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

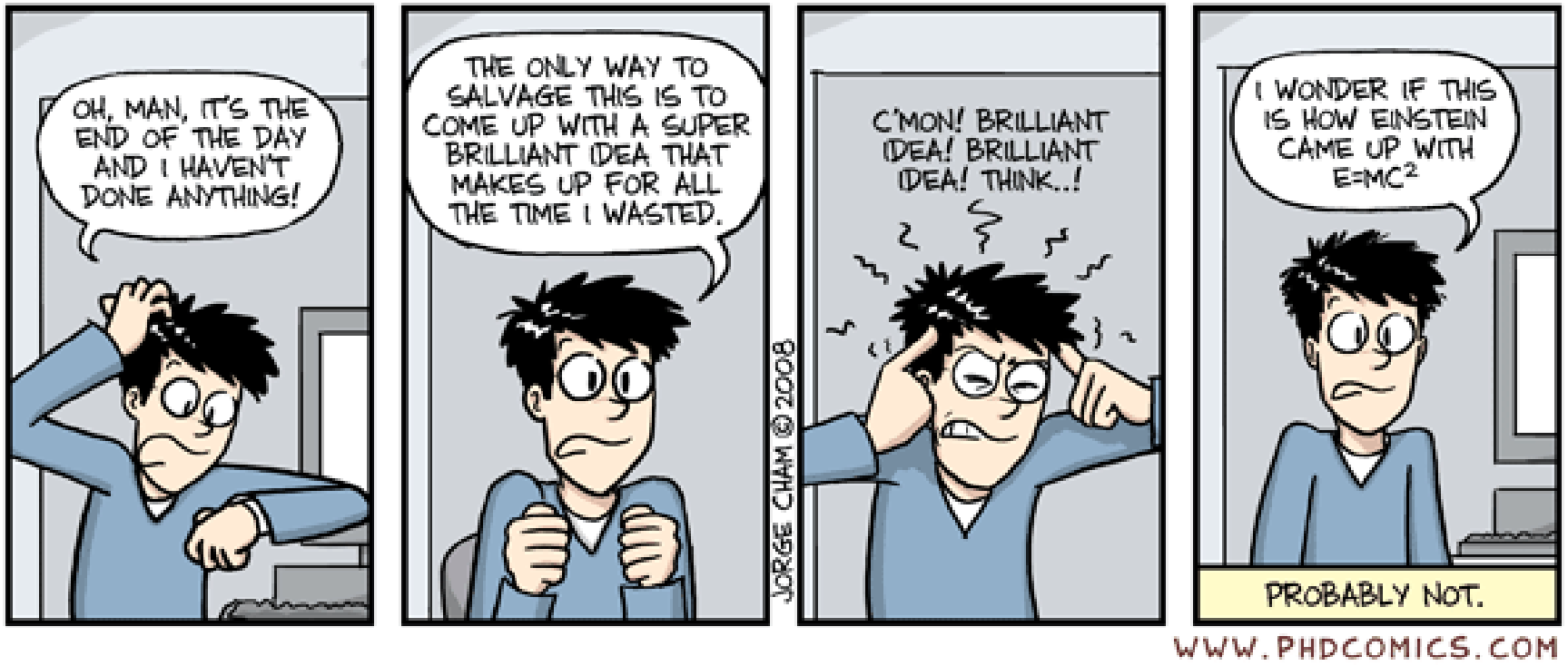
Agenda for Class

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



How to be a good idea generator (a.k.a. creative)

Practice, practice, practice

- "Never be limited by other people's limited imaginations."
  —Dr. Mae Jemison, first African-American female astronaut
- "Genius is 1% inspiration and 99% perspiration!"
  - Thomas Edison, American Inventor
- "The secret of creativity is knowing how to hide your sources"
  - Einstein, Scientist- general theories of relativity
- "All sorts of things can happen when you're open to new ideas and playing around with things."
  - Temple Grandin, Scientist- animal behavior
- "I use not only all the brains I have but all that I can borrow."
  - Woodrow Wilson, American president during World War 1

<u>References your sources for this class and explain their connection to your results</u>

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*)

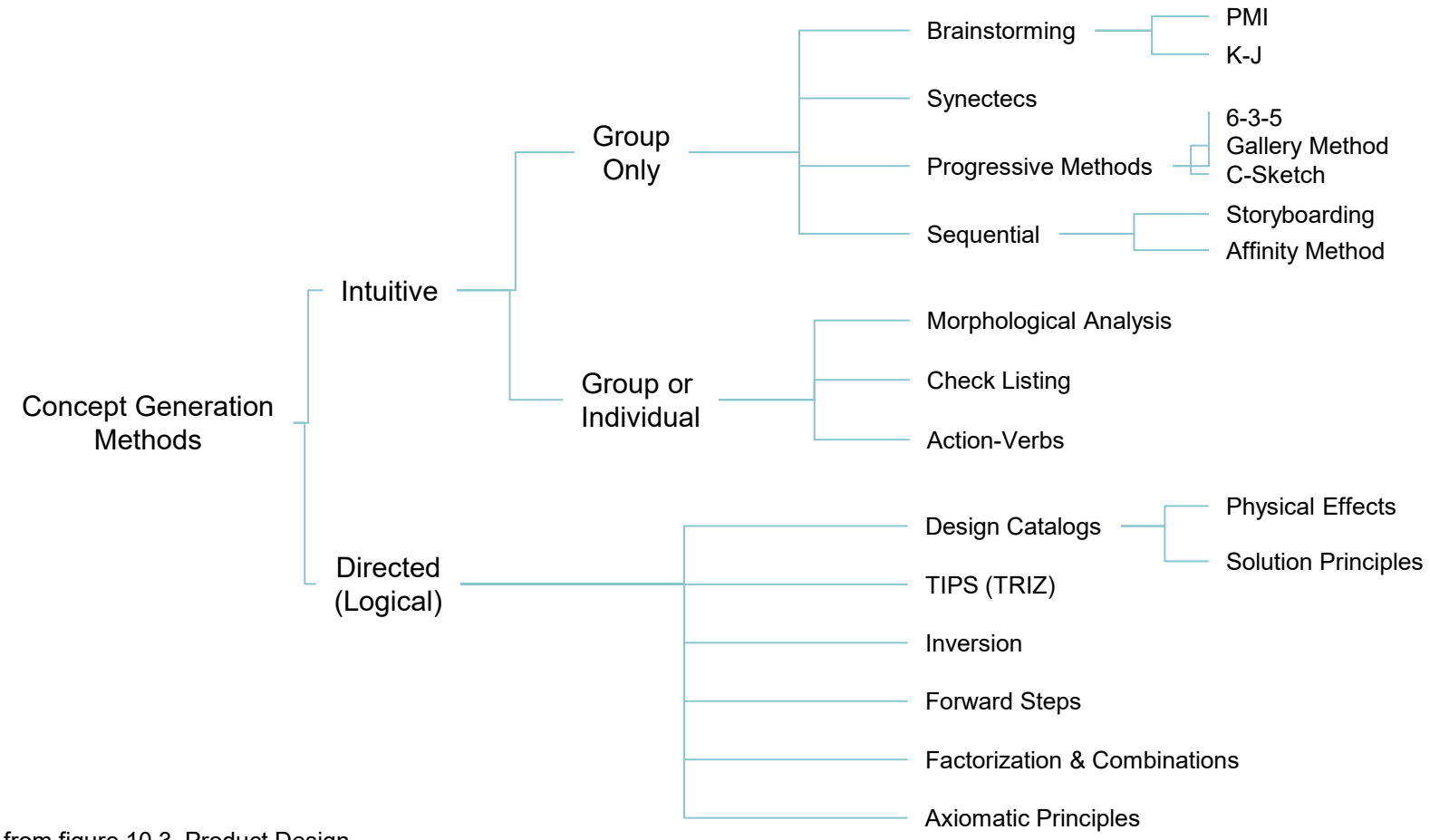
Why Use Concept Generation Methods?

