DEBUT Technical Workshop #3: **Introduction to 3D Modelling**

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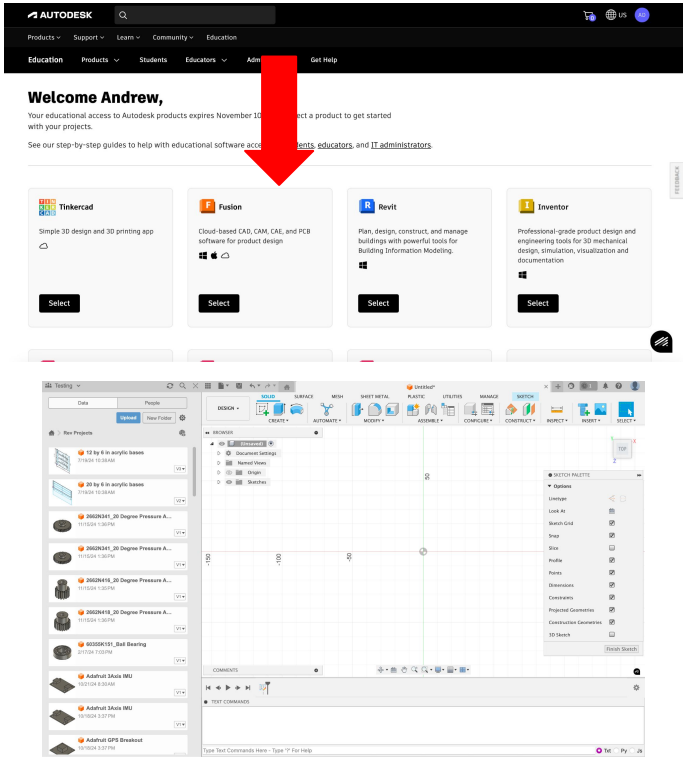
Prefix

Please download Fusion360 through this link:
[Fusion Educational]

- Create a Fusion360 Account with your school email address
- Register for the Educational License (may require a photo of school ID)
    - Access is available through a Personal License as well, but for DEBUT, preference is for projects to be hosted on school emails
- Download the “Fusion” application and Sign In



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Contents

I.
What are the first steps towards realizing a concept as a design?

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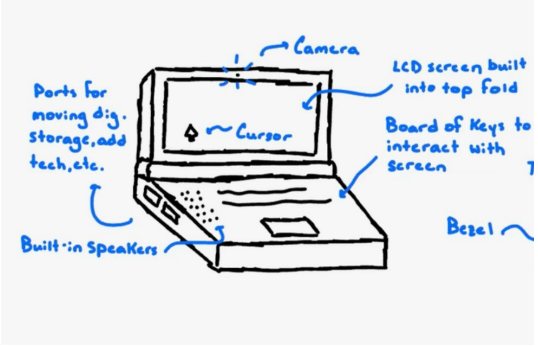
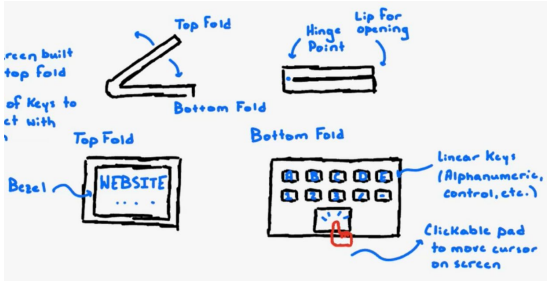
Explanatory Drawings

- Initial concept describing the key components
- Quick method for conveying thoughts
- Key Components
  - *Describe Motion* - Showing motion of the device itself (hinging, switches, etc.)
  - *Describe Interaction* - Showing the method by which end-users/ customers interact with a product (tactility)
  - *Describe Components* - Showing major components that comprise the individual device





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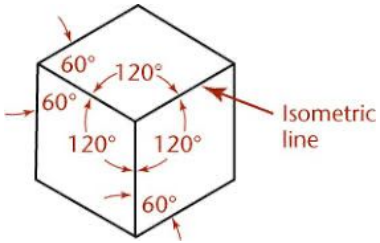
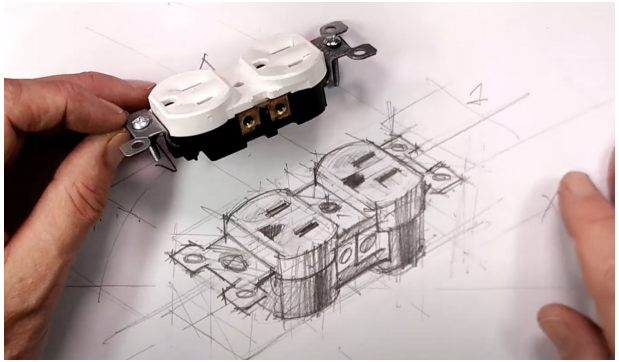
Wireframe Drawings

- A diagram that adds additional information about the form factor of the design
  - Emphasizes details and form
  - Illustrates volume
  - Shows cohesion of individual parts
- All important components/ aspects a consumer interacts with should be visible and apparent
  - Draw Isometrically
  - Include Shading
  - Use dark, congruent lines for outlines
  - Be creative!





