ideas must be put to the test.
that's why we make things,
otherwise they would be no more than ideas.

Andy Goldsworthy, 1956-
English sculptor and photographer
2.009
PRODUCT ENGINEERING PROCESSES
BALLOON CHALLENGE 2018
2.009 Product engineering processes today

**sketch model review** broaden and deepen

**sketch models** test ideas
Sketch model review
10 days after ideas presentation!

Monday

Three ideas presentation
September 24, during class
3 ideas per section

Mockup review
October 18
2 mockups per section

Assembly review
Oct. 31 & Nov. 2
1 assembly

Sketch model review
October 4
3 models per section

Final selection
October 22-25
1 concept per team

Technical review
November 15
1 (almost) prototype

Final presentation
December 10
1 alpha prototype
Schedule
Keeping track of it!

2.009
PRODUCT ENGINEERING PROCESSES

Coming up: 3-ideas presentation, Sept. 24
This week in 2.009!
Please check your team page! (certs required)

class Wednesday: Sketch models!
Schedule a time for your section’s idea poster plotting (we will be there to help)
Schedule a time for your section’s idea presentation practice session

Of interest: (archive)
- credit card training: for financial officers, noon-1 PM Thursday in 3-434
- illustrator 101 and poster workshop: Friday. Tutorial is 4-5 PM, poster workshop 5-6 PM in Pappalardo

Labs
Lab #2. Exploring ideas and preparation for the 3-ideas presentation.
- please read the lab 2 outline
- be ready to present your top idea from the observation exercise (discussed in class on Friday).

Observation location signup form. See where classmates are going, if you want to coordinate.
idea/opportunity selection
last week (categories)

lab this week
ideas must be put to the test.
that's why we make things,
otherwise they would be
no more than ideas.

Andy Goldsworthy, 1956-
English sculptor and photographer

2.009 Product Engineering Processes
Sketch model review means... development of opportunities into product ideas

**1. First Order Energy Feasibility**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C/ D/E/F/G/H/I/J/K</th>
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<tbody>
<tr>
<td>2</td>
<td>To meet weight constraint of less than 30 lbs</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>battery weight must be less than 13 lbs</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Best known solution</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>150 W-hr at 1 hour rate</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>12.3 lbs total weight</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Assume 2.5 mph</td>
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</tr>
<tr>
<td>8</td>
<td>For 30 mi with user weight of 165 lbs</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>and scooter weight of 29 lbs</td>
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</tr>
<tr>
<td>10</td>
<td>with energy</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>150 W-hr</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>187.5 W available</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>1.5% distance of</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>0.9 coefficient</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Total mechanical power</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>139 W required</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Minimum drivetrain efficiency allowable</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>74%</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Gearbox</td>
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</tr>
<tr>
<td>20</td>
<td>96%</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Continuous Power (W)</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>182</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Motor efficiency</td>
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<td>Power electronics</td>
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<tr>
<td>25</td>
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<td>95%</td>
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<tr>
<td>27</td>
<td>82%</td>
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<td>28</td>
<td>78%</td>
<td>92%</td>
</tr>
<tr>
<td>29</td>
<td>74%</td>
<td>91%</td>
</tr>
</tbody>
</table>

**More idea generation**

**More research**

(customer needs/benchmarking)

**Sketch models/testing**

**More feasibility estimates**
And what is a sketch model?

**definition**

Simple *physical* models made of soft, low cost, easy-to-work materials

3D analog to sketching

**Made to learn and test**

articulate an idea
understand product scale
explore user interaction issues
assess operational issues
establish common shared view
What is *NOT* a sketch model?

anti-definition

Simple *physical* models that have no purpose and are made of soft, low cost, easy-to-work materials
Sketch models: what should we do?

I need to make something?
OK, I’ll make something!
Sketch models: what should we do?
step 1: what is the question?

**articulate:** what are we uncertain about?

- **definition:** what is the idea?
- **feasibility:** does core technology exist and do we understand it?
- **user need:** do we understand the user and our value proposition?
- **market:** who is our customer and how interested are they?
- **scope:** do we have the needed resources and skills?
Sketch models: what should we do?

step 1: what is the question?

prioritize: which questions do we answer first?

Pugh chart
level of uncertainty
Sketch models: what should we do?
step 1: what is the question?

prioritize: which questions do we answer first?

*Pugh chart*
level of uncertainty
criticality to viability
learning outcomes
Sketch models: what should we do?
step 2: what type of model?

explore: what model foci relate to the question?

form: focus on shape embodiment
scale: focus on properties such as size or mass
visualization: focus on communication
operational principles: focus on tech and physical behavior
system configuration: focus on “what are the bits?”
integration: focus on “do these bits play well together?”
interaction: a focus on the use model
usability: a focus on user understanding
experience: a focus on the user’s feeling
Sketch models

step 2: what type of model?

select: what type of model?
    based on question and focus
        looks-like: fidelity in appearance
        works-like: fidelity in behavior

may be physical or digital!

lowest fidelity possible to resolve the question!
Sketch models: what should we do?
example

electric scooter
concern: product definition  
model focus: scale, usability  
type: works-like

helicopter lift
concern: product definition  
model focus: visualization, operation  
type: works-like
Sketch models: what should we do?

articulate uncertainties as questions

prioritize questions

explore relevant model focus categories

select model type
Sketch models: what should we do?
Low fidelity vs BAD
what’s the difference?

just enough fidelity, well executed
Low fidelity vs BAD
what’s the difference?

insufficient fidelity, not looks-like, not works-like—it’s nothing like!
Sketch modeling techniques

Cardboard
Cardboard
bending sharp corners
Cardboard
fastening (when you cannot bend)
Cardboard
bending allowance
Cardboard
making large radii
Cardboard holes
Sketch modeling techniques

foam core
Foam core

Sharp radii
Sketch modeling techniques
blue foam
Blue foam

cutting straights, circles and other shapes
Blue Foam
joining

water-based contact cement
Blue foam shaping
Blue foam painting

water-based is good

organic solvent-based is bad
Wrap up

miscellaneous items

sketch modeling tutorials on website (of interest)
credit card training Thursday noon PM in 3-434
illustrator tutorial 4-5, 5-6 PM Friday in Pappa

plotting and poster mounting schedule online
presentation practice schedule online
Happy career fair
no class on Friday

WE ARE HIRING