- 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

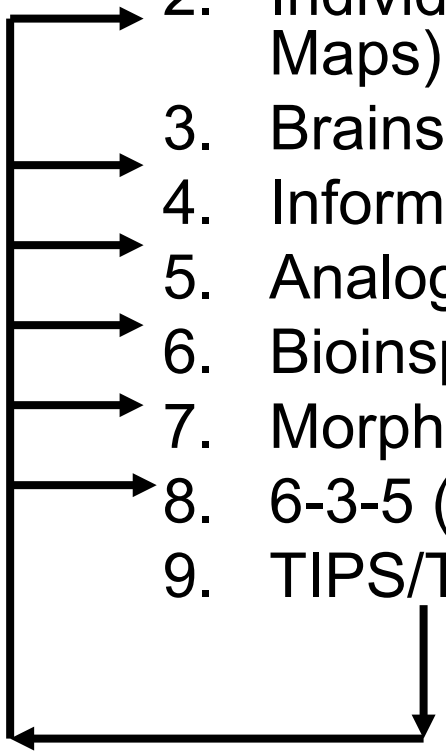
Overview of Methods- This is just a few



Redrawn from figure 10.3, Product Design

What a Concept Generation Process Might Look Like

1. Start with design opportunity
2. Individuals generate ideas alone (Mind Maps)
3. Brainstorming with Mind Maps
4. Information Gathering
5. Analogy: WordTree
6. Bioinspired Design Methods
7. Morph Matrix
8. 6-3-5 (combine ideas and draw)
9. TIPS/TRIZ



Mind Maps?

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.)