II.
What do engineers typically use to design these softwares in the real world?

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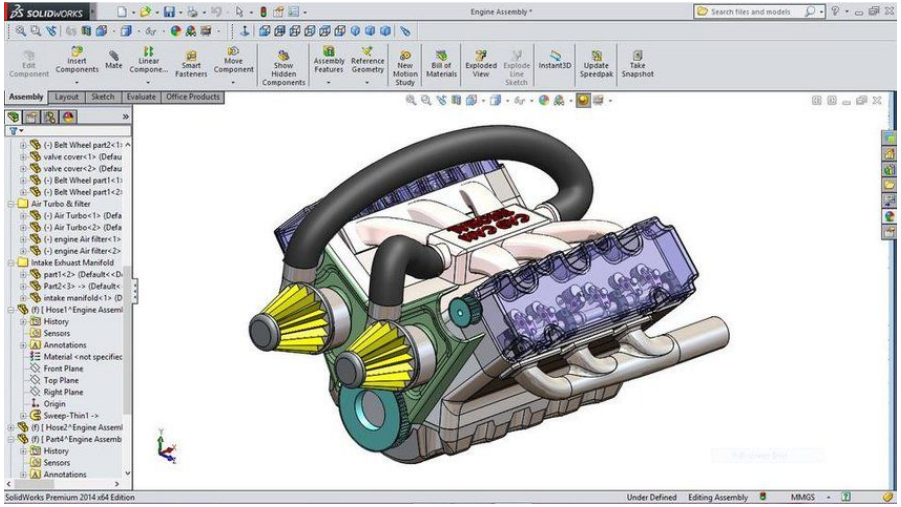
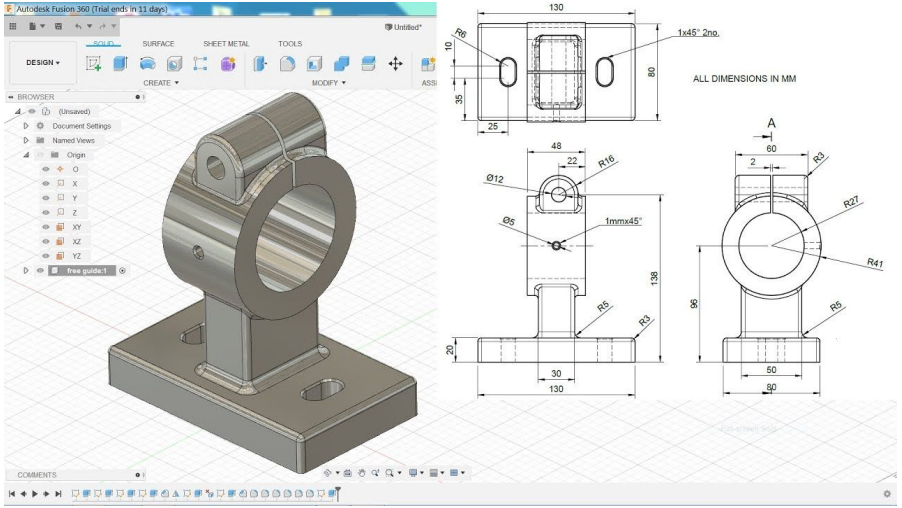
CAD (Computer-Aided Design)

Computer softwares engineered for designing 2D/3D representations of objects





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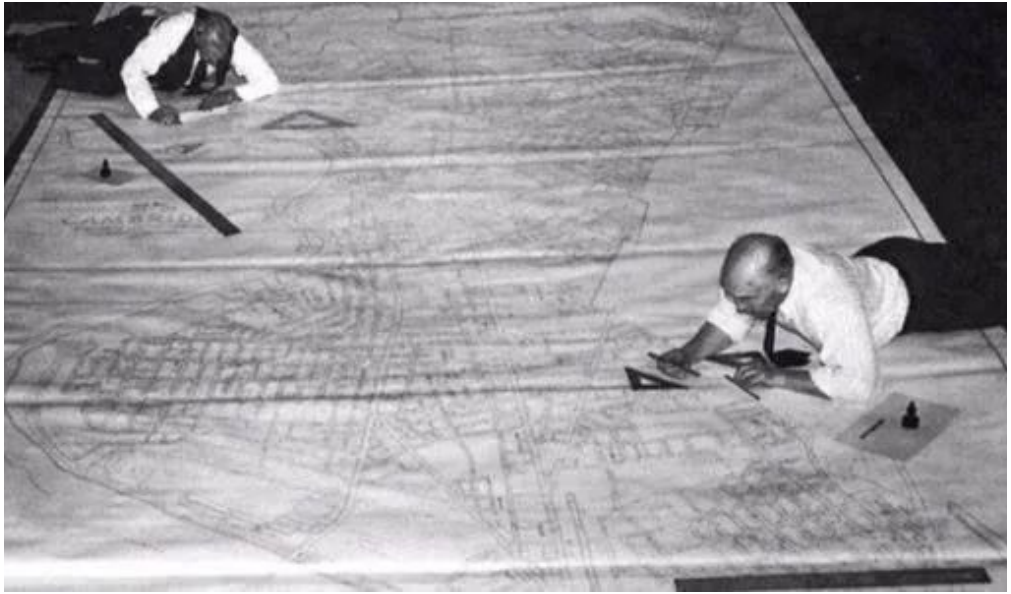
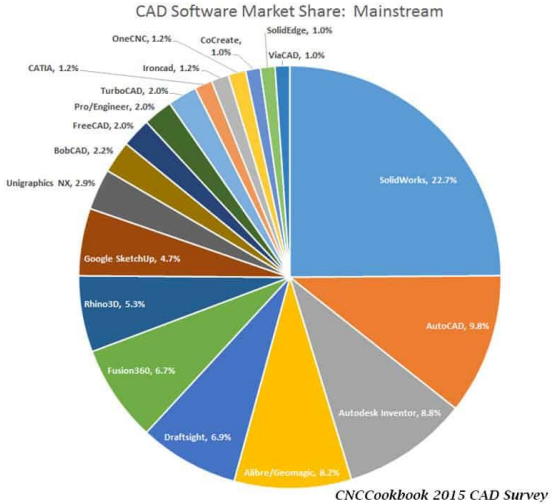
CAD (Computer-Aided Design)



CAD (Computer-Aided Design)

- Every industry and company chooses preferred 3D software based on preference
  - ***Industry*** - Rhino, Creo, SolidWorks, Autodesk Inventor
    - Stronger Softwares, Older, Require Paid Licenses)
  - ***Research*** - Fusion360
    - More Interactive, Newer, Free Licenses for Student/ Educators
- Learn one, become fluent, and explore around
- CRUCIAL to learn one well



Expecting to do many CAD drawings?

