MJHS CAD Guide: Fusion 360

MJHS Team Site

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**Fusion Add-In Link*

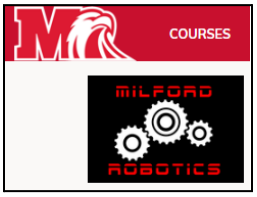
Fusion 360 Account

Your Fusion 360 account is linked to your Great Oaks computer login/password.

Fusion360 Account

Fusion 360

Login to your **Great Oaks** email account at outlook.office365.com/mail. This link is typically posted on your MJHS Robotics Schoology page. Your login is **19.first.lastname@greatoaks.com** and your password matches your classroom computer login password.



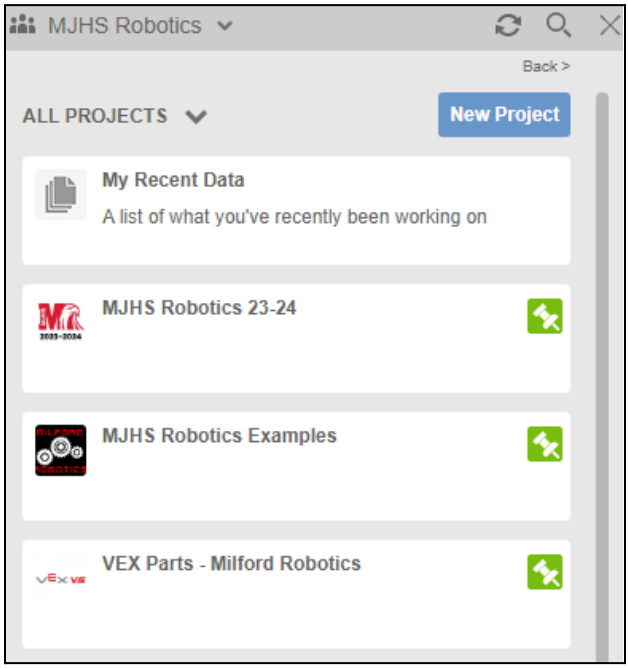
- Open the email inviting you to join MJHS Robotics - Fusion 360 Team (or Create a Fusion360 Account email).
- Sign up using your Great Oaks email and password from the previous steps.

*Always log in to Fusion 360 using this account.

MJHS Robotics- Fusion Team

Teachers/Coaches will provide access to the MJHS Robotics Team Folder in Fusion 360. Within this Fusion Team, there are multiple folders.

- **MJHS Robotics *Year-Year* Folder**
  - This is where you'll save your personal folder with your first and last name and all of your work within it.
- **MJHS Robotics Examples Folder**
  - This contains sample mechanisms, model bases, past robots, and other class items.
- **VEX Parts- Milford Robotics Folder**
  - This folder contains all usable VEX parts to build your mechanisms and robots in CAD.

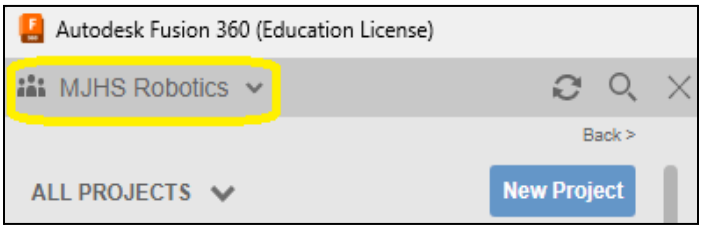


Fusion 360 Basics

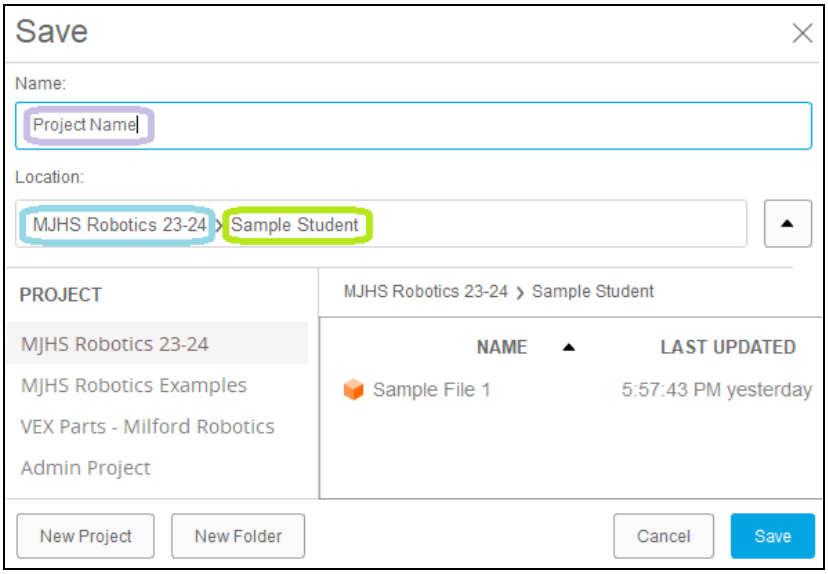
Working with Fusion 360 CAD Software requires a bit of training and practice.