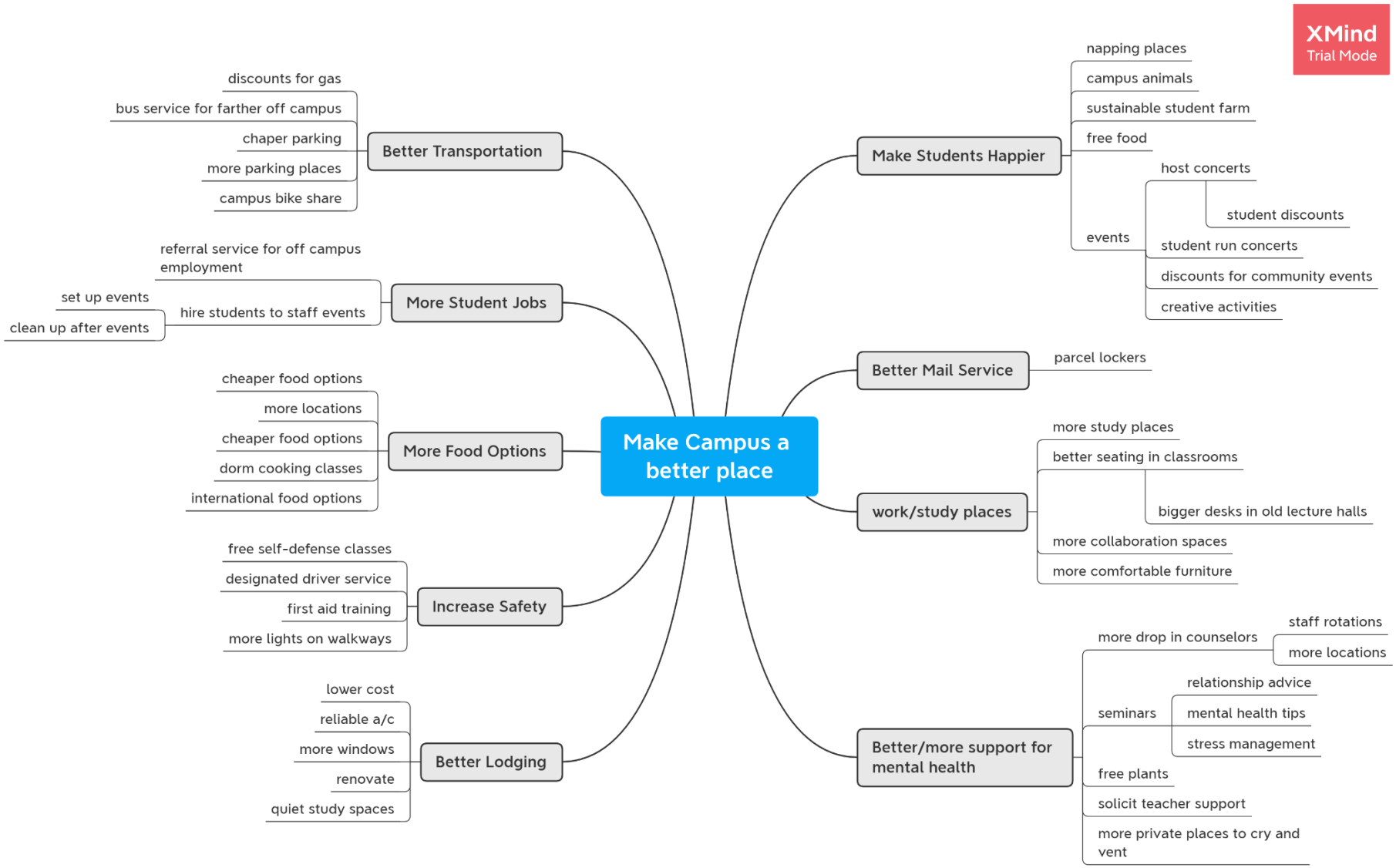
Recording a Brainstorm: Mind Maps

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

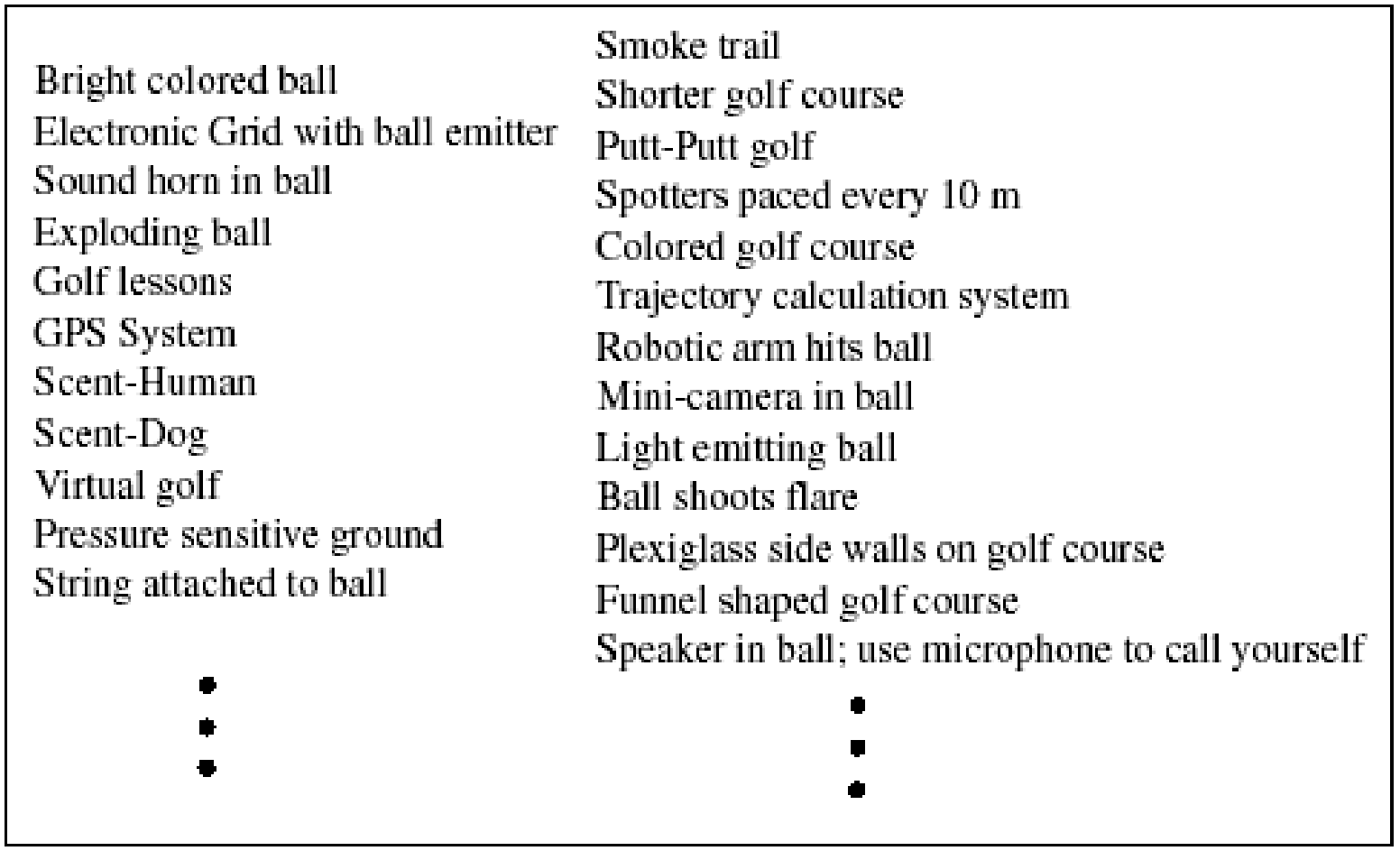
- Look for categories!!
- Groupings help lead to more ideas
- Documents brainstorming
- Power of technique – utilizes fact that ideas in memory are linked by association

Mind Map-

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


Make Campus a better place
Better Transportation
discounts for gas
bus service for farther off campus
chaper parking
more parking places
campus bike share
More Student Jobs
referral service for off campus employment
hire students to staff events
set up events
clean up after events
More Food Options
cheaper food options
more locations
cheaper food options
dorm cooking classes
international food options
Increase Safety
free self-defense classes
designated driver service
first aid training
more lights on walkways
Better Lodging
lower cost
reliable a/c
more windows
renovate
quiet study spaces
Make Students Happier
napping places
campus animals
sustainable student farm
free food
events
host concerts
student discounts
student run concerts
discounts for community events
creative activities
Better Mail Service
parcel lockers
work/study places
more study places
better seating in classrooms
bigger desks in old lecture halls
more collaboration spaces
more comfortable furniture
Better/more support for mental health
more drop in counselors
staff rotations
more locations
seminars
relationship advice
mental health tips
stress management
free plants
solicit teacher support
more private places to cry and vent
XMind
Trial Mode

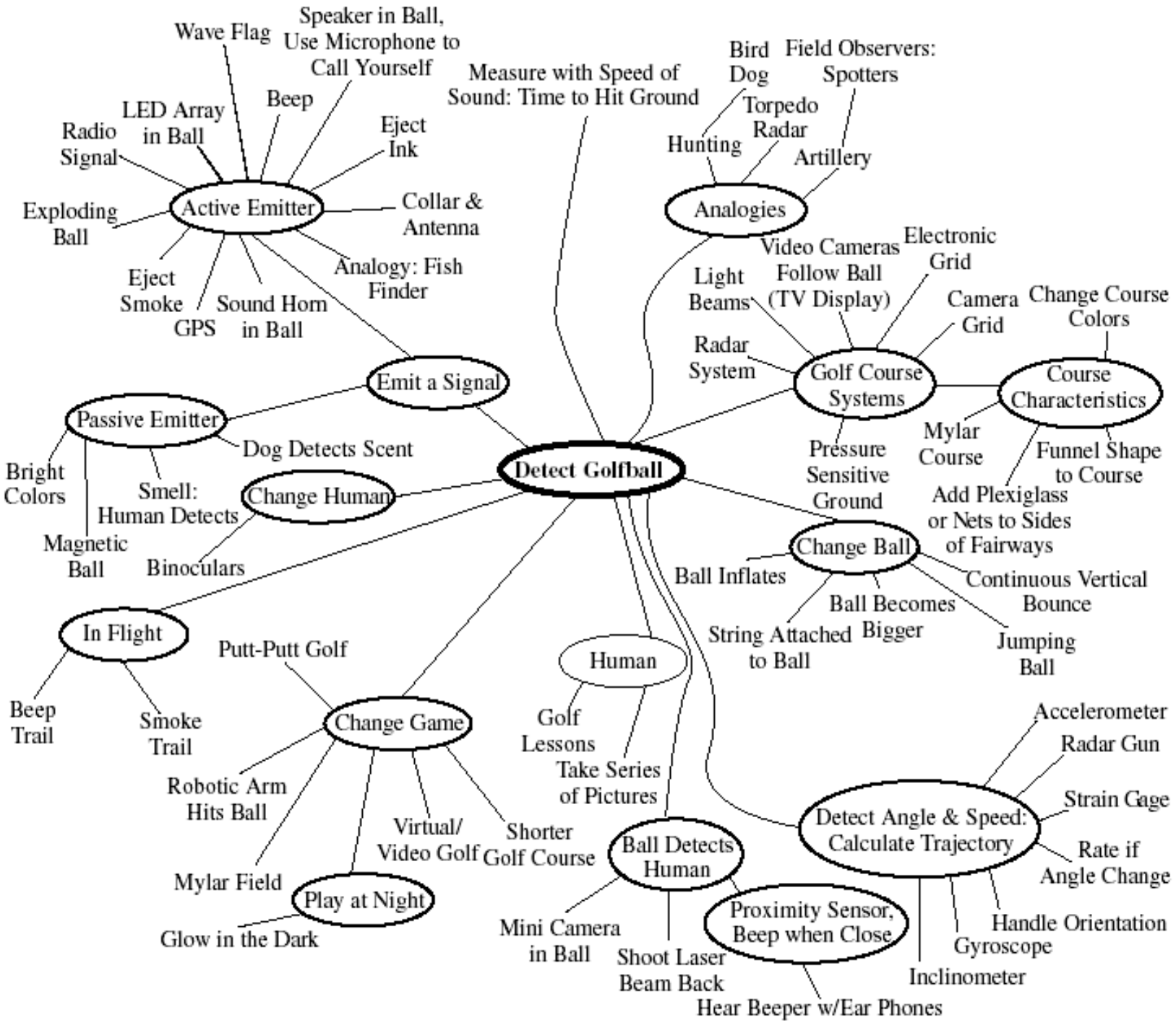
Detect & display the location of a golf ball



▼ ***Figure 10.5.***

Partial brainstorming list generated for the function of "detecting a golf ball."

