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PRATT SCHOOL of ENGINEERING
Concept Generation, Selection, and Prototyping
BME 590L

Pitch Format

- Monday, Oct 22nd during lab time (4:40-7:40)
- 10 minutes (timed!) with 5 minutes for Q&A and transition
- Not all team members must present, but all must be present (those not presenting should contribute extra to slide deck prep)
- Business casual, video recorded for self-critique and distribution to your mentor
- Draft due on Oct 11th with you cycle 1 documentation (ungraded, for feedback)
- Share your top concept, as if it was a final product (obviously subject to change)

Suggested Format (Flexible)

1. Title slide with team name, team members
2. Background of the clinical problem
3. Need statement
4. Unveiling of your solution (currently your top concept, but pretend it's a finished product)
5. Chart of how it meets your customer needs and/or specifications
6. Market Size
7. Competition grid (Hint: use your customer needs)
8. Strong conclusion slide (circle back to how you are solving your need)

Rubric

Assessor's Name: _____

Project Intro Presentation

Team Name: _____

	Not Acceptable		Average		Excellent
Technical Content					
1. Started with an effective introduction	1	2	3	4	5
2. Summarized motivation and scope of problem	1	2	3	4	5
3. Gave a strong need statement for the project	1	2	3	4	5
4. Described the market for the product	1	2	3	4	5
5. Described the customer needs and/or specs	1	2	3	4	5
Visuals or Slide Design					
1 Visual appeal of slides	1	2	3	4	5
2 Quality of graphs, figures and tables	1	2	3	4	5
3. Clear, concise supporting text	1	2	3	4	5
Organization of Presentation					
1. Appropriate tone for audience	1	2	3	4	5
2. Time management	1	2	3	4	5
3. Organization of content	1	2	3	4	5
5. Finished with a convincing conclusion	1	2	3	4	5
Oral Presentation Quality					
1. Team's confidence and enthusism	1	2	3	4	5
2. Team's control of Q&A and quality of responses	1	2	3	4	5
3. Presentation length	1	2	3	4	5
4 Preparedness of team	1	2	3	4	5

Individual Presenter comments:

Name:

1. _____
2. _____
3. _____
4. _____
5. _____

Comments: _____

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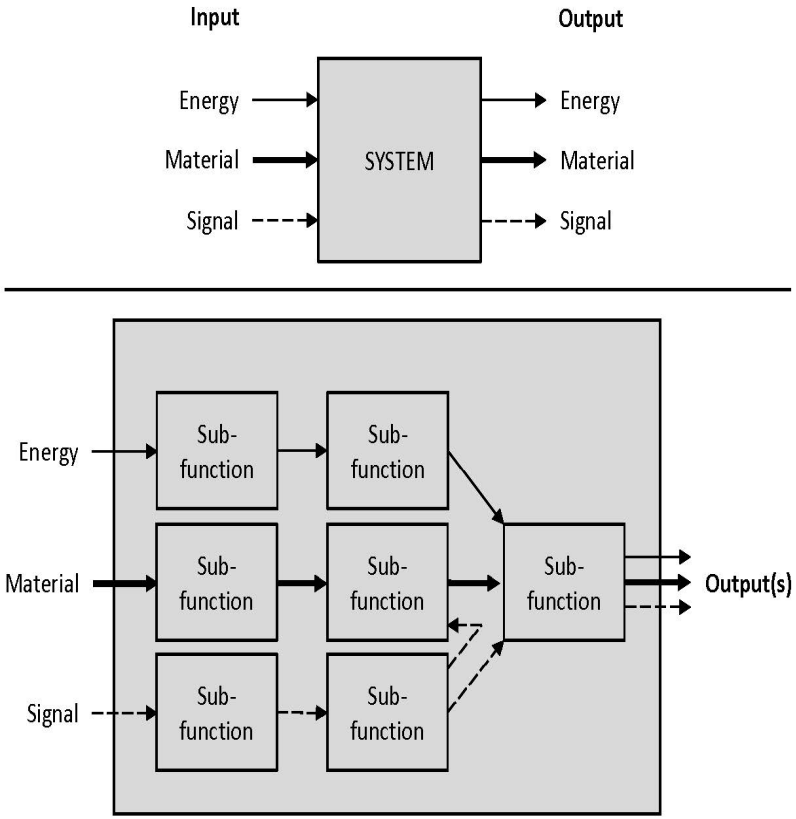
The Ulrich & Eppinger text uses a “black box” approach to Functional Decomposition. Very well suited for process design or system-level design.