Saving Your Files

After logging into Fusion 360, always make sure your Team is set to MJHS Robotics in the top left corner. A CAD file *must* be saved before adding any parts to or modifying your assembly.



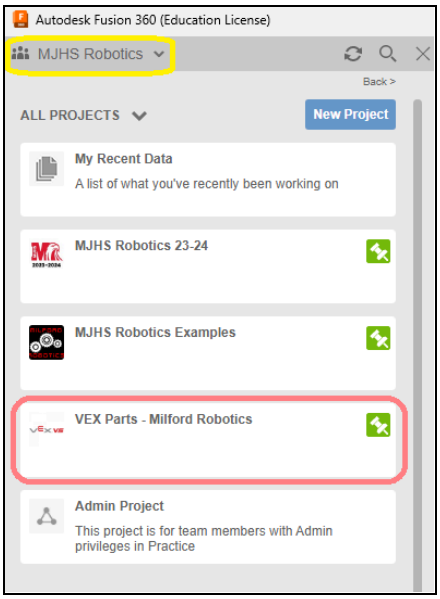
- Please save all Robotics Club work in the "Robotics Club *Year-Year*" folder associated with the *current* school year.
    - Within that "Robotics Club *Year-Year*" folder, you will create a folder named with your *First and Last Name* to save all of your work in.
    - Save your file with a *relevant project name*.
- Saving here ensures that your work can be shared with your teachers, coaches, and teammates.

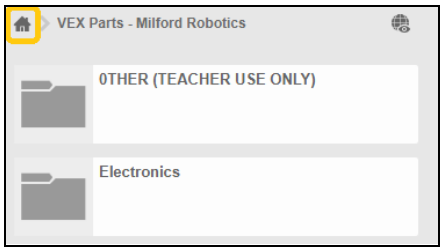


Accessing VEX Parts

After logging into Fusion 360, make sure your Team is set to MJHS Robotics in the top left corner.

- Double-click on the folder titled "VEX Parts - Milford Robotics". This will open the subfolders that you will use to find all VEX parts.
    - *We recommend that you always begin an assembly by inserting structure pieces first.*
    - To return to the main Team folder, click on the house icon (⌂) in the top left corner of the Data Panel.
    - Parts are split into the following categories:
        - Electronics
            - Brains, Batteries, Cables, Motors, Radios, Sensors, etc.
        - Game Elements
        - Hardware
            - Bearings, Collars, Inserts, Screws, Shafts, Spacers, Standoffs, etc.
        - Motion
            - *Advanced Mechanisms*, Chain/Tank Tread, Flex Wheels, Gears, Linear Slides, Lock Bars, Pneumatics, Sprockets, Turntables, Wheels, etc.
        - Structure
            - Aluminium
                - *Multisized* Angles, Bars, C-Channels, etc.
            - Brackets, Gussets, License Plates, Polycarbonate, Steel, etc.

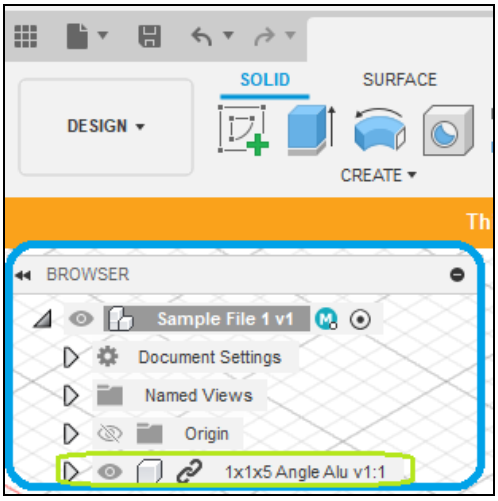




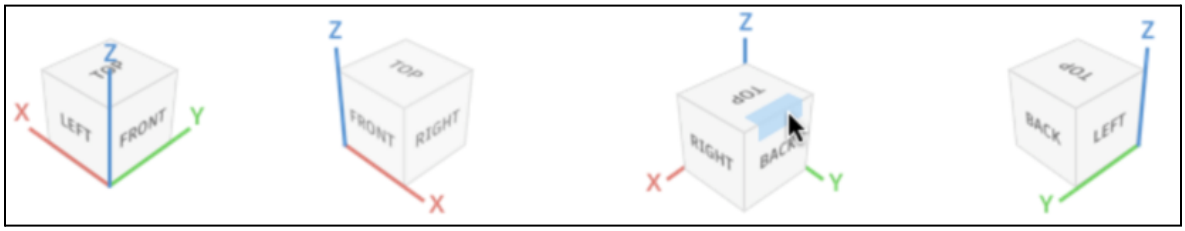
Inserting VEX Parts

*We recommend that you always begin by inserting structure pieces **1st**.*

- **To insert a part**: Click on a part and drag it into your workspace to insert it. *Do not double-click parts; this will edit them*. Move the file where you want it and click OK.
- An individually inserted part will appear below your file name in the File Browser to the left of your build.