Option #1: Buy a Mouse

Option #2: Carpal Tunnel

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III.
What is the process for creating a design in a software such as Fusion360?

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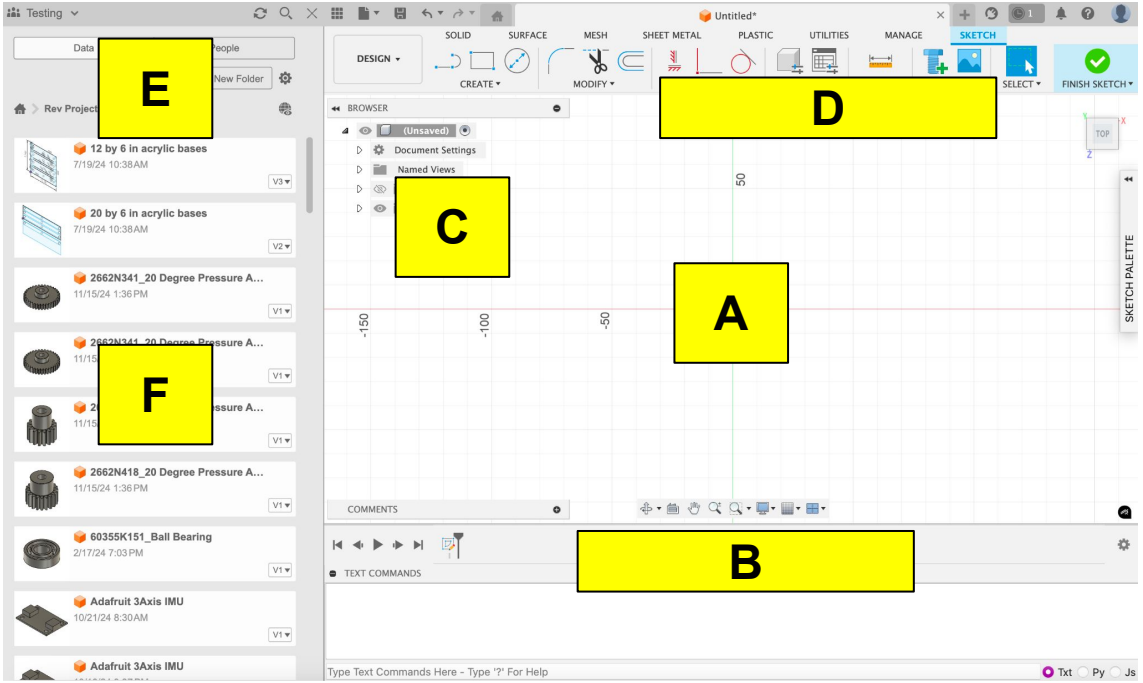
Navigating the Home Page



A. **Workspace** - Major work area for creating designs
B. **Timeline** - Hosts linear timeline of all design changes
C. **Browser** Includes settings and major designs in workspace
D. **Tools** - Commands for specific design actions
E. **Account Setting** - Designate "Host" User
F. **Projects** - All projects

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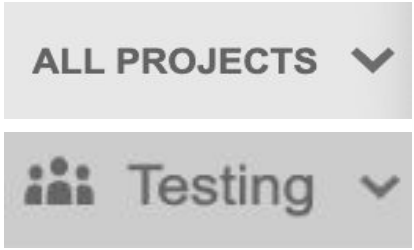
Home Page (Common Issues)

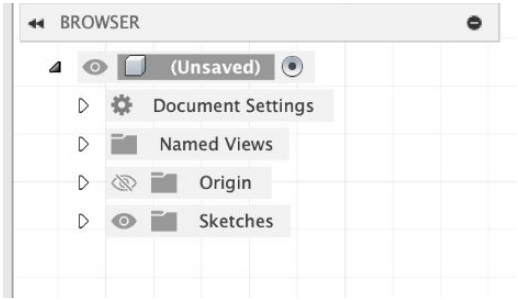
Unable to Find a Project

1. Check in all the folders under “All Projects”
2. Double Check your “Team Account” is correct



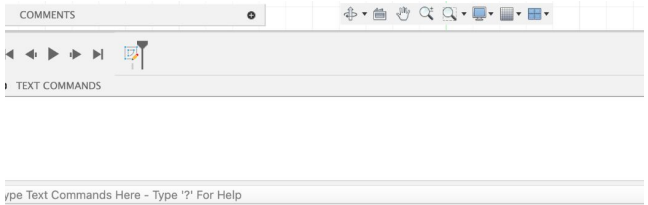
Incorrect Settings (Units)

1. Check under “Document Settings” in the Browser
2. Create a New File



Design Looks Weird

1. Consult with others
2. Check Project Version
3. Check for warnings in the “Timeline” and ask a project manager to resolve



