you have to work hard to get your thinking clean to make it simple.
Steve Jobs, 1955-2011

2.009 Product Engineering Processes

informed decisions lead to good outcomes, but uninformed decisions are easier to make

Robin White
Director, Surface Ship Design
Naval Sea Systems Command
2.009 Product engineering processes today

Product architecture structure the problem
What's now workflow

- **Three ideas presentation**
  - September 25, during class
  - 3 ideas per section

- **Sketch model review**
  - October 5
  - 3 models per section

- **Mockup review**
  - October 19
  - 2 mockups per section

- **Final selection**
  - October 23-26
  - 1 concept per team

- **Assembly review**
  - November 1 & 3
  - 1 assembly

- **Technical review**
  - November 16
  - 1 (almost) prototype

- **Final presentation**
  - December 11
  - 1 alpha prototype

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ONE SUBTHEME

ONE TEAM
Assembly review

overview

digital submission 11 PM, Tuesday October 31 (red, green, blue, yellow)
digital submission 11 PM, Thursday November 2 (pink, orange, purple, silver)
images (up to 10), CAD files, list of who-did-what, product contract
product variations
storyboards, circuit designs, etc.
Assembly review

Overview

10 minute presentations/discussion
Wednesday November 1 (red, green, blue, yellow)
Friday November 3 (pink, orange, purple, silver)

project your contract (or large mounted poster)

show your most current work
not a homework assignment!

can work in pairs, everyone must contribute
no make work!
avoid meaningless detail
keep working to understand user needs
keep doing tests
But first…

A mini quiz

put your name on the index card

list two words you should avoid when referring a design during a critique
Product architecture

**definition**

the organization or chunking of the products functional elements, and the definition of the interfaces between these elements.

functional and physical decomposition
Product architecture

purpose

The architecture and product specifications together define the structure/framework of the product.

The architecture is an important vehicle for organizing and focusing team activities.
Product architectures

two fundamental types

Modular

Integral
Product architecture 1
hand power tools

Several different tools for same customer segment

Reverse engineering exercise
Blank piece of paper, name on top of page
Draw the circuit for the drill
Collect papers after 4 minutes
Please DO NOT look at your neighbor’s work
Product architecture 1

hand power tools

Several different tools for same customer segment

Modular product architecture

Modules are functionally self contained
Component interfaces well defined
Low packing density
High volume, commodity elements
Product architecture 2
hand power tools

Individual tool designed for a specific market

Integrated product architecture
components designed or adapted for the specific product
geometric or functional relationships tightly coupled
## Product architecture

**drill performance comparisons**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Integral Modular</th>
</tr>
</thead>
<tbody>
<tr>
<td>weight</td>
<td>1.2 (2.0 with batteries)</td>
</tr>
<tr>
<td>charge time</td>
<td>0.2</td>
</tr>
<tr>
<td>power/weight</td>
<td>2.5</td>
</tr>
<tr>
<td>purchase price</td>
<td>~8-10</td>
</tr>
</tbody>
</table>
Product architecture 3
hand power tools

Several different tools for same customer segment
Modular architecture

advantages

- task allocation and out-sourcing
- economies of scale
- reuse/standardization for developing new products
- maintenance
- adaptation/mass customization (combinatorial design)
Integrated architectures

advantages

Performance: modularity can mean performance sacrifices especially when performance is $f(\text{size, shape, mass})$

It is easier to optimize overall system with an integrated architecture
Product architecture decision

key role in defining what the product can be

integral

modular
Product architecture decision
key role in defining what the product can be

often linked with corporate identity
Product architecture
innovation through a new architecture

first sold in?
1998

change color and style for ‘price of evening dress’
$10,000
~1800 lb.
0-37 mph in 6 seconds, ~80 mph max.
40 mpg combined
Finally

reminders

codes of conduct (feedback 5 PM, email final to me noon Thursday)
peer review (5 PM today)

assembly 11 PM Oct. 31, (red, green, blue, yellow)
assembly 11 PM Nov. 2, (pink, orange, purple, silver)

in-class presentations Nov. 1, Nov. 3
(having design variations is a good thing)

technical review with alpha prototypes, Nov. 16
Finally
reminders

tonight, 7 PM in Pappalardo!
mediating design decisions. Sls, Yodas, and all

Yoda workshop (8 PM also in Pappalardo)

think about what you need work on/prepare so team can make a good, informed decision, and please let me know!