Note: The Canvas, or Workspace, consists of the X, Y, & Z axes.

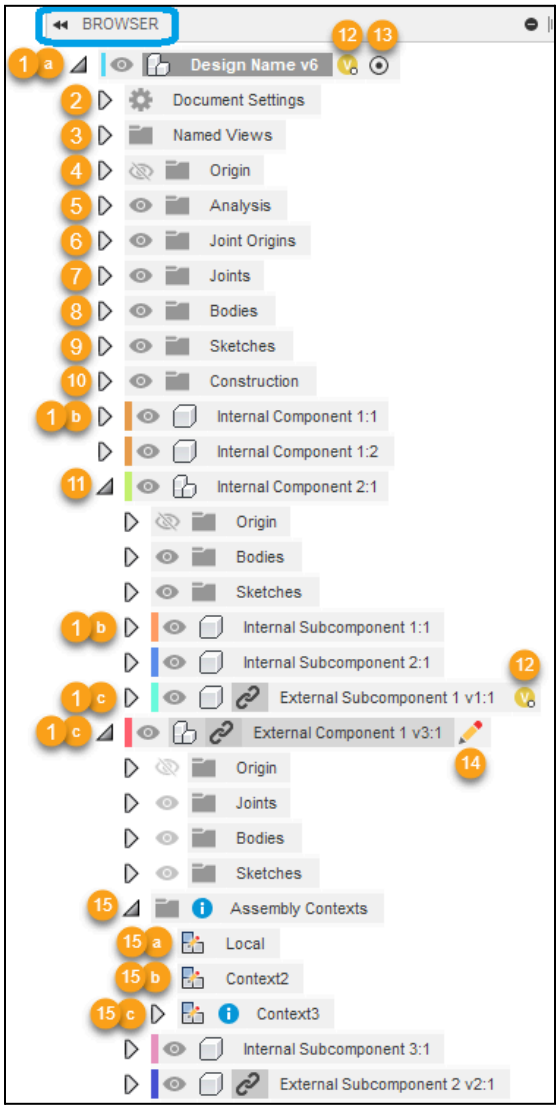


Fusion 360 Assemblies

For Fusion 360 tutorials, click here. There are multiple ways to perform some of the below functions, but this guide will give you the simplest option. As you use Fusion 360 more, you will become more familiar with other methods. Autodesk's website also offers the blog, Autodesk Fusion 360 Basics: The Fundamentals of Assemblies and other similar Getting Started blogs.

Elements of an Assembly

The assembly is organized in the Browser, like this. ➡

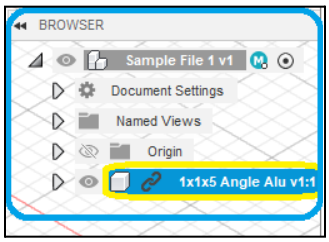


1. **Components**: Contain and organize the elements of your design. All components can contain an origin, construction geometry, sketches, bodies, & joint origins. *Fusion 360 Guide*
   a. **Default Component**: The top component in every design. In addition to the elements that all components can contain, the default component also contains document settings, named views, analyses, and joints for the entire assembly.
   b. **Internal Component**: Contained entirely within the current design.
   c. **External Component (xref)**: Contained in a separate design & referenced into the assembly in the current design. Can contain assembly contexts created during **Edit In Place**.
2. **Document Settings**: Controls the units for the assembly.
3. **Named Views**: Contains all standard and custom-named views for the assembly.
4. **Origin**: Contains the origin point, X/Y/Z axes, and XY/XZ/YZ planes associated with a component.
5. **Analysis**: Contains analyses created in the assembly, including those created with the **Section Analysis** command and surface analysis commands.
6. **Joint Origins**: Contains joint origins associated with a component. *Fusion 360 Guide*
7. **Joints**: Contains joints associated with the assembly, used to define relationships and motion between components.
8. **Bodies**: Contains 3D bodies associated with a component.
9. **Sketches**: Contains design sketches associated with a component, which drive & define bodies.
10. **Construction**: Contains construction geometry associated with a component, which aids the process of creating sketches and bodies.
11. **Subassembly**: Any component with additional components nested within. The top-level component is the **Parent Component**. Any component nested within is a **Child Component**.
12. **Avatar** with **Reservation Badge**: The project member is editing the design or external component, and it is reserved by the project member to prevent design conflicts.
13. **Activated Component**: The component you are currently working on. Click the radio button next to a component to activate it.