Fig. 10.6:
Mind Map



Include Pictures in Mind Maps

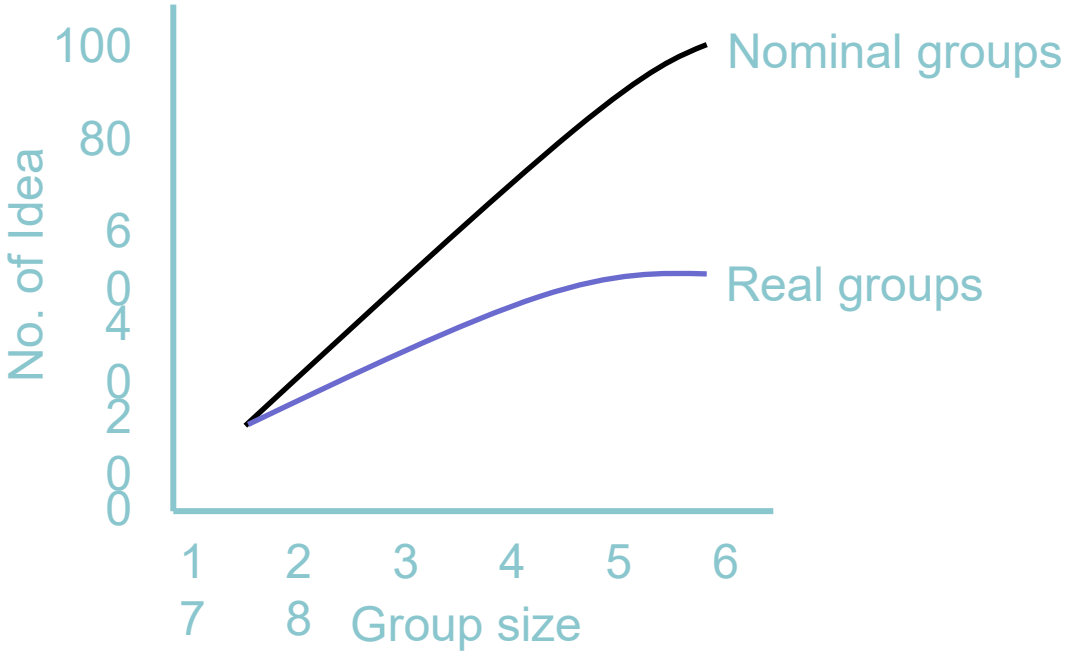
Hands-on Activities

- Beams and Bending
  - 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.
  - Find Everyday Devices Under Bending Loads
- Stress Elements
  - Deformable rubber sheet.
  - Deformable Foam Shaft
- Stress Transformations
  - Hands-on tube connected to a computer program that shows Mohr's circle and the stresses
- Thin walled Pressure Vessels (Hoop Stress Compared to Circumferential)
  - Balloon
  - over-cooked hotdog
  - Pressurized Soda Can with Strain Gages
- Statics
  - Statically equivalent loads produce equivalent motions.
  - Two different distinct, statically equivalent loads can both balance the spoon.
  - Statically equivalent loads cause the same deformation.
  - Trusses and Method of Joints
    - Replace a part of a truss structure with a string and then load the structure.
- Combined Loading
  - Activity: Find items under combined loading
  - Visualization of a Stress Element using a Click Eraser
  - Visualizing Stress Concentrations
  - Observation of Failure Planes using Crayola Model Magic

A Sticky Note Mind Map

Design Research: Shortcomings of Osborn's Brainstorming

Participants feel productive but it is an inefficient process.



Adapted from Paulus, NSF Innovation Workshop 2008

Generate 40% More Ideas!!!!

in the same time with a team of 5

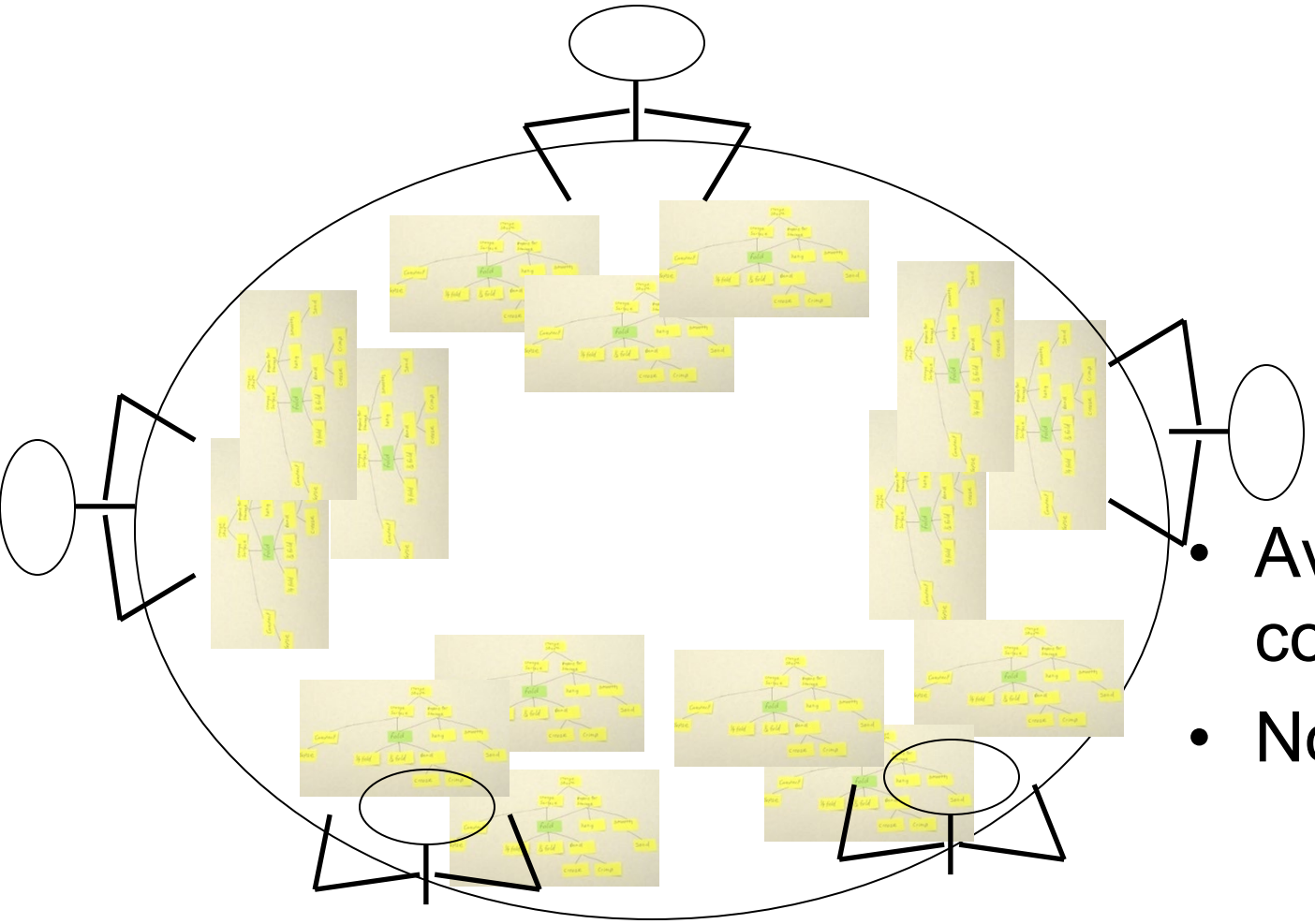
6-3-5 (brainwriting)