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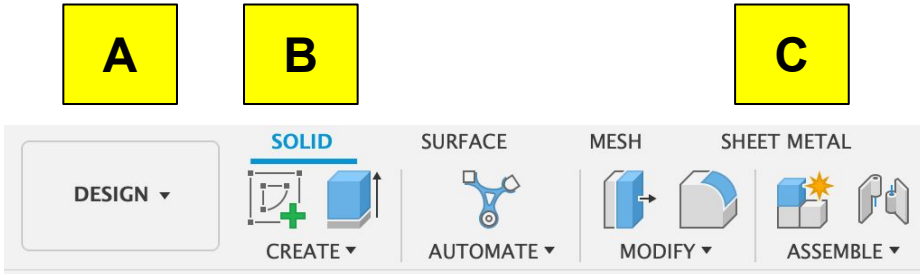
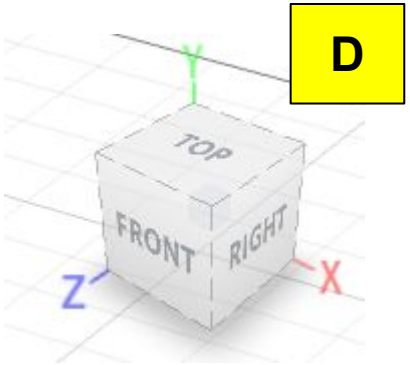
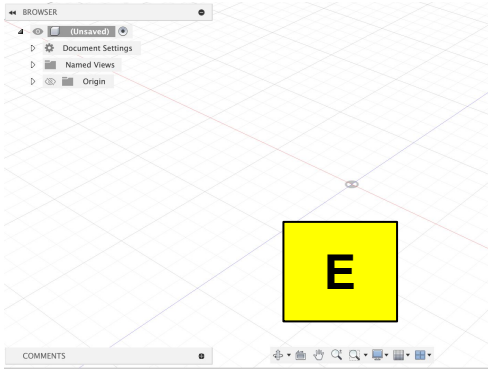
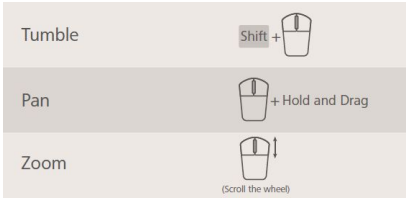
Navigating the Workspace







A. **"Change Workspace"** - Toggle between workspace types (Design, Render, Animation, etc.)
B. **Solid** - Hosts 3D design tools
C. **Sheet Metal** - Hosts 3D design tools ideal for boxes
D. **"ViewCube"** - Select an orientation for viewing a drawing
E. **Sketch Plane Settings** - Edit aesthetics of the workspace



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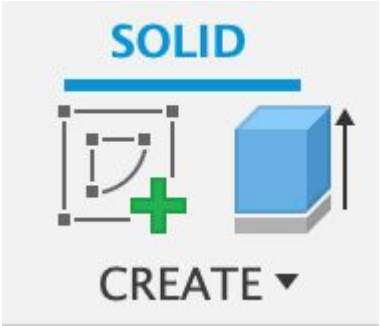
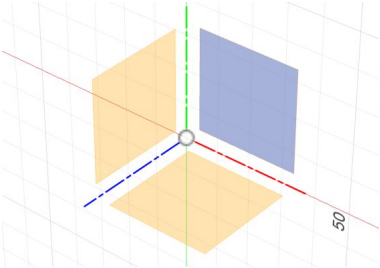
Sketch Plane

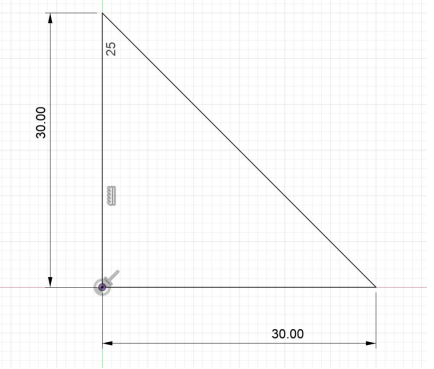
- ALL components should start from a sketch
- The sketch plane is entered once the “Sketch” tool is selected (“Solid” > “Create” >“Sketch”)
  - Requires Selecting the Orientation of Sketch Plane
- Remain in the Sketch Plane until “Finish Sketch” is Selected
  - Out of Sketch Plane once the blue “Sketch” symbol disappears from the top-right of the tools bar
- To return to a sketch to edit, select the sketch in the bottom of the timeline or in the browser
- Edits to sketches are not visible in the Timeline, so BE CAREFUL

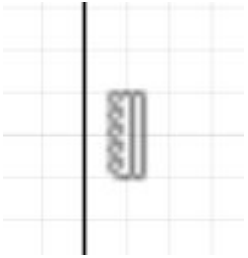




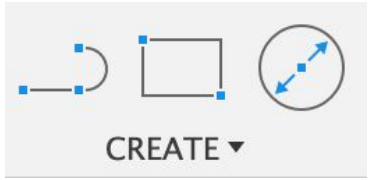
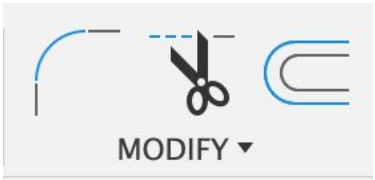
Constraints

- Prevents lines and polygons from moving during sketching
- Show up as little symbols next to polygons
- Certain sketch tools will create constraints
- One common constraint - **Dimensioning**
  - Setting the dimension of an object of the sketch plane prevents further tools from edits the size
- Types of Constraints
  - *Spatial* - Constraining designs in XY-Directions
  - *Sizing* - Constraining sizes for objects
  - *Angular* - Constraints from angular motion
- Although not required for sketches, STRONGLY helps