14. **Edit In Place**: Activates & edits an external component in context without leaving the current design.
15. **Assembly Contexts**: Contains assembly contexts associated with a component, which define relationships between components during **Edit In Place**.
    a. **Local Context**: This represents an external component as the design would appear if you opened it in its own document tab. It maintains its own set of positions for child components.
    b. **Assembly Context**: The connection between a parent design and an external component at a specific point in time. Holds positional information related to the assembly.
    c. **Out-Of-Sync Assembly Context**: Right-click and select **Synchronize Assembly Context** to update associative design changes.

Grounding a Part

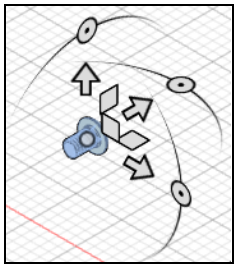
*When *starting* an assembly, you should always ground ONE structure piece after inserting it. This prevents the rest of the parts from moving randomly within your assembly.



- **To ground a part**: Right-click on the part name in the File Browser and select Ground. *Clicking on the file name selects the entire component instead of just its faces or bodies.*
    - The link to the left of the part name specifies that if the original file changes, this will be updated also.

Move/Copy a Part

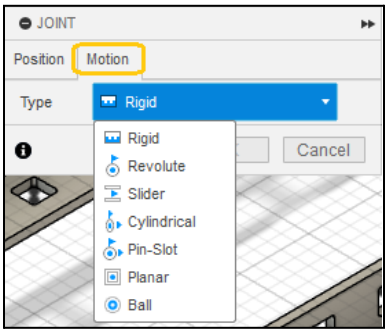
- **To copy a part**: Right-click on the part name in the File Browser and select Copy (or *Ctrl + C*). *Clicking on the file name selects the entire component instead of just its faces or bodies.* Then right-click in your workspace and select Paste/Paste New (or *Ctrl + V*).
    - **Paste** vs. **Paste New**: When copying and pasting parts, keep in mind that if you change an original part, the copied parts may also change.
        - Use the **Paste** command to create an identical copy of a component. *When you change one copy, all of the copies are created using Paste update to reflect the same changes*.
            - An Out-Of-Date icon displays in the following places when a project member saves a new version of the design or component in the assembly. You can update outdated components by right-clicking on them in the Browser.
        - Use the **Paste New** command to create an independent, unique copy of a component. *When you change one copy, none of the copies created using Paste New will update to reflect the changes.*
- **To move a part**: You can simply click and drag a part to a location in your workspaces or click and drag the arrows for the 3 axes.
    - To move a part to a very specific spot, click on the part name in the Browser and press the "M" key to move/rotate it along the 3 axes. ➡

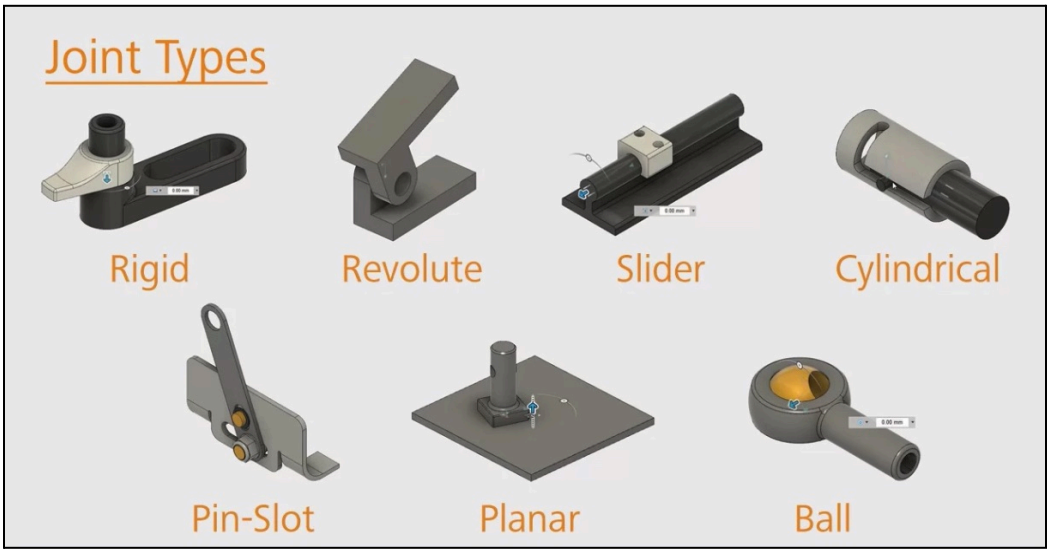


- **To rotate a part**: After clicking on the part name in the Browser and pressing the "M" key, you can rotate a part along the X, Y, or Z axes by dragging the dots in different directions.