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Concept Generation!

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Morning Overview

- Generating divergent concepts from research
- Engineering decision making to select solutions

Brainstorming Exercise
Dr. Matthew Wettergreen, Rice

- Take out a fresh piece of paper
- List all the things you can do with a paper clip (5 min)
- How many ideas did you write down?

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Group Brainstorming Exercise

- Get into groups of 3.
- Prepare a single list of all ideas generated by the individuals in the group.
- Add ideas that pop in your head as you prepare the common list.
- Mark new ideas from the group session.

Discussion and Debrief

- How many ideas did you have individually?
- How did that compare to the number of independent ideas in the group?
- Did you have additional ideas after you heard those of group members? How many?

Uses for a Paperclip

- Guitar pick
- Key ring
- Zipper handle
- Tie off a bag
- Attaching paper
- Hair clip
- Money clip
- Clothespin
- Spare board game piece

Uses for a paperclip

- Engraves metal
- Form of currency
- Make a new shape
- Writing utensil
- Hands of a clock
- Press grimy phone buttons
- Fix braces
- Prying something
- Magazine binding
- Whisk
- Glasses frame
- Engagement ring
- Earrings
- Christmas tree ornament
- Nose ring

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Uses for a paperclip

- Lock pick
- Scrape paint
- Scratch a lottery ticket
- Measuring tool
- Pop balloons
- Bookmark
- Cut tape
- Write in dirt
- Clean out crevices
- Sewing needle
- Poke holes


Colorado Springs Daily Photo
http://csdailyphoto.blogspot.com

A Technique for Producing New Ideas

James Webb Young

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“An idea is nothing more or less than a new combination of old elements.”

James Webb Young
A Technique for Producing New Ideas
Quoted from Vilfredo Pareto

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“The capacity to bring old elements into new combinations depends largely on the ability to see relationships.”

James Webb Young
A Technique for Producing New Ideas

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Four Rules of Brainstorming

1. Generate as MANY ideas as possible.
2. WILD ideas are welcome.
3. “Hitchhiking” encouraged.
4. Criticism is NOT allowed.

Goal is Quantity

1. Generate as many ideas as possible
    - Quantity counts
    - The more ideas you generate, individually and collectively, the better the chance the team will come up with an innovative solution
    - No long explanation with ideas- just offer ideas with simple key words
    - Be brief- no discussion

Wild Ideas are Good

2. Wild ideas are welcome – be as creative as you can be
   - The more odd, weird, impossible or crazy ideas that are generated, the better your chances of coming up with a truly original solution
   - Avoid words and ideas that are offensive to your team – that will only serve to squelch creative thinking

Idea Hitchhiking

3. "Hitchhiking" is encouraged – build on the ideas of others
   - Ideas do not have to be completely new
   - It is ok to expand, build on others ideas

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Don’t Criticize

4. No criticism is allowed – defer judgment until later
   - Don’t put down ideas (especially your own!)
   - Laughter, humor and applause are allowed to build team spirit
   - In brainstorming there are no ‘dumb ideas’ or ‘right’ or ‘wrong’ answers
   - Defer judgment to a later phase (ideas evaluation, critical judgment)

Techniques for Brainstorming

- Shared Card Method
- Writing Slip Method
- My preferred method:
  - Individual brainstorming
  - Group (Shared card or Writing Slip)
  - Rinse and repeat.

