td>
<td>Moving Mass</td>
<td>Liquid Reservoir</td>
<td>Capacitor</td>
<td>Heated Liquid</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Flowing Liquid</td>
<td>Magnet (magn. field)</td>
<td>Super Heated Steam</td>
</tr>
<tr>
<td>4</td>
<td>Metal Spring</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Checklists & Idea Generators for Concept Generation

• Use when the group “runs” out of ideas

• Jump starts new ideas

• Have the list ready during a Concept Generation Session

• Table 10.3
<table>
<thead>
<tr>
<th>Idea generator</th>
<th>Questions or application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make analogies</td>
<td>What analogies exist in nature? What analogous products exist in any product domain? How do these products solve the same product functions?</td>
</tr>
<tr>
<td>Wish and wonder</td>
<td>What if . . . ?</td>
</tr>
<tr>
<td>Sketch/use physical models (e.g., Tinkertoys or LEGO)</td>
<td>What would an idea look like? How does this model satisfy the function? What can we change?</td>
</tr>
<tr>
<td>Eliminate or minimize?</td>
<td>If we remove a feature, how does the device perform? What can we use to replace the feature? What if a feature were smaller? What should I omit? Should I divide it? Split it up? Separate it into different parts? Understate? Streamline? Make miniature? Condense? Compact? Subtract? Delete? Can the rules be eliminated?</td>
</tr>
<tr>
<td>Substitute</td>
<td>What can be substituted? Who else? What else? Can the rules be changed? Other ingredient? Other material? Other process or procedure? Other power? Other place? Other approach? What else instead?</td>
</tr>
<tr>
<td>Combine</td>
<td>Can we combine purposes? How about an assortment? How about a blend? An alloy? Combine units? What other article or device could be merged with this?</td>
</tr>
<tr>
<td>Adapt</td>
<td>What else is like this? What other idea does this suggest? Does the past offer a parallel? What could I copy? Whom could I emulate? What idea could I incorporate? What other process could be adapted?</td>
</tr>
<tr>
<td>Modify or magnify</td>
<td>What can be magnified, made larger, or extended? What can be exaggerated? Overstated? What can be added? More time? Stronger? Higher? How about greater frequency? Extra features? What can add extra value? What can be duplicated? How could I carry it to a dramatic extreme? Convert a round action to straight? How can this be altered for the better? What can be modified? Is there a new twist? Change meaning, color, motion, sound, odor, form, or shape? Change name? What changes can be made in the plans? In the process? In the marketing?</td>
</tr>
<tr>
<td>Put to other uses (repackage an old idea)</td>
<td>What else can this be used for? Are there new ways to use as is? Other uses if modified? What else could be made from this? Other extensions? Other markets?</td>
</tr>
<tr>
<td>Reverse or rearrange</td>
<td>What other arrangements might be better? Interchange components? Other pattern? Other</td>
</tr>
</tbody>
</table>
SCAMPER

- Substitute
- Combine
- Adapt
- Magnify or minify
- Put to other uses
- Eliminate or elaborate
- Rearrange or reverse
SCAMPER: Substitute, Combine, Adapt, Magnify or minify, Put to other uses, Eliminate or elaborate, Rearrange or reverse
CREATIVITIVITY

- Combine
- Reverse
- Enlarge
- Adapt
- Tinier
- Instead of
- Viewpoint change
- In other ways
- To other uses
- Yes!
Innovation through Design-by-Analogy

Analogy to Existing Products

Environmentally friendly, collapsible sail for cargo ships

Bioinspired Design

Dyson vacuum based on a saw mill dust collector

Dyson vacuum

Dust Collector

Gas Outlet Tube

Dirty Air

Cyclone Body

Conical Section

Cleaner Air

Inlet

Dirt
Questions? There are many more techniques and tools for idea generation

- Asknature.org
- WordTree Method for Analogy
- patents
- ideamache.ecologylab.net
- TRIZ/TIPS

Need Help? Set-up an appointment: julie.linsey@me.gatech.edu