Fusion 360 Joints

Joint is the name of a connection/interaction between parts. To change a joint type, click on the Motion tab in the Joint Menu. *It will default to the last used joint type.*



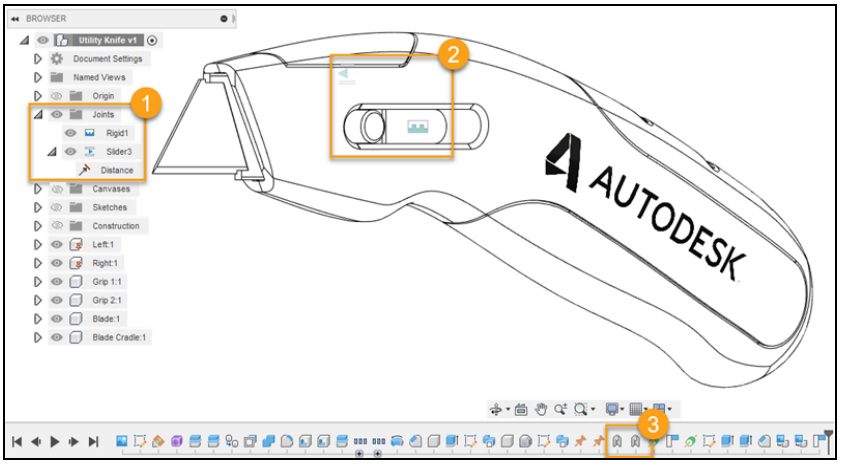


Types of Joints

- **Rigid**: A rigid joint attaches components to one another. It provides no degrees of freedom, so they can't move.
- **Revolute**: A revolute joint has a single rotational degree of freedom, much like a hinge. This joint can rotate around the standard X, Y, or Z axis, or around an edge in the model (a custom axis).
- **Slider**: A slider joint has a single translational degree of freedom. It is used for components that slide along one another. *Options are similar to revolute joint options, except that components slide along the selected axis rather than rotating around it.*
- **Cylindrical**: A cylindrical joint provides two degrees of freedom: one translational and one rotational. Components joined with a cylindrical joint always rotate around the same axis.
- **Pin Slot**: A pin slot joint also allows two degrees of freedom, but components can rotate around different axes.
- **Planar**: A planar joint allows three degrees of freedom. It allows two directions of translation in a plane and a single rotational direction normal to that plane. It is useful for joining two components so they can rotate while sliding across the plane.
- **Ball**: A ball joint has two degrees of rotational freedom: pitch and yaw. Pitch allows components to rotate around the Z axis. Yaw rotates components around the X-axis.

Elements of a Joint

A Joint is a connection between 2 parts or components. There are 3 access points where you can interact with joints you create in an assembly: **1**- In the Browser, within the Joints folder. **2**- In the Canvas, directly on components, by the Joint type icons. **3**- In the Timeline; as pictured. ➡



Note: In the **Browser**, each component has its own **Joints** folder. You can use the **Assemble** panel to create and modify joints:

- **Joint** : Creates a joint between components that are not yet positioned in relation to each other.
- **As-Built Joint** : Creates a joint between components that are already positioned in relation to each other.
- **Joint Origin** : Creates and positions a joint origin on a component.
- **Rigid Group** : Locks components together so that they move together in an assembly.
- **Tangent Relationship** : Creates a tangent relationship between a face on a body in one component and a set of connected faces on a body in another component within an assembly.
- **Drive Joints** : Modifies joint motion inputs, like rotation angle and distance, to control degrees of freedom.
- **Motion Link** : Links the motion of 2 joints together.

You can right-click any existing joint in the Browser and modify it:

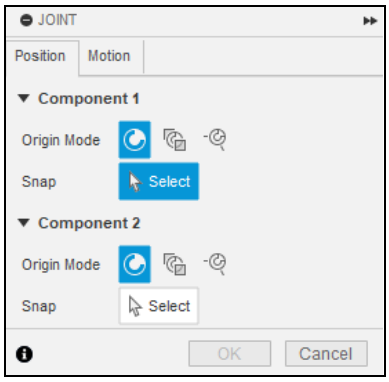
- **Edit Joint**: Opens the **Edit Joint** dialog and lets you edit all settings associated with the joint.
- **Edit Joint Limits**: Opens the **Edit Joint Limits** dialog and lets you edit the minimum, maximum, and rest limits of the joint.
- **Lock**: Locks the current position and settings of the joint.
- **Suppress**: This *temporarily* removes the joint to prevent it from acting upon the components.
- **Animate Joint**: Animates the single joint.
- **Animate Model**: Animates all joints in the assembly.

