any intelligent fool can make things bigger and more complex
it takes a touch of genius to move in the opposite direction

Albert Einstein
14 March 1879 – 18 April 1955
2.009 Product engineering processes today

product architecture

product form

design for assembly making things easier for yourself

thinking about designing this week
HAPPY BIRTHDAY NICK!!!!!!
Last class…
what is an ethic?

a code of behavior or conduct justified according to a reasoned value system

“something all politicians are lacking”
“don’t be a lying, mischievous @$$*#%!"
Product architecture
name two product architectures

inherent to design, not an add-on
probably modular unless it can’t be

modular
integral

"macro and nano"
Modular architecture

advantages

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

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
Form follows function

Sullivan’s intent (father of modernism, skyscrapers)
Mini quiz

yep, another one!

form follows function means?

the principle of pragnanz is…

KISnS stands for…?
Product development process so far...

rigor in breadth
Product development process so far…

exploring options and deciding where to invest

- information-based decisions
- needs and goals
- realistic risk-taking

facilitating difficult decisions through process
Product development process

now...

rigor in depth
Workflow
now…

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

Mockup review
October 19
2 mockups per section

Assembly review
November 1 & 3
1 assembly

Final presentation
December 11
1 alpha prototype

Final selection
October 23-26
1 concept per team

Sketch model review
October 5
3 models per section

ONE TEAM

ONE SUBTHEME

A

B

ONE

Assembly review
November 1 & 3
1 assembly

Technical review
November 16
1 (almost) prototype
Prototype development countdown

19 days

17 days

14 days

12 days

10 days

7 days

5 days

3 days

Tech review
design for assembly

so what?
Design for assembly
screw 4 fasteners, exercise

- 4 no predrill (phillips)
- 4 phillips
- 4 slot
- 4 mixed (two phillips, two slot)
- 4 blind (phillips)
- 4 upside-down (phillips)
- 4 upside-down, blind
- 4 mixed, upside-down, blind
- 4 holes, almost symmetric

Assembly times: 0-350 seconds
Design for assembly
why care?

thinking about it will save you time, and now is the
time to think about it

typically consider things like production volume, part count,
capital investment, per product cost, and payback period when
deciding how to assemble
Design for assembly

manual assembly

manual almost always chosen method for low volume (few thousand per year)

human assembly with simple, low cost fixtures

- low initial capital outlay compared to automated systems
- high flexibility and adaptability
- assembly cost stays the same regardless of volume
- can be error prone
- it can be a really tough job
Design for manual assembly

overall procedure

i) for each part, decide if it is really necessary

ii) if a part is necessary…
    design it so that it is easy to assemble
Design for manual assembly guidelines

reduce part count

- is there relative motion during use?
- is a different material needed?
- does it need to separate for assembly, maintenance or end-of-life? (debugging)
- will it be difficult to make?
Design for manual assembly guidelines

reduce part types

standardize fasteners (Robertson, Phillips, Allen)

eliminate unnecessary product features

avoid wiring harnesses, connecting cables
Design for manual assembly

guidelines

eliminate adjustments (design to fit):

*judgment and decisions during assembly take time and lower reliability*

avoid joining parts if they can be made from one piece

use locating pins or features (e.g., for bolted elements)
Design for manual assembly guidelines

design parts to be self locating/aligning
  parts that do not have to be held in place during assembly (e.g., spot face)
  use chamfers or tapers to guide parts into one and other
  avoid multiple surfaces that need to be aligned simultaneously
  let gravity work for you
Design for manual assembly guidelines

consider access

provide adequate space for hands, tools, and post assembly operations (lubricating, debugging, batteries)

ensure that there is a direct line of sight for mating surfaces during each assembly step

adopt a single assembly direction (e.g., vertical stack)
Design for manual assembly

guidelines

make parts easy to handle

- avoid heavy, sharp, fragile, awkward parts
- avoid parts that require special tools for gripping or insertion (e.g., e-clips)
- avoid flexible parts
- avoid parts that tangle easily (e.g., open-end springs)
Design for manual assembly guidelines

design parts so they can only be installed correctly

- make parts fully symmetric
- make parts clearly asymmetric
- make it obvious if parts are not correctly aligned (no almost fits)
- add features to block incorrect assembly (e.g., memory chips)
- provide registration marks
- avoid flexible parts since they almost always can be installed incorrectly
Last coming up!

**Monday:** we start in 10-250 and then will have consulting sessions in your team areas

discussion related to your design and the assembly review