Sketch Tools/Commands

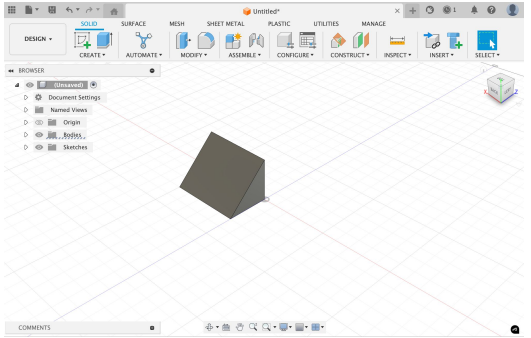
Category	*"Name", [Single Key Command]*	*Description*
	"Rectangles" [R], "Circles" [C], "Splines"	Creating Polygons
	"Circle Pattern" and "Rectangular Pattern"	Create Linear Patterns for Designs
	"Project" [P]	Move Sketches to New Planes
	"Sketch Dimensions" [D]	Show Dimensions
	"Fillet"	Curves Pointed Edges
	"Trim" [T]	Remove Parts of Curves
	"Sketch/Scale"	Edit Sizing of Line Groups

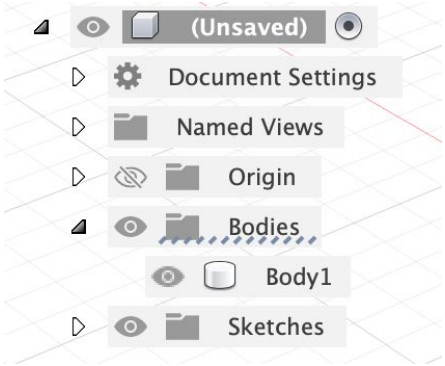
Sketch Tools/Commands

Category	*"Name", [Single Key Command]*	*Description*
	"Parallel", **"Coincident"**, "Perpendicular", "Collinear", "MidPoint"	Constraints 2 Lines w/ Condition
	"Tangent", "Concentric",	Constraints Line and Polygons
	"Finish Sketch"	Move out of the Sketch Plane

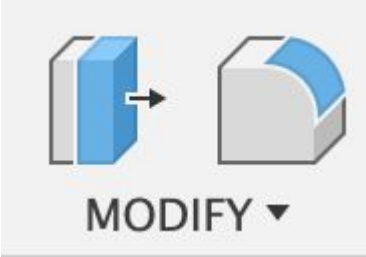
Solid Space

- Expands sketches into the 3D space with solid tools by creating “Bodies” (The precursor for a “Component”)
- Dozens of tools are available throughout the “Solid” tab of the toolbar
    - *Create* - Major Shaping/ Design Tools
    - *Modify* - Refining/ Splits Bodies
    - *Assembly* - Jointing Components to Create Motion
    - *Construct* - Create Special Planes for Sketches
    - *Inspect* - Run special observations on components
    - *Insert* - Import components, images, etc.
- Best learned by exploring on your own and practicing with trial/error (As long as no errors, no wrong designs)

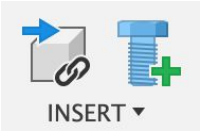




Solid Tools/Commands

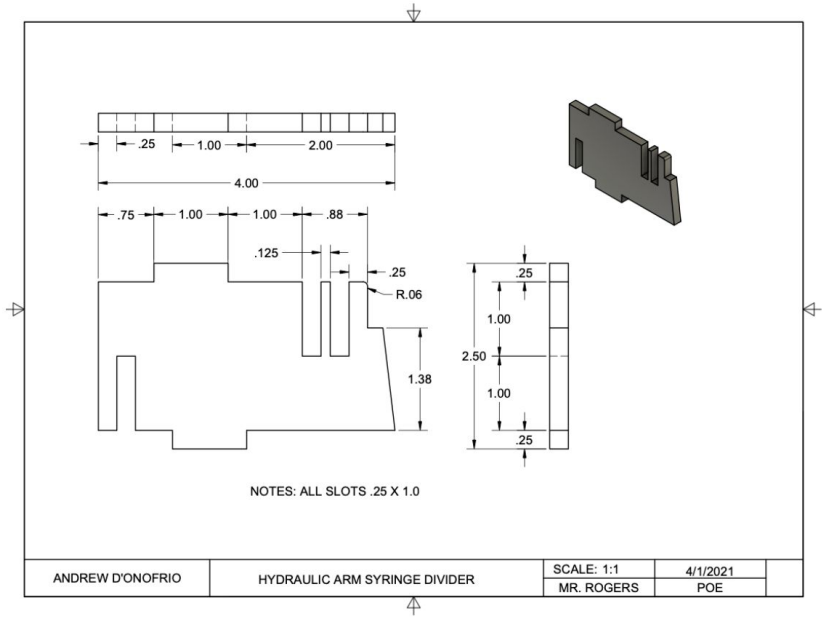
Category	*"Name", [Single Key Command]*	*Description*
	"Extrude" [E], "Revolve", "Loft", "Hole" [H]	Add/Removes 3D Bodies
	"Box", "Cylinder", "Sphere", "Pipe"	Creates Pre-Set Bodies
	"Pattern", "Mirror", "Thicken"	Tools for Repetitive Body
	"Filet" [F], "Chamfer"	Smooth Edges of Bodies
	"Split Face", "Split Body"	Create Multiple Bodies from One
	"Shell"	Hollow Bodies
	"Move/Copy"	Move Bodies Along the Plane