Fusion 360 Joint Guide Links

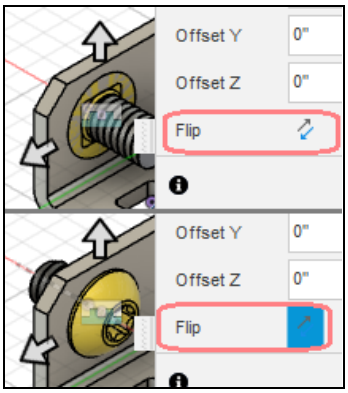
- Joint types
- Joint
- Duplicate With Joints
- As-built joints
- Joint origins
- Edit joints
- Joint Motion Limits
- Insert a subassembly & create joints
- Create a tangent relationship
- Drive Joints reference
- Motion Link reference
- Rigid groups

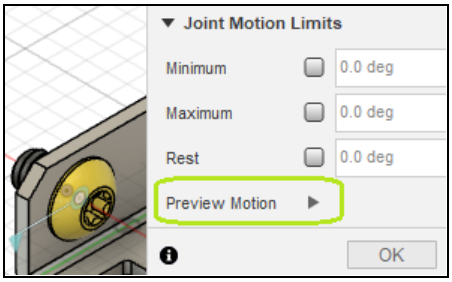
Creating a Joint (Attaching Components)

Make sure both parts that need to be assembled are already inserted into your workspace. See Joint Tutorials here. We found that it is best to create joints ***before*** putting parts into subcomponents.



- In the SOLID tab, click on the Joint icon above the "Assemble" section. *Or press "J" to start a joint.*
  - *Component 1* is the part that you want to move.
  - *Component 2* is the part that you want to connect it to.
- Be very careful when selecting a joint origin.
- When selecting a rounded area, move your mouse around the outermost circle to select its center point.
- If a joint comes together on the opposite side of what you want, click on "Flip" in the Joint menu.
- The Joint menu also allows you to *offset* different axes to add space between [arts.
- Motion joints allow you to set *motion limits* which prevent a part from rotating past a certain point. You can also preview this motion to ensure it is moving correctly play clicking the play button next to Preview Motion.





Contact Sets

Contact sets can be applied to components in a design so that they only move when they come into contact with one another. They use physical contact between components to limit movement. If interference is detected, the components do not move. *This method requires more computation than a motion joint.*

- **Enable Contact Sets**: Activates contact analysis between components in contact sets. Contact sets are managed in the browser.
- **Disable All Contact**: Turns off contact analysis for all components.
- **Enable All Contact**: Activates contact analysis for all components.
- **New Contact Set**: Creates a contact set between selected components. Select the bodies or components to participate in the contact analysis.

Contact sets manage which components are evaluated for contact when moving. They constrain components so that they cannot pass through each other, and thus behave as they would in the real world. For example, you can constrain a component to revolve around a joint but not pass through its bracket.

The **Enable All Contact** command analyzes contact between all components in the design

regardless of contact sets. The number of components in an assembly affects the performance.

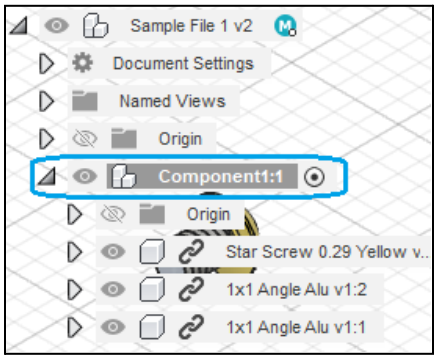
The **New Contact Set** command constrains components that you specify for the contact set.

The **New Contact Set** command sets contact analysis between the selected components. Contact sets prevent parts from passing through one another.

The **Drive Joints** command shows exactly where the motion occurs and displays the limits of the component's movement in the component assembly.

Fusion 360 Components

Components (or Subcomponents) are a collection of parts within an assembly. The parts within Component1 are listed below it. Assemblies can be made up of multiple components. It is best to create components ***after*** jointing all parts.