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

<u>Guidelines</u>

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

6-3-5 Illustration

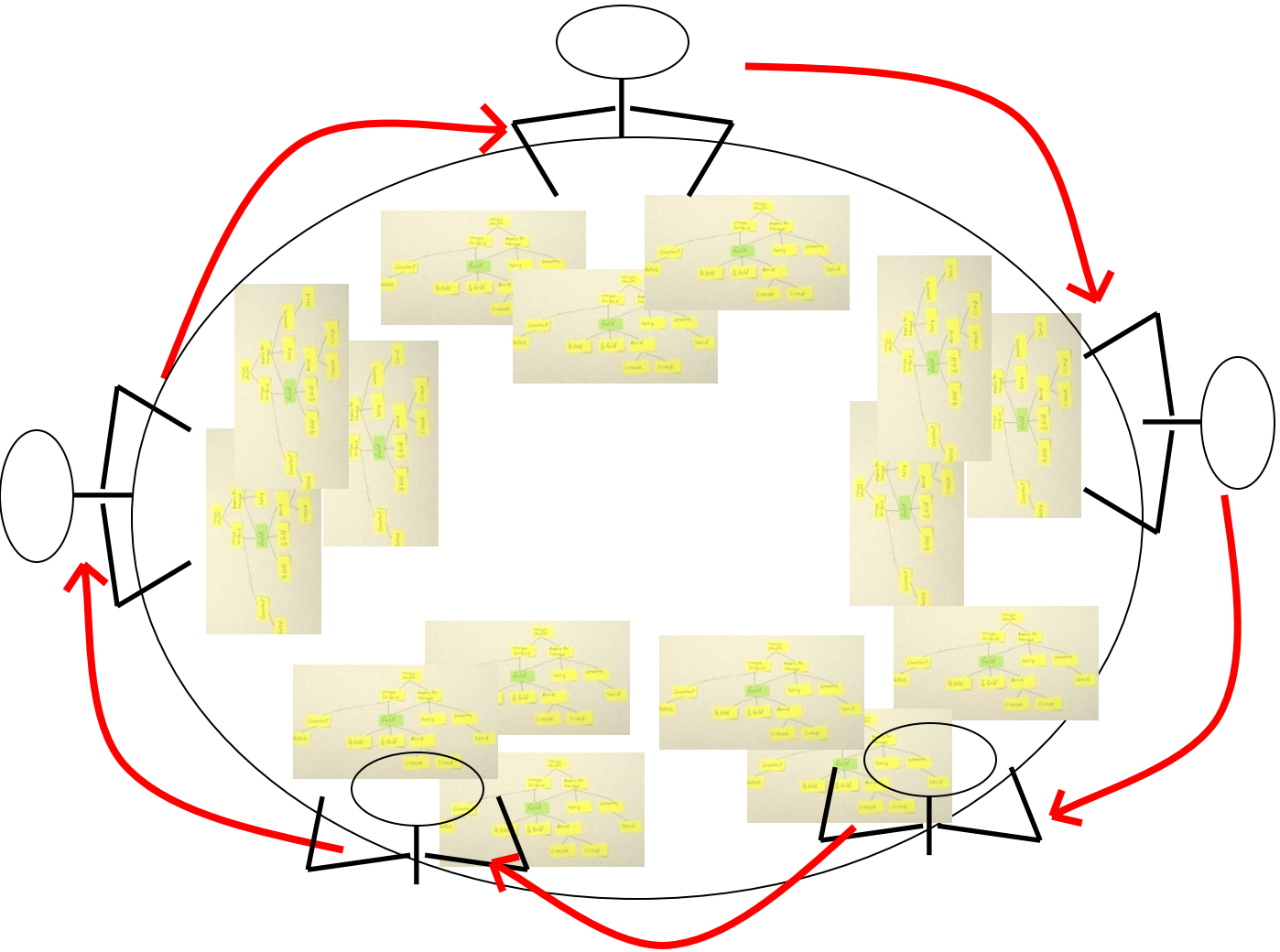


10 Minutes

- Avoid negative comments
- No talking!

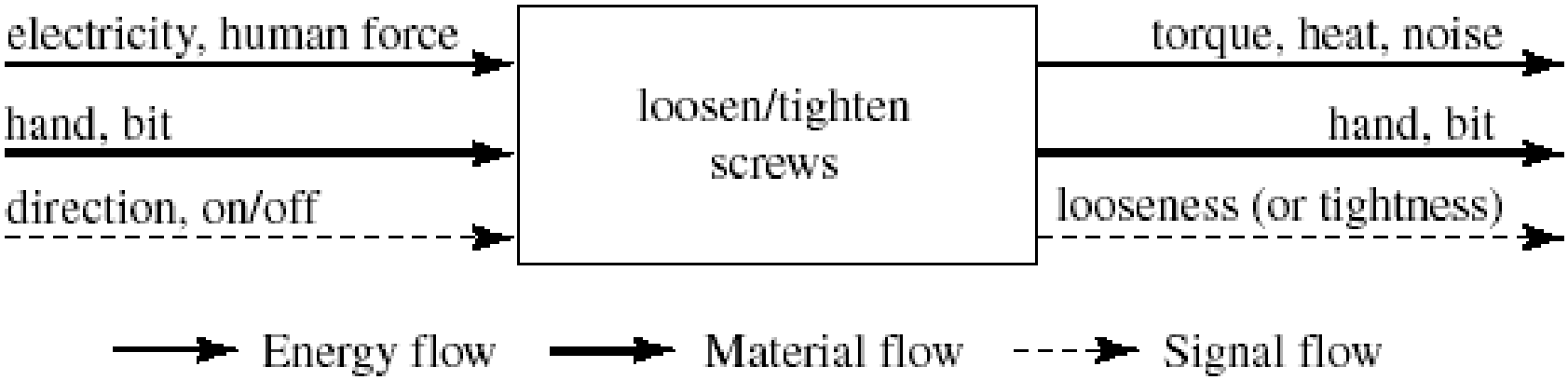
6-3-5 :