Shared Card Method

- Everyone writes down as many ideas as they can on note cards - one idea per card.
- Cards are passed to the left around the table or group.
- Next person jots down related ideas or improvements on cards.
- Cards passed around the table to add several levels of additions.

Writing Slip Method

- Problem definition/issue is presented.
- Each participant is asked to write 20-30 ideas on separate slips of paper.
- Slips are collected quickly so no changes are made.
- Alternate/sub group categorizes and evaluates ideas.

(Good for a small or very large group)

Brainstorming Starter Questions

- Substitute?
  - Who else instead?, What else…? Other place?, Other time? Other process?, Other power source? Other approach?, Other tone of voice?
- Combine?
  - Blend? Combine purposes?, Combine ideas?, Combine units?, Combine ideas?, Combine functions?
- Adapt?
  - What else is like this?, What other ideas does that suggest?, Ideas from the past to copy/modify?
- Magnify?
  - What to add?, Greater frequency? Stronger?, Larger?, Higher?, Thicker?, …..

Brainstorming Starter Questions

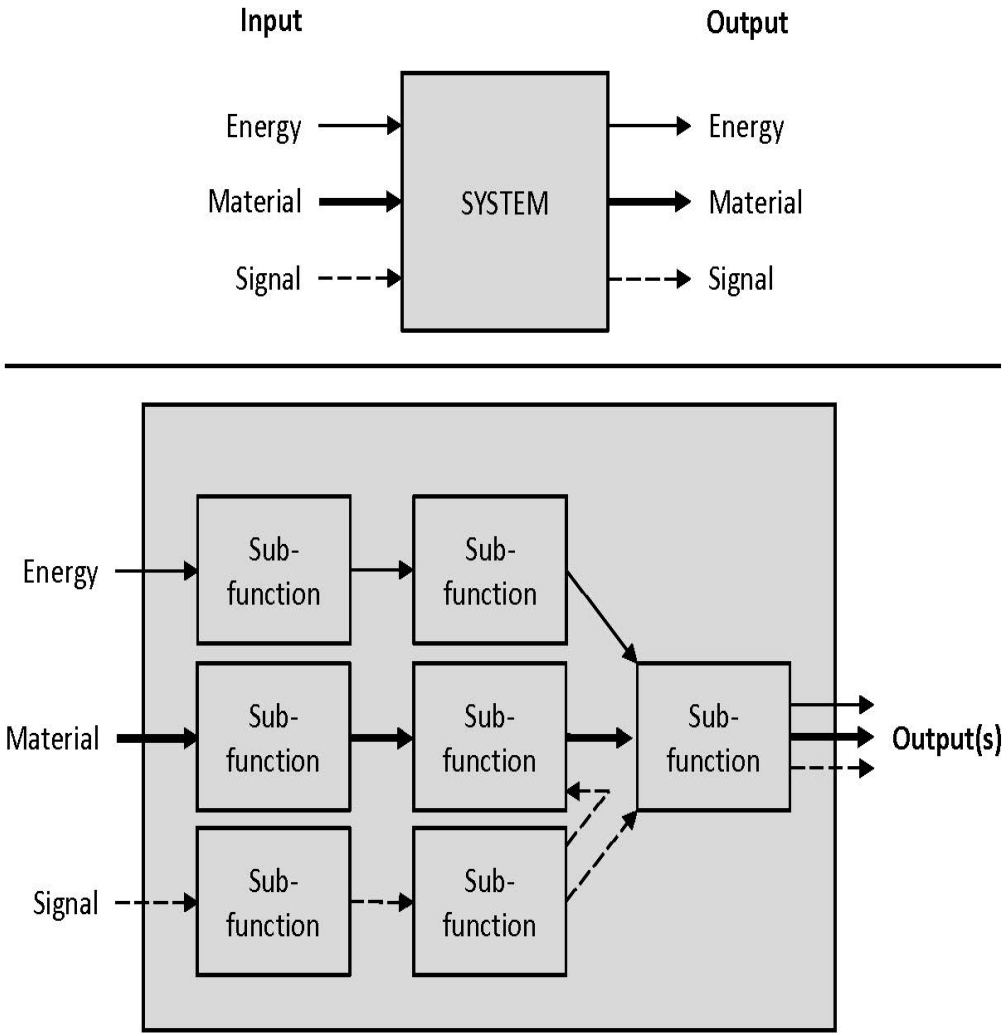
- Modify?
  - Change meaning, color, motion, sound, appearance…? New twist?
- Put to other uses?
  - New ways to use as is?, Other uses if modified?
- Eliminate?
  - Subtract?, Smaller?, Streamline?, Simplify?, Condense?
- Rearrange?
  - Other layout?, Other sequence?, Change pattern?, Change schedule?
- Reverse?
  - Opposites?, Turn backwards? Upside-down? Mirror?