Solid Tools/Commands

Category	*"Name", [Single Key Command]*	*Description*
	"New Component"	Turn Bodies into Components
	"Joint" [J], "Drive Joint", "As-Built Joint"	Joint Components Together
	"Enable Contact Sets"	**AVOID AT ALL COSTS**
	"Offset Plane", "Plane at Angle", "Midplane"	Create Specialty Planes
	"Axis through Edge"	Create Specialty Axes
	"Insert Component"	Insert .steps, .stl, etc.
	"Decal", "Canvas"	Insert photos to workspace

Engineering Drawings

- Most Effective Means for Describing 3D components to other engineers, manufacturers, etc.
- Created from the “Drawing” Workspace (“Drawing” > “From Design”
- Typically “ASME A” Size
- Includes Multiple Views, Dimensions, and Design Comments
    - *Views* - Front View, Side View, Orthogonal View



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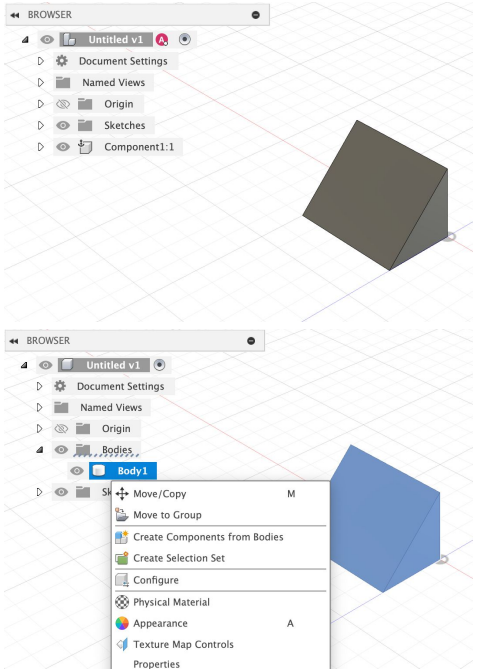
Parts/Bodies to Assemblies

- *Bodies* - 3D Shapes of Design Elements
  - Major Design Changes
  - Malleable with Little Effects
  - Only “Create” and “Modify” allowed
- *Components* - Definitions of the major aspects that dictate relationships
  - Minor Design Changes
  - Massive consequences for changes
  - All Design Changes allowed, recommended to only use “Assemble” in Design workspace
- For complicated designs, create components and segment into individual files



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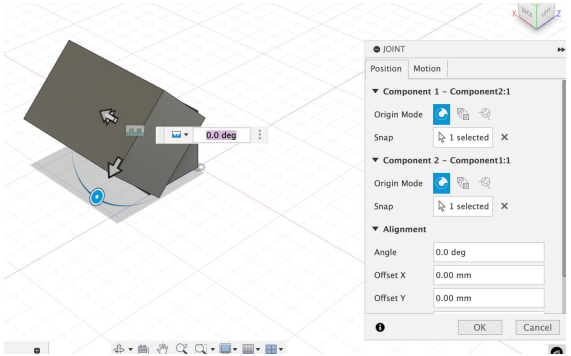
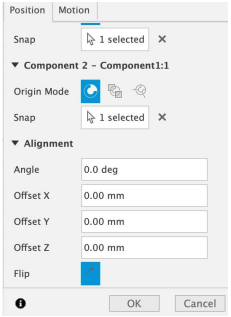
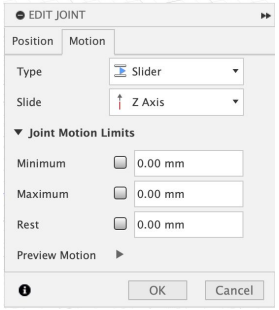
Joints

- Create motion between two components in a design
- Set a relationship between points, edges, or faces
- Types of Joints
  - *Rigid* - Locks faces, edges of a body together
  - *Revolute* - Faces to slide circular
  - *Slider* - Faces or edges slide linear
  - *Cylindrical* - Combines revolute and slides
  - *Ball* - Spherical Ball Joint
- Drag bodies in order to “drive” motion
- Options are available to limit motion in tool settings

***Tip - Hold control while selecting points for a joint to form for each component**







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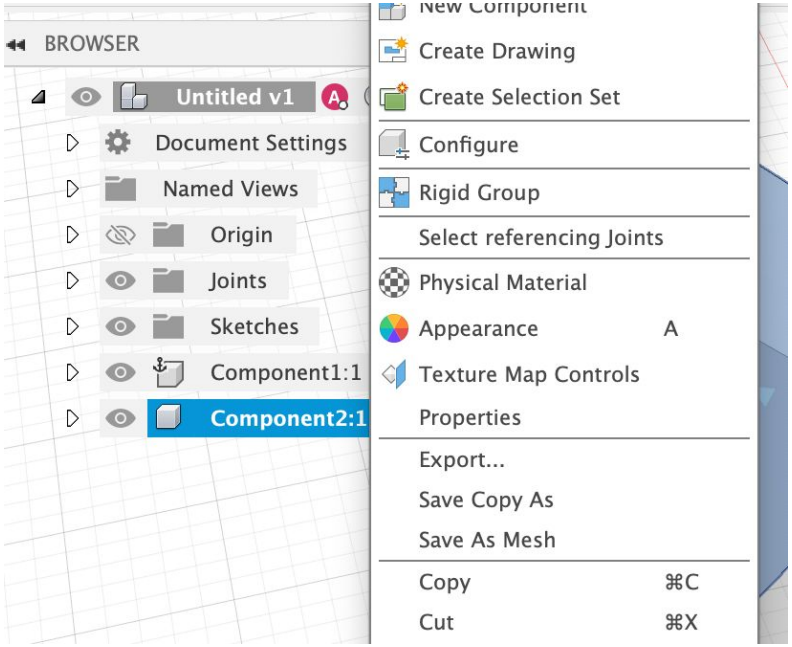
Assigning Properties

- Assigning specific designs, colors, or properties to components in the design
- Very helpful for determining weight, volume, and approximations of design
    - *"Physical Material"* - Designates a material type of the component (typically for internal data, some materials assign appearances and textures as well)
    - *"Appearance"* - Sets color
    - *"Properties"* - Gives data for calculations (MOI, density, etc.)