Rotate sets of concepts, spend 7 minutes adding ideas and combining



7 Minutes More per exchange

6-3-5 Case Study: Power Driver



F10.7:
6-3-5

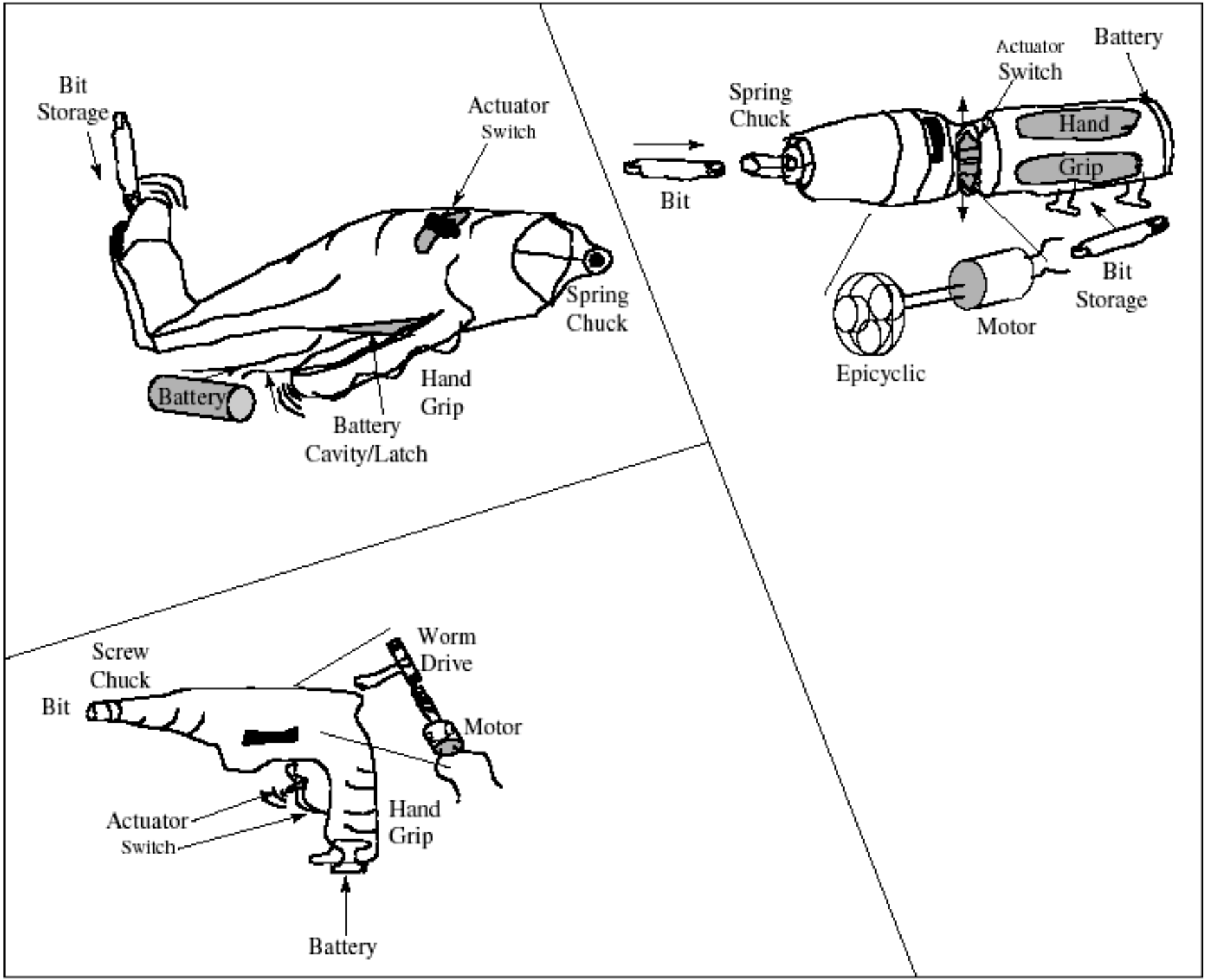
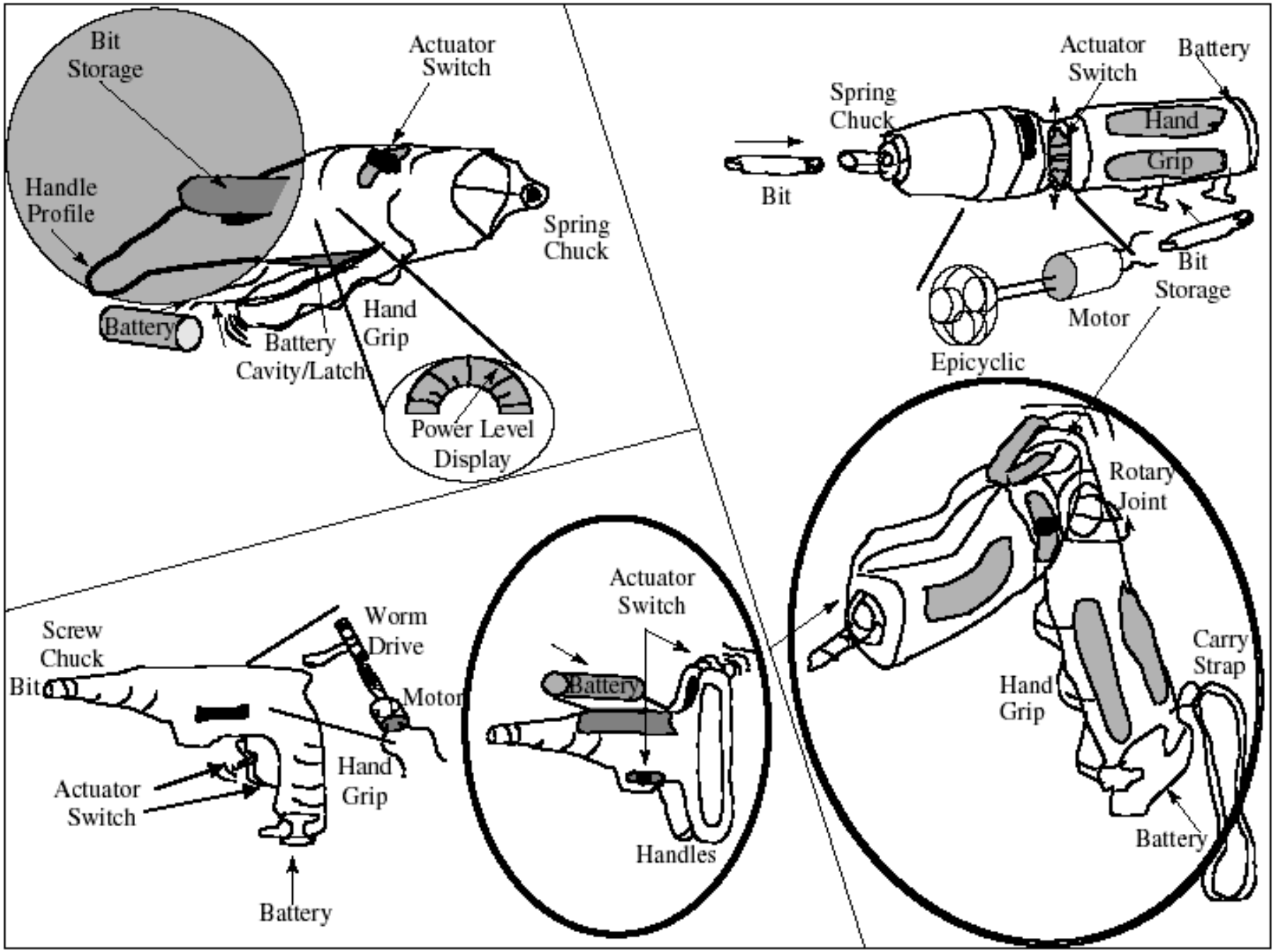
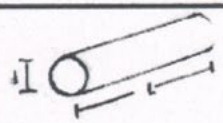
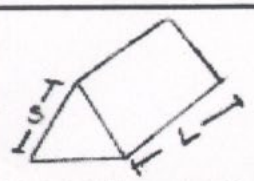
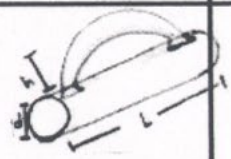
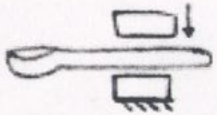
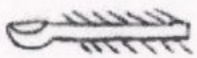
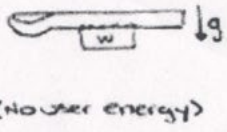
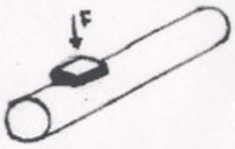
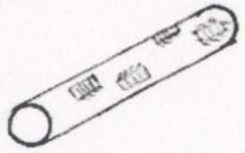