Each component is capable of motion and has its own unique:

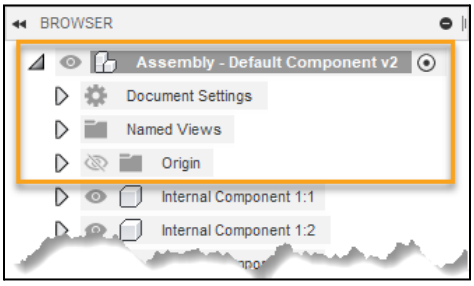
- Origin
- Coordinate system
- Timeline
- Name, number, and description that will display in a parts list

All components can contain the following elements:

- Origin
- Construction geometry
- Sketches
- Bodies
- Joint origins
- Other components

The top node in the **Browser** is the **Default Component** that exists in every design. These elements are always located in the default component:

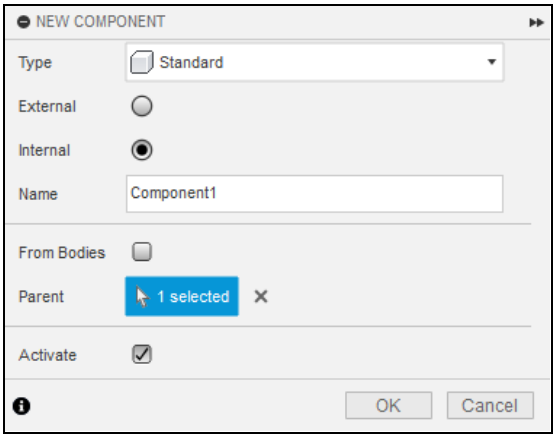
- Document settings
- Named views
- Analyses
- Joints
- Contact sets
- Motion studies



Create a New Component

1. In the browser, right-click the default component.
   You can also access the **New Component** command on the toolbar, in the **Create** or **Assemble** panels. The **New Component** dialog displays.
2. In the **New Component** dialog, select the component **Type**: **Standard**

3. Enter a unique **Name** for the new component.
4. Select the location to create the new component, relative to the design:
    - **Internal**: Created and contained in the current design.
        - **Parent**: The new component is created within the parent component. The active component is automatically selected as the parent. To change:
            a. Click the **X** to clear the selection.
            b. In the **Browser**, click to select the new parent component.



    - **External**: Created and contained in a separate design, then referenced into the assembly in the current design.
        - **Location**: The new design that will contain the new component is saved here. The current project folder is automatically selected. To change to location:
            a. Click the folder name.
            b. In the **Select Folder** dialog, navigate to the new location where you want to save the design.
            c. Click **Select**.

For **Internal Components**:

- The new component displays in the browser beneath the parent component you selected.
- If the **Activate** setting was checked, the component is automatically activated, so that you can start working on the new component.

For **External Components**:

- In the **Data Panel**, the new design is created in the project folder you selected.
- The new component is referenced into the current design and displays in the browser beneath the parent component you selected.
- If the **Activate** setting was checked, the component is automatically activated, and an **Edit In Place** session begins so that you can start working on the new component in the context of the current design.

Create a Component *Within* Another Part

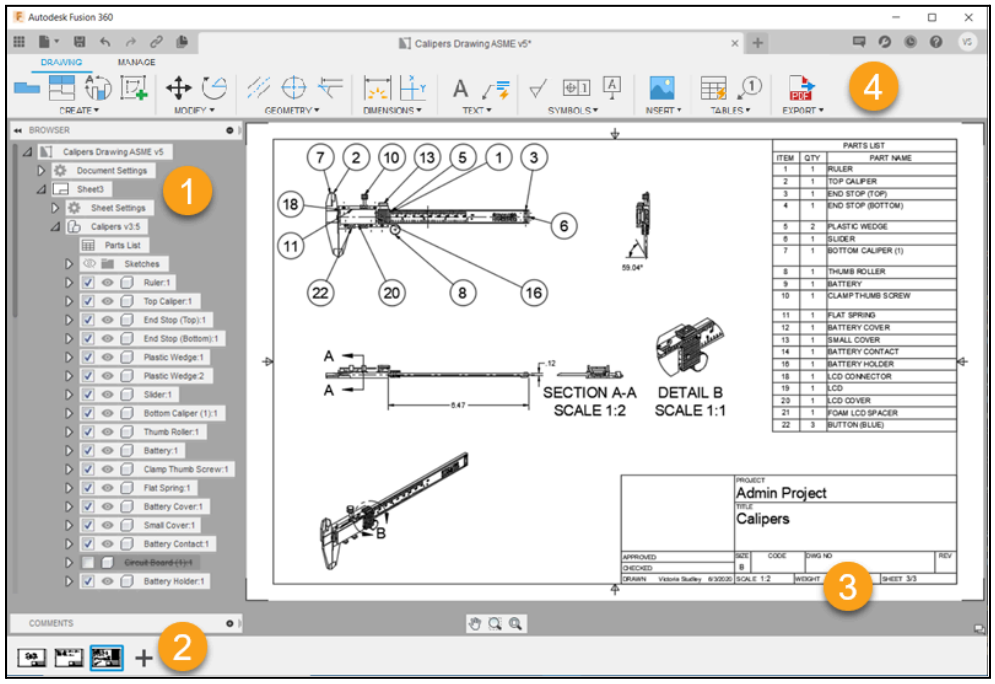
If doing this with a linked part or component, you will have to break the link to its original design by right-clicking on it in the Browser and selecting Break Link. This is **extremely** useful when building bases to help duplicate subcomponents like wheels, gearing, etc.