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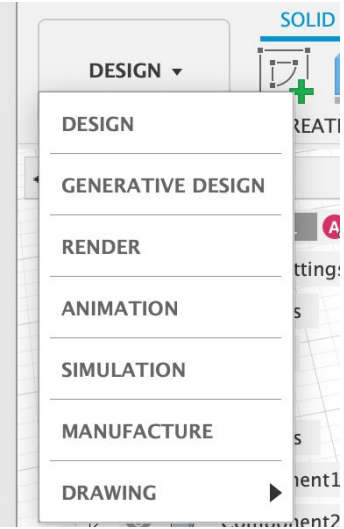
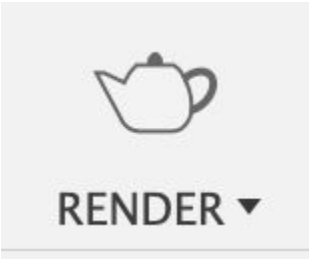
Renderings

- A simple process for realistic renderings of designs
- All finished designs typically undergo rendering to show a high quality image of the final product
  - *Ex*. SteadyStride Rendering shown at BMES
- Renderings occur individually, and are one of the last steps in the engineering design process
  - Avoid until the last moment

CAUTION - Some renderings will take a VERY long time (>30 minutes depending on quality) and may crash other softwares (experience)





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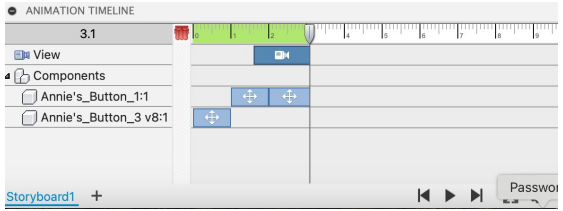
Renderings Tools

Category	*"Name", [Single Key Command]*	*Description*
	"Physical Material", "Appearance"	Edit appearances and textures
	"Scene Setting"	Set environment and lighting
	"Decal"	Add decals to component faces
	"In-Canvas Render"	Create render quality display
	"Capture Image"	Photos the workspace display
	"Render"	Create a full Fusion rendering

Animations

- Create low-fidelity animations to illustrate motion or show an exploded view of a design
- Consists of storyboards, explosions, and transforms
    - *Storyboard* - Hosts all the motions of one singular component (similar to a timeline)
    - *Transform* - Movements for objects across the XYZ plane
    - *Explosions* - Computed estimates of components moving normal to one another
- Views impact the scope of the animation
- Select component, add a transform/motion, edit in the storyboard



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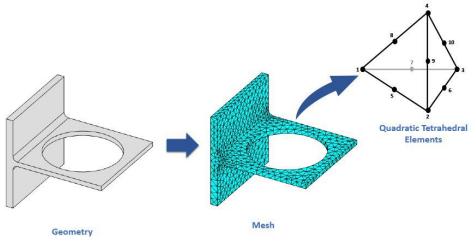
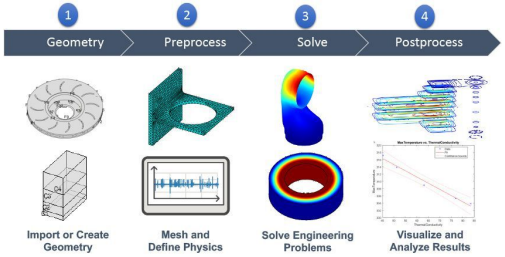
Finite Element Analysis (FEA)

Finite Element Analysis - A computed method for breaking a structural or electrical component into much smaller and simpler elements, and using a different ***boundary conditions*** and ***initial conditions*** to solve these elements

- ***Boundary Condition*** - What is happening at the edge of the element?
- ***Initial Condition*** - What is happening at the start of the simulation
- Interested in learning about the specific formulas? > “Mechanics of Materials” (MAE3270) and “Finite Element Analysis in Mechanical and Aerospace Engineering” (MAE 4700)





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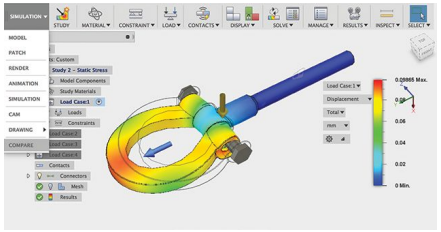
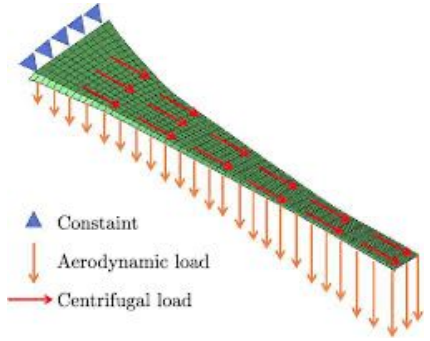
FEA Major Steps

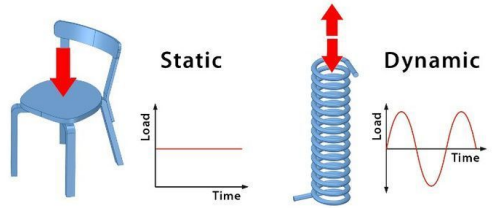
1. Navigate to the “Simulation” workspace
2. Provided a Screen to Select Study Type OR Select “New Simulation Study” (First Button on Top Left)
3. Select Study Type (See Next Slide)
4. Verify model, material type, etc. (See in “Study Materials”)
5. Add “Constraints” to the Model
6. Add “Loads” to the Model
7. Right Click “Mesh” in Browser and Select “Generate Mesh”
8. Click the Drop down under “Solve” and “Pre-Check”
    - Conducts a preliminary check that set-up is correct
9. Select “Solve” or “Results” to run the FEA
10. Toggle between “Safety Factor”, “Stress”, etc.