Bit
Storage
Actuator
Switch
Spring
Chuck
Battery
Hand
Grip
Battery
Cavity/Latch
Actuator
Switch
Battery
Spring
Chuck
Hand
Grip
Bit
Bit
Storage
Motor
Epicyclic
Screw
Chuck
Bit
Worm
Drive
Motor
Actuator
Switch
Hand
Grip
Battery

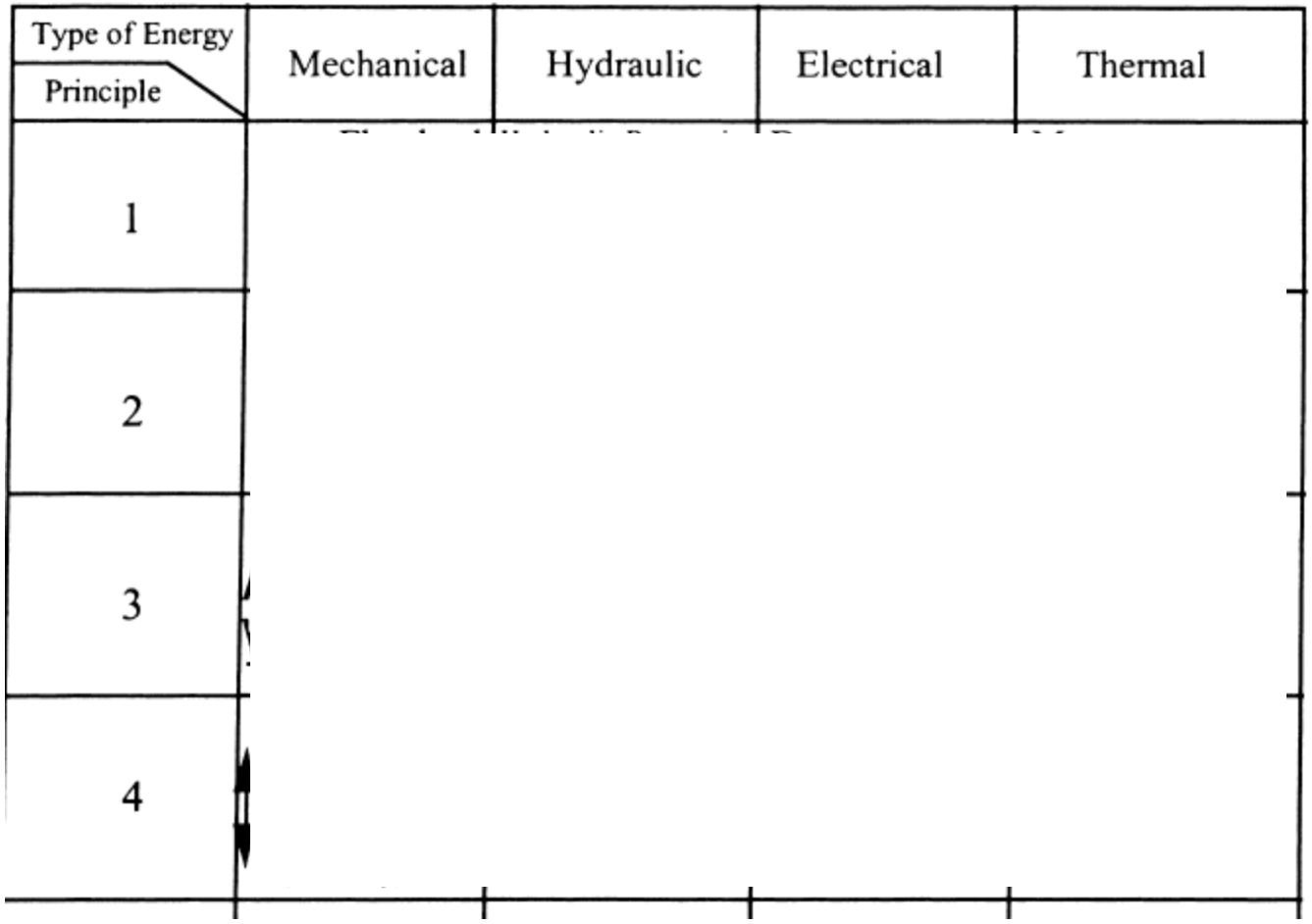
Figure 10.8: 6-3-5, Second Rotation



Morph Matrix Example

	Cylindrical	Toroidial	Prism	Outer Handle	Deformable
Accept User (shape)					
	Dycem	Ridges	Santoprene		
(surface)					
	Clamping	Permanent Attach	Slot	Magnets	
Accept Utensil					
	Eccentric Weight	Lever	Button	Squeeze Tube	Photocells
Accept Energy					