Brainstorming Used in Many Areas of Engineering Practice

Whenever you need divergent thinking!!!

- Team names
- Possible solutions
- Design concepts and devices
- Evaluation criteria
- Mathematical models
- Optimization

Functional Decomp: A way to structure brainstorming sessions!



Team Activity

- For your prototyping skills, one of the functional requirements is: “Survive 3 foot drop with battery installed”
- As a team, generate as many ideas that might meet this subfunction

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Now, Converge!

Why use tools or processes like decision matrices to converge on top solutions?

- Prevents idea “champions” from steamrolling introverts (minimizes bias)
- Aligns team on decision criteria
- Promotes “mix and matching” elements of a solution
- Acts as a record of your decision

The value of these tools is in the conversation, not necessarily in the result

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First step: choosing criteria

Elements of good criteria for a matrix:

- Customer- or stakeholder-selected
- (Semi) quantitative
- Differentiating
- Few (not more than five)

Activity

Generate four criteria for drop-resistance subfunction

Flavors of Matrices

- Common format: Criteria (or factors) in each row, and solutions (or designs) in each column
- Screening matrix vs. Scoring matrix
- Reference solutions
- Weighted criteria

Screening (Pugh) Matrix

	Concept #1	Concept #2	Reference Concept
Desired Char. 1	-	+	0
Desired Char. 2	+	-	0
Desired Char. 3	+	-	0
Desired Char. 4	0	0	0
Desired Char. 5	+1	-1	0

Activity

Using your criteria and solutions, perform a screening matrix.

Share

What was your top-scoring concept?

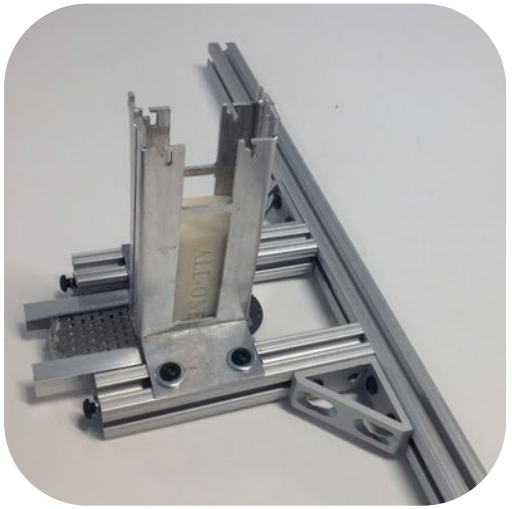
Now what?

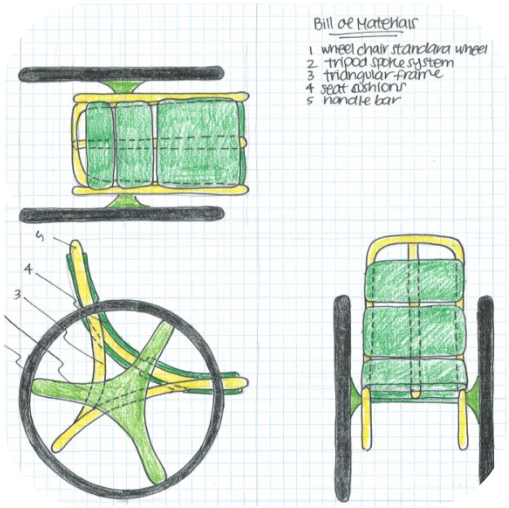
- Gut check
- Mix and match features
- Reconsider (or reweigh) your criteria
- Begin another cycle of divergence!

