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

2.009 Product Engineering Processes

thinking is the hardest work there is, which is probably the reason why so few engage in it.
Henry Ford, 1863-1947
2.009 Product engineering processes

Today

Product architecture structure the problem
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.
Professional Ethics

wait wait, don’t tell me: bluff the listener

Number true
Design for manual assembly

mini quiz from Monday

list 4 design-for-manual-assembly guidelines

“list customer support contact info”: Joyce Zhang
Design for manual assembly
mini quiz from last Monday

list 4 design-for-manual-assembly guidelines
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.

Chapter 10 (5th edition)
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</th>
<th>Modular</th>
</tr>
</thead>
<tbody>
<tr>
<td>weight</td>
<td>1.2 (2.0 with batteries)</td>
<td></td>
</tr>
<tr>
<td>charge time</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>power/weight</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>purchase price</td>
<td>~8-10</td>
<td></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 $f$ (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)

Solidworks tutorial Friday: multi-user assemblies

assembly 11 PM Nov. 3, (red, green, blue, yellow)
assembly 11 PM Nov. 5, (pink, orange, purple, silver)

in-class presentations Nov. 4, Nov. 6
(having design variations is a good thing)

technical review with alpha prototypes, Nov. 16
Prototype development countdown

19 days

12 days

5 days

17 days

14 days

10 days

7 days

5 days

technical review