2.009 Product Engineering Processes

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

design for assembly
making things easier for yourself
Product development process

goal so far

ensure your team…

has a real and understood problem/need
has a clear value proposition relevant to strategic interests
knows for whom it is designing
understands what it is up against (competition)
has confidence about knowhow to resolve the big risks
has a good sense for the issues that remain
has a feeling for what it will take to get it done
knows it can manage the project within available resources
Workflow
looking ahead

Three ideas presentation
September 26, during class
3 ideas per section

Mockup review
October 20
2 mockups per section

Assembly review
November 2 & 4
1 assembly

Final presentation
December 12
1 alpha prototype

Sketch model review
October 6
3 models per section

Final selection
October 24-27
1 concept per team

Technical review
November 17
1 (almost) prototype
Chicken chart!
21 days to the technical review

Prototype development countdown
But first... what is an ethic?

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

“a good thing to follow”
“something all politicians are lacking”
“Jiminey Cricket”
Product architecture

name two product architectures

modular

integral

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

list an advantage for each architecture

if you can’t remember, you won’t use it
Modular architecture

advantages

decoupling facilitates task allocation and out-sourcing

economies of scale

reuse/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)
Drill circuit reverse engineering

unfinished business

Kyle Saleeby
Mini quiz
yep, another one!

the principle of pragnanz is…

form follows function means?
design for assembly

so what?
Design for assembly

screw 4 fasteners, exercise
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
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? a
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)
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!

5 PM today in 3-370: designing multiple-designer assemblies in SW—top-down design and master models

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