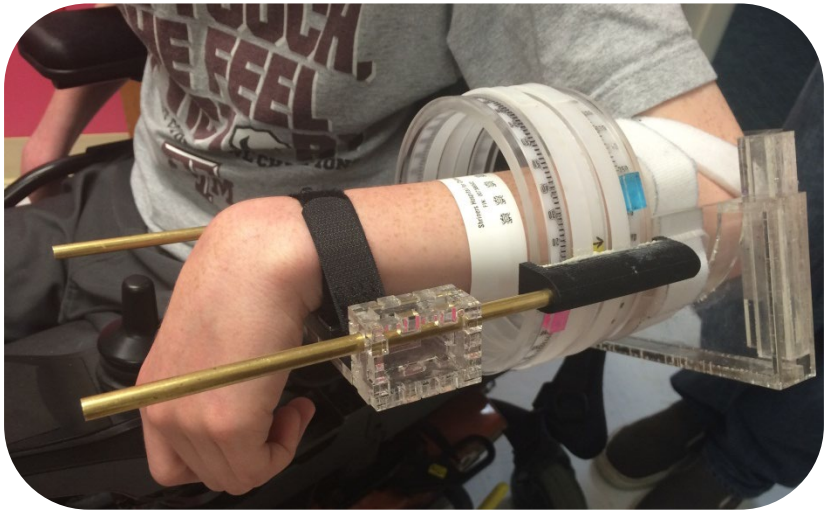
Decision matrices are a powerful tool in team management

- Great solutions rely on both divergence and convergence
- Decision matrices should be used often in generating solutions, and customized depending on need
- Decision matrices remove bias, bring alignment, and act as a record

Prototyping is solving problems by creating physical objects.







