Design for X
MCHE 201 – Spring 2019

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Design for X

How can the design be improved with respect to X?
Phases of Design

1. Problem Understanding
2. Specification Development
3. Conceptual Design
4. Detail Design
5. Production Specification
6. Manufacture
7. Disposal

Think about $X$ throughout the design process

Don’t wait until here to think about $X$
Design for Manu. and Assembly

• Formalized methods developed by Geoffrey Boothroyd & Peter Dewhurst

• Won National Medal of Technology

• http://www.dfma.com/
Design for Assembly

• Methods consists of a design review by:
  - Design and development personnel
  - Production personnel

• The technique imposes:
  - Discipline
  - Objectiveness
Design for Assembly

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Like so much of what we’ve discussed, one objective is to make formerly-implicit requirements explicit.
Examine Assembly Operations

- Storing
- Handling
  - Identifying
  - Picking-Up
  - Moving
- Positioning
  - Orientating
  - Aligning
- Joining
- Adjusting
- Securing
- Inspecting
DFA Goals

• Standardization of assembly operations

• Use of existing assembly equipment and tools

• Use of standard assembly tools
DFA Evaluation Process

• Are there “favorable” sequences?
  - Preassemble parts
  - Parallel assembly

• Can it be automated?

• Can errors be reduced?

• Can component damage be reduced?

• Can we avoid special training?

• How can we improve assembly safety?

• How can we better enforce ergonomic/human factors standards?
DFA – Questions to Ask

• Can some part of the process be eliminated?
  - By a better material choice
  - By combination of the part with another

• What is the cost to:
  - Deliver parts to the assembly location
  - Give correct orientation and position information?

• What is the actual assembly cost of the part?
DFA – Questions to Ask

• During operation does the part move?

• If so, is the motion small enough such that an elastic hinge or similar can achieve that motion?

• Does the part need to be isolated or of different material than parts assembled before it?
Designing for Automated Assembly

• Layered Designs
• Self-alignment
• Combine detail parts
• Utilize symmetry
• Use common fasteners
• Minimize springs
• Minimize cables
Self-Alignment

Avoid

No Chamfers

Better

Bottom Part Chamfered

Top Part Chamfered

Best

Both Parts Chamfered
Self-Alignment

This part could be oriented in any direction

These parts can be oriented only one way

Hole to accept swaged part

Hole to accept notched part

“D” shaped hole
Nest Parts

This part could be placed in any orientation and not be secured

This part has a “nest” to orient and help it secure
Features for Orientation

This slot would be hard to detect

Pin to help orient slot

Chamfer to help orient slot
Symmetry

Preferred
Tangling

These parts can tangle easily

The same parts redesigned, will not tangle
Parts that interconnect will not feed

A fillet will keep the parts from interconnecting

Springs with open loops will tangle

Springs with closed loops will not tangle
Jamming

Methods to Avoid Jams

This results in shingling

Base causes leading edge to be lower than trailing edge

Direction of Flow

A nonfunctional corner can eliminate this problem
Jamming (cont.)

Methods to Avoid Jams

- Rounded corners can prevent jams
- Mating surfaces with sharp edges can cause jams
- A groove can prevent jams by centering the part
Avoid Fasteners, If Possible

Avoid designs that require fasteners

Design parts that snap together
Avoid Fasteners – Moving Parts

C-Clip

Chamfered Surface

Snaps
If you have to use fasteners...

Round Side

Round Head

Slanted Side

Flat Head

Preferred: Have flat vertical sides for vacuum pickup

Socket Head

Fillister Head

Hex Head
Cables and Connectors

Avoid:
Components that are connected with cables to circuit board

Preferred:
Components that are plugged on a slave circuit board
If the use of a cable cannot be avoided. Have the cable plugged into a dummy connector to locate the cable end. Then a robot can locate the connector and plug it in.
Assembly Motion Design

Avoid: Three motions required for insertion

Preferred: Only one motion required