Morph Matrix Example: Ways to Store Energy



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

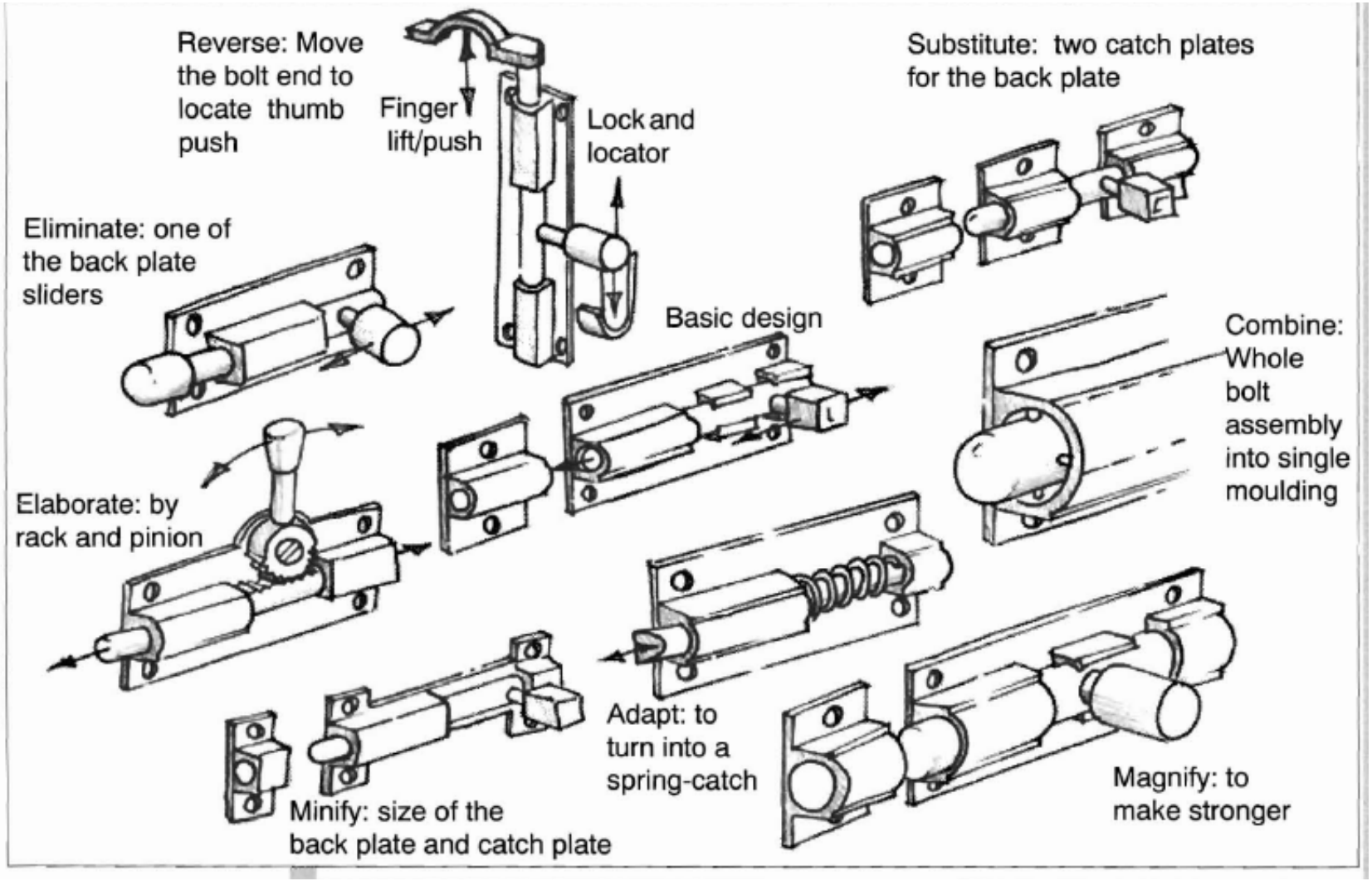
TABLE 10.3. IDEA GENERATORS FOR INTUITIVE CONCEPT GENERATION METHODS

Idea generator	Questions or application
Make analogies	What analogies exist in nature? What analogous products exist in any product domain? How do these products solve the same product functions?
Wish and wonder	What if . . . ?
Sketch/use physical models (e.g., Tinkertoys or LEGOs)	What would an idea look like? How does this model satisfy the function? What can we change?
Eliminate or minimize?	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?
Substitute	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?
Combine	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?
Adapt	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?
Modify or magnify	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?
Put to other uses (repackage an old idea)	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?
Reverse or rearrange	What other arrangements might be better? Interchange components? Other pattern? Other

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



CREATIVITITY

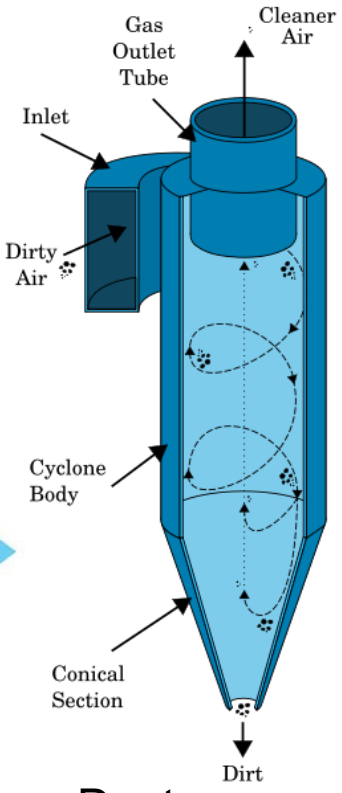
- Combine
- Reverse
- Enlarge
- Adapt
- Tinier
- Instead of
- Viewpoint change
- In other ways
- To other uses
- Yes!

Innovation through Design-by-Analogy

Analogy to Existing Products

Dyson vacuum based on a saw mill dust collector

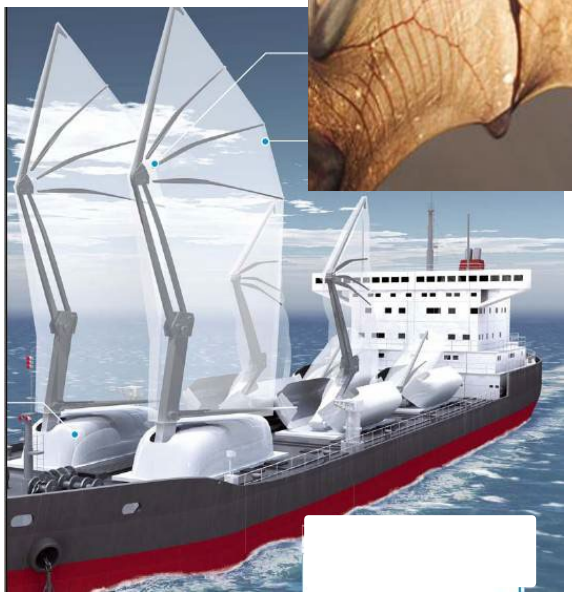
Dyson vacuum



Dust Collector

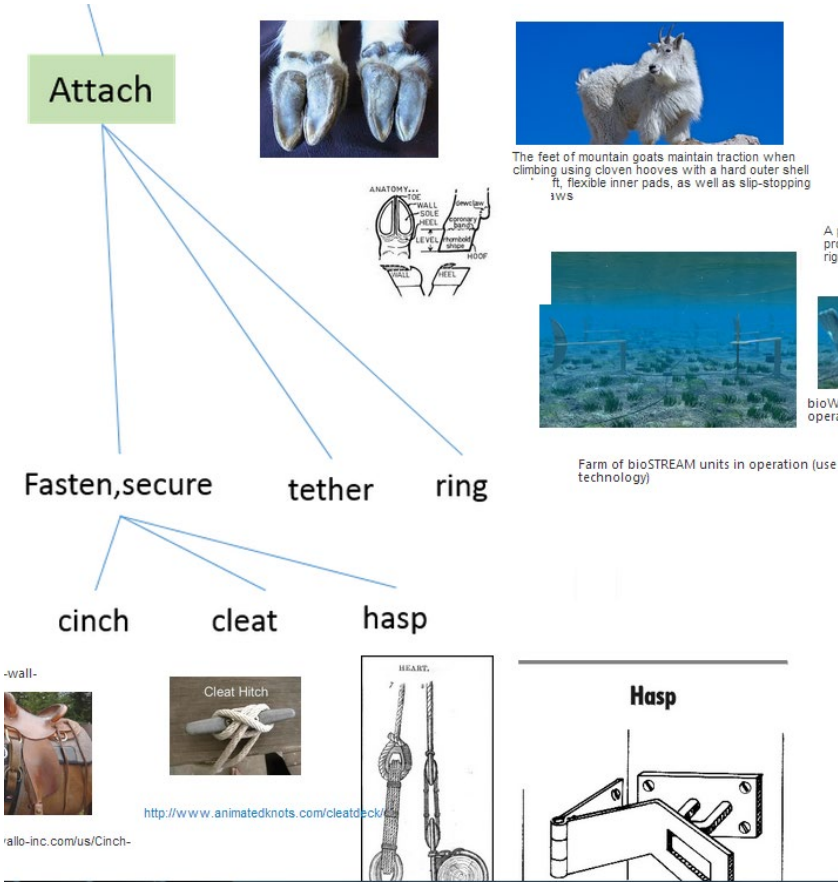
Bioinspired Design

Environmentally friendly, collapsible sail for cargo ships



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

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



Need Help? Office Hours: Wed. 11:30-12:15
GTMI 256, julie.linsey@me.gatech.edu