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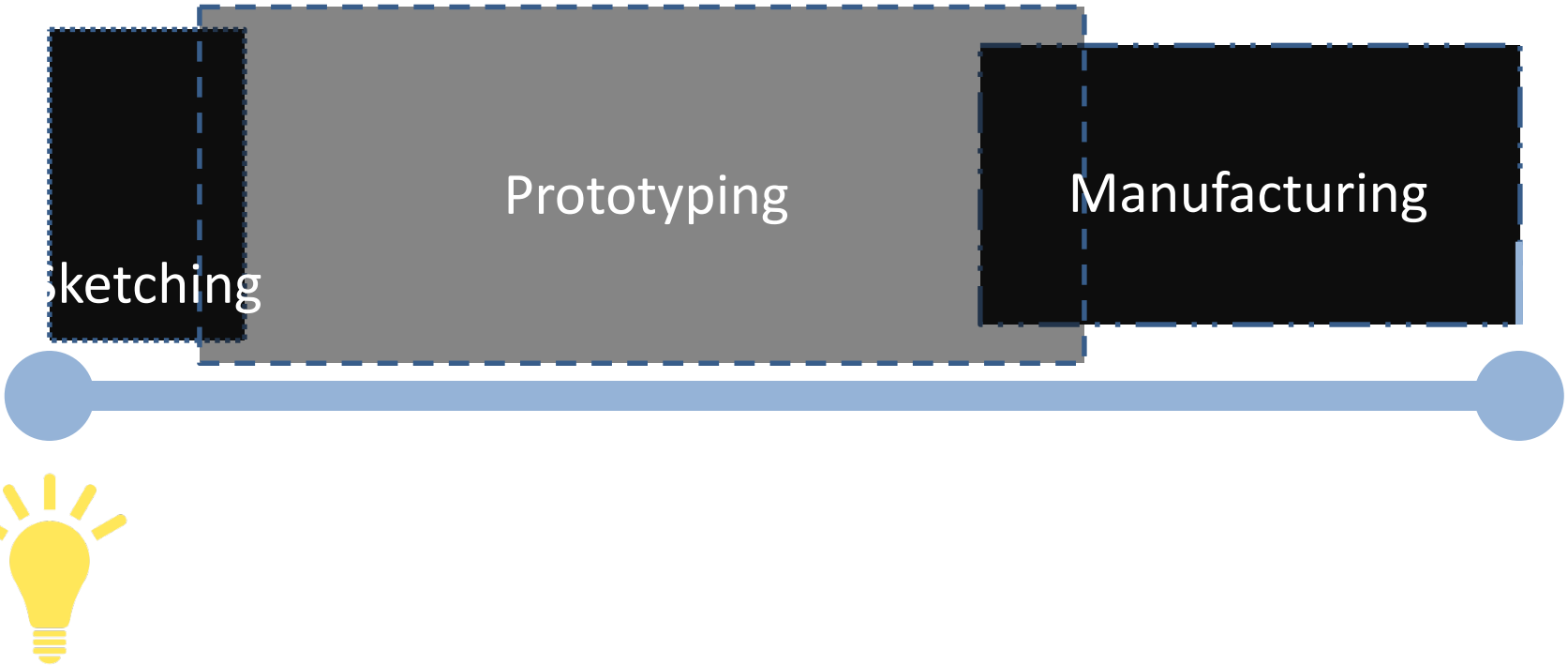
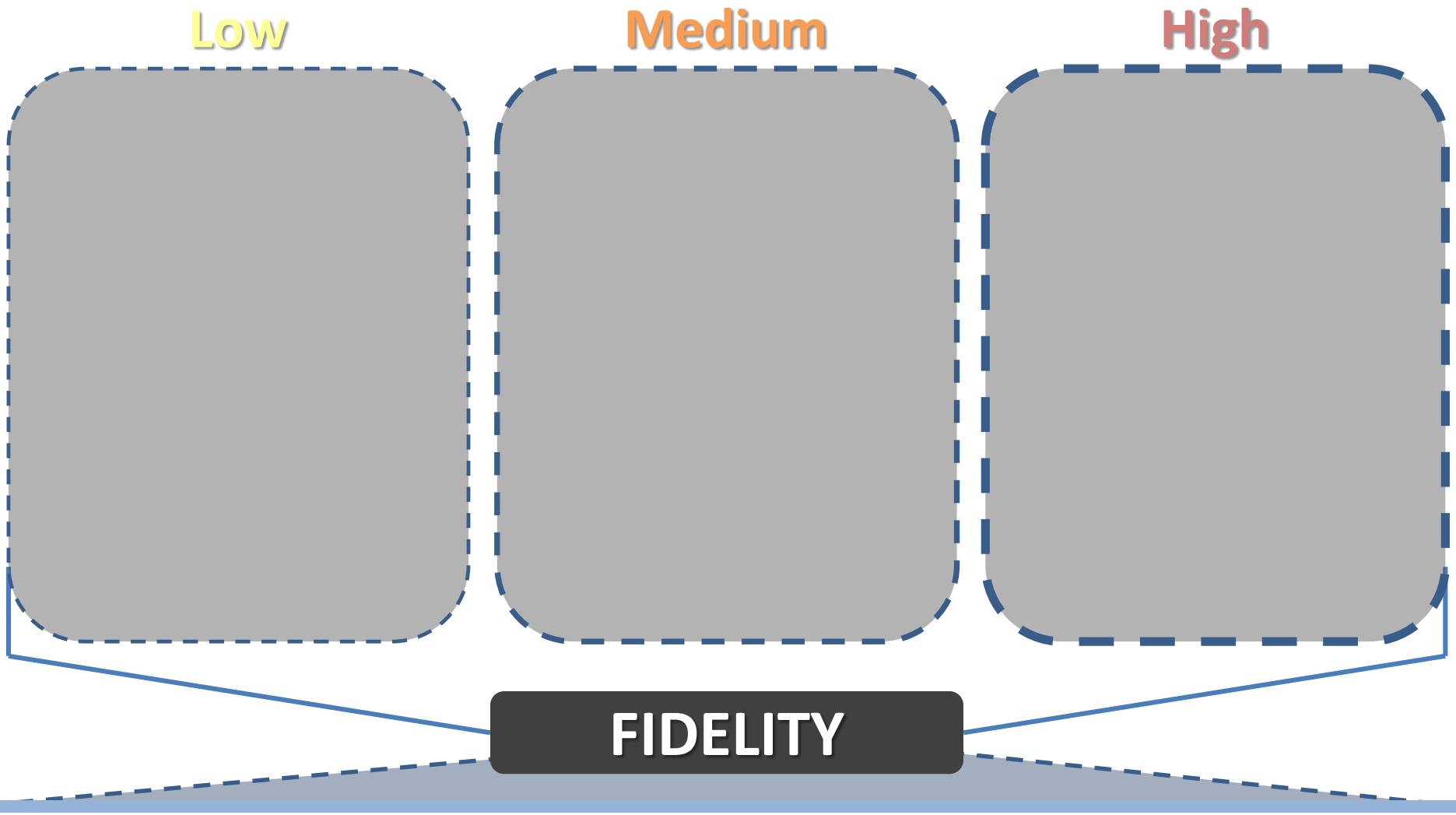

