

# Introduction to Computer Aided Design (3D Modeling)

## Prototyping Skills (BME290L)

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January 17, 2023

# Outline

General Workflow

Modifying Edges

Common Types

Why?

Holes

Screws

Mechanical Drawings

Mechanical Design Considerations

Demo

Lab

# OnShape



- ▶ We will be using OnShape, a cloud-based CAD package with a similar workflow to SolidWorks.
- ▶ You have been automatically registered to join Duke's OnShape team (<https://duke.onshape.com>).

# Tutorials

- ▶ OnShape
  - ▶ Introduction to Sketching
  - ▶ Introduction to Part Design
  - ▶ Introduction to 2D Drawings
- ▶ Enclosure Design for 3D Printing
- ▶ How to assemble 3D printed parts with threaded fasteners
- ▶ How to design snap-fit joints for 3D printing

# General Workflow

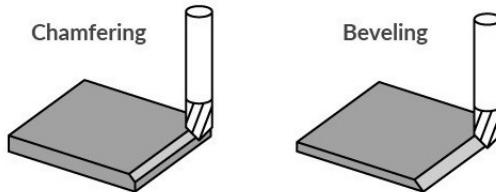
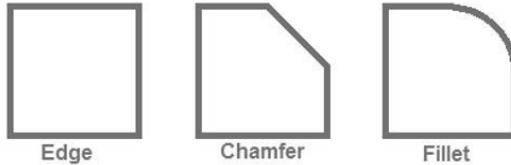
1. Sketch 2D profiles (dimensioned).
2. Use constraints to align sketch features to one another.
3. Extend 2D profiles to 3D parts.
  - ▶ Extrude (new, add, subtract, intersection)
  - ▶ Revolve
4. Utilize part symmetry and patterns to reduce manual effort.
5. Define new sketch planes on part references that “make sense”.
6. Assemble multiple parts.

# Practice Makes Perfect

- ▶ There are many ways to create the same parts. Some are more amenable to future modification than others; those aren't always the fastest to create from scratch.
- ▶ Experience is highly valuable!

## Modifying Edges

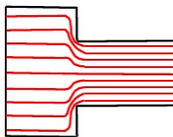
- ▶ Fillet: rounded corner / edge
- ▶ Chamfer: sloped / angled corner / edge



Why?

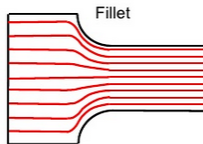
## Why modify edges?

- ▶ Reduce stress concentrations (fillet > chamfer).
- ▶ Reduce sharp edges.
- ▶ Ease assembly (potentially at cost to manufacturing).



### Abrupt change

Stress "flow lines" crowd together causing high stress concentration in transition zone

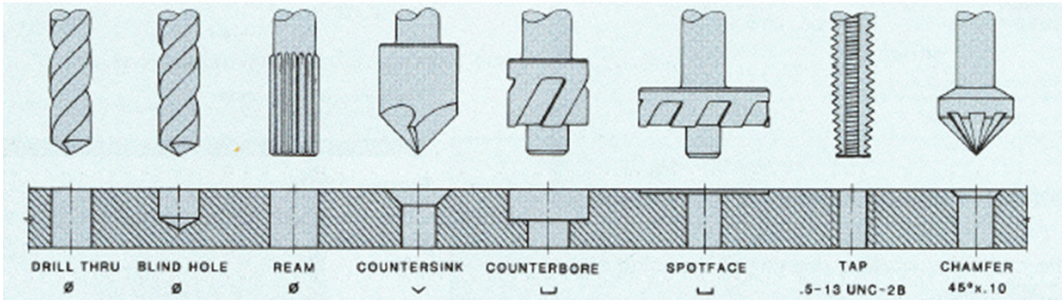


### Smooth change

"Flow lines" more evenly distributed causing lower stress concentration in transition zone



## Types of Holes



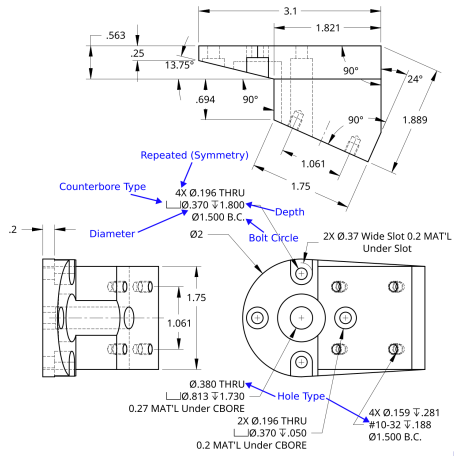
CAD software has a specific Hole tool that can be very handy. Specify diameters and threading based on ANSI and ISO standards (e.g., ANSI #10-32 bolt or ISO M5-0.8). Additionally, a table of holes can be generated on mechanical drawings.

# Types of Screws



# Mechanical Drawings

- ▶ Multiview / orthographic projection
- ▶ ISO 8015 (“Geometrical product specifications (GPS) — Fundamentals — Concepts, principles and rules”)
- ▶ Dimension callouts / values should not overlap any part lines!



# Mechanical Design Considerations

- ▶ Purpose
  - ▶ Protection (water, debris?)
  - ▶ Holding components in relation to each other
  - ▶ Mounting
- ▶ Loading
  - ▶ Shipping
  - ▶ Gravity / Momentum
  - ▶ Falls (especially corners)
  - ▶ Buttons
- ▶ Interfaces
  - ▶ Cables
  - ▶ Displays
  - ▶ Buttons
- ▶ Minimize all else!

# Flange

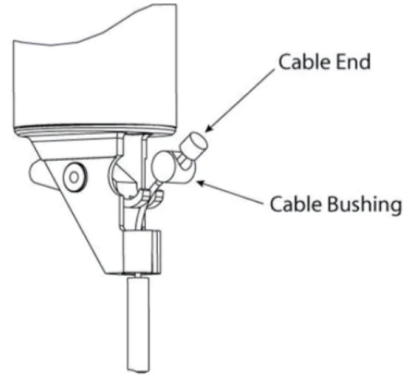
What is a **flange**?

- ▶ Internal/external ridge/lip/rim
- ▶ ↑ **strength** / distribute **contact force** between mating pieces
- ▶ Commonly uses a **bolt circle** (BC)



- ▶ Demo
- ▶ Tips:
  - ▶ Rename steps to build the part
  - ▶ Use variables for dimensions that may change
  - ▶ Use patterns when possible
  - ▶ Note version history / tag specific revisions
  - ▶ Look at different views, including “sections”
  - ▶ Create mechanical drawing

- ▶ What is a **bushing**?
  - ▶ It is actually a **bearing**.
  - ▶ Reduces friction between a rotating shaft and a fixed support member.
  - ▶ Typically made of metal or plastic, with lubrication.
- ▶ Other types of bearings:
  - ▶ Ball bearings
  - ▶ Roller bearings



## Lab This Week

1. Create flange specified in the mechanical drawing
  - 1.1 Add a 5 mm hex head set screw (other specifics, e.g., thread pitch, are arbitrary) to the flange collar to hold a rod in place
  - 1.2 Generate an assembly with a mocked rod part
  - 1.3 Generate a mechanical drawing based on your part
2. Create the part and mechanical drawing for the Fox bushing

Please submit everything through Gradescope.