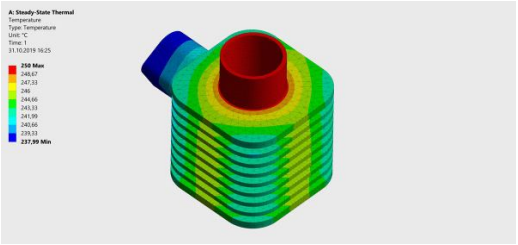


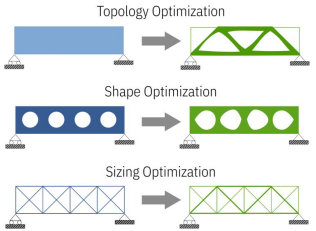


Types of FEA

- *Static Stress* - For Stress, Strain, and Deformation calculations of static (non-moving) structures
- *Modal Frequencies* - For Stress, Strain, and Deformation calculations of dynamic /vibrating (moving) structures
- *Thermal* - For Thermal and Heat Output of Electrical Components
- *Dynamic Event Simulation* - For Stress, Strain, and Deformation calculations of a force over space and time (F(x,t))
- *Shape Optimization* - For optimizing designs based on static loads by reducing weight







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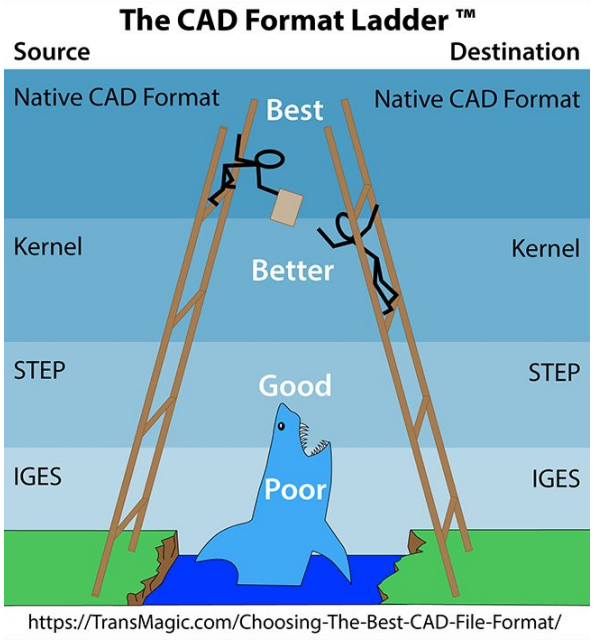
Export Options

- Export depends on the file's intended usage
  - *.f3D* (Fusion's "Native" file)
    - Provides all information about the timeline for other individuals to edit independently
  - *.step* (Common polygonal export)
    - Sharing non-editable 3D designs, either for imported designs or manufacturing
  - *.dwg* (Common drawing export)
    - Sharing non-editable 2D design, typically for reference



IV.
What are resources available on DEBUT to collaborate with peers or learn more?

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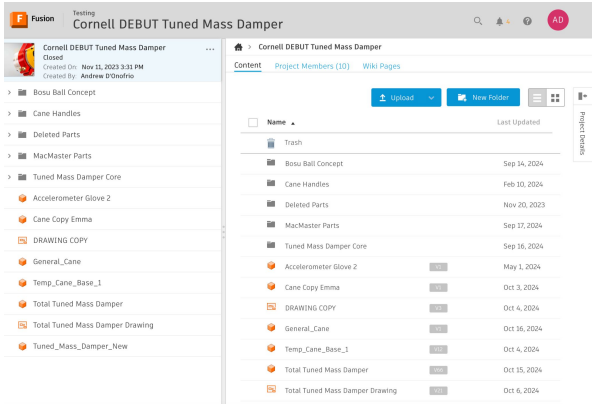
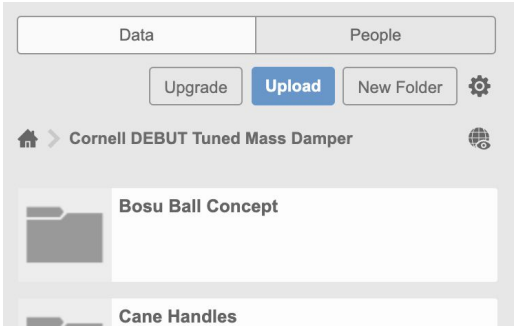
DEBUT Resources

- See Open Source files, ideally .f3D native files
- See previous projects in the DEBUT archives to see previous CAD projects
  - Contact project managers for more information
  - Ask for access to previous “Team Projects”
- Speak with senior DEBUT members about CAD
  - *Me* - Long hours CADing
  - *Emma Weiss* - BMES CAD Representative
  - *David Bruk-Rodriguez* - “The CAD Man” (Note: Graduated)





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Thank You!

Any questions/ comments?

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