ketching
Prototyping
Manufacturing


Low
Medium
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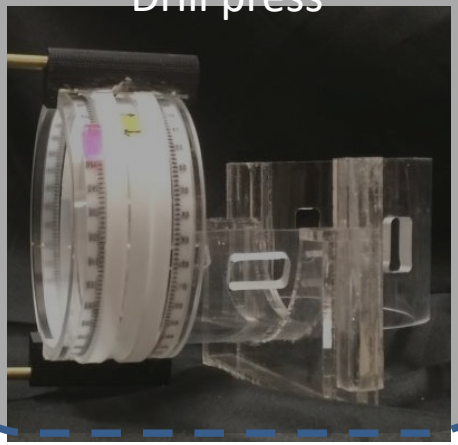
Low

Scissors
Tape
Glue
Hand tools

Medium

Laser cutters
3D printers
Hand tools
Power tools
Drill press



High

3 or 4 Axis CNC Mills
Lathes
Sheet metal benders
Plasma cutters
Injection molding

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Don’t do long-shot prototyping…

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Characteristics of Prototypes

- The wrong scale (too small or large)
- Made of cheap materials (foam, paper, etc)
- Manufactured rapidly (low attention to detail)
- Crude in appearance
- May lack integration of core functions
- Contain artisan-based defects

Prototyping Maxims

- What is the lowest fidelity I can create while still answering my question?
- Prototype quickly
- Prototype to learn
- Always start with rough, or, low fidelity prototype
- “Freely dive into prototyping”
  - When it makes sense
  - When you can’t say it in words
  - When there are several options to evaluate

- “If a picture is worth 10,000 words, a prototype is worth 10,000 pictures” – David Kelly of IDEO

CONCEPT GENERATION.
CONCEPT SELECTION.
PROTOTYPE.
REPEAT.

Objectives

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Objectives

- Preparation for industry - your negotiation with your boss
- While specs are consistent, objectives can be dynamic
- Write them clearly, usually 6-10 of them per cycle
- These can feed into your backlog (may want to consider subtasks)
- Allocate points based on how much effort you think it
- Make it clear how they will be finished

PDW

- Add Objective sheet to PDW for objectives that looks like this:

	A	B	C	D	E	F	G
1	**Objectives for Cycle 2**						
2	*Related Specifications*	*Objective*				*(<300)*	*Graded Points*
3	Spec 1, Spec 4					150	
4							
5							
6							
7							
8							
9							
10							
11							
12					**TOTALS (=2000)**	**150**	
13							

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