- In the Browser, hold Ctrl and Select all parts that you want to contain within a component (without selecting the parent component).
- Drag the selected parts on top of the name of the parent component that you want them to merge into. This will create a component within the parent part so that you can simply click on its name to select all parts contained within it.

Fusion 360 Drawings

A drawing is a set of sheets that document a design using scaled 2D orthographic and isometric views, annotations, tables, etc.

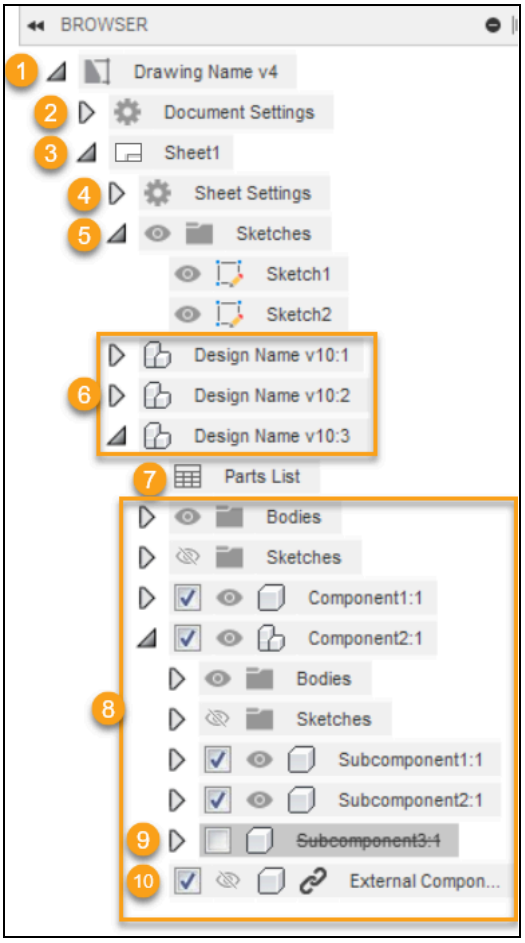
Elements of a Drawing



1. **Browser**: Presents an organized view of the data in your design. You can control document settings, sheet settings, component suppression, and component visibility.
2. **Sheets**: Represent portions of a design, with annotations and tables, sized to print within a drawing set.
3. **Title Block** and **Border**: Displays information about the current sheet and a border around the perimeter.
4. **Toolbar** commands:
    - **Create**: Display 2D projections of a 3D design on a sheet. The first view you place is the base view. You can project additional views from the base view.
    - **Modify** tools: Move, rotate, and delete objects on a sheet.
    - Annotation **Geometry**: Add center marks, center lines, edge extensions, and drawing sketches to a sheet.
    - **Dimensions**: Measure geometry displayed on a sheet.
    - **Text** and **Leaders**: Point to, label, and annotate important elements on a sheet.
    - **Symbols**: Add surface texture, feature control frame, and datum identifiers to a sheet.
    - **Image**: Add supplemental PNG, JPG, OR TIF images to a sheet.
    - **Tables**: Add a parts list with numbered balloons and bend identifiers to a sheet.
    - **Export**: Generate a drawing set in PDF, DWG, or DXF format. Generate a parts list in CSV format.

Drawing Browser

In the Drawing workspace, the Browser presents an organized view of the data in your design.



1. **Drawing**
   - View the drawing name and current version.
   - Document settings and the current sheet node display beneath this node.
2. **Document Settings**
   - View and edit the document settings for the current drawing, including the drawing standard, units, text settings, dimension settings, and line widths.
3. **Current Sheet**
   - View the current sheet name.
   - Current sheet settings, drawing sketches on the current sheet, and references on the current sheet display beneath this node.
4. **Sheet Settings**
   - View and edit the sheet settings on the current sheet, including sheet size, title block, and border.
5. **Drawing Sketches**
   - View, rename, edit, delete, or toggle visibility for drawing sketches on the current sheet.
6. **References**
   - View and edit references that are displayed on the current sheet.
   - Control component visibility and suppression for each reference node separately.
7. **Parts Lists**
   - View, edit, or delete the parts list associated with the reference.
8. **Components, Subcomponents, Bodies, and Design Sketches**
   - Toggle visibility for components, subcomponents, bodies, and sketches in all drawing views associated with the reference.
   - Toggle suppression for components and subcomponents in all drawing views and parts lists associated with the reference.
9. **Suppressed Component**
   - Does not display in drawing views associated with this reference.
   - Does not display in parts lists associated with this reference.
10. **Hidden Component**
   - Does not display in drawing views associated with this reference.
   - Displays in parts lists associated with this reference.