Benha Faculty of Engineering
Mechanical Engineering Department

M1382 : **Computer Aided Design CAD**

First Semester 2018, Y3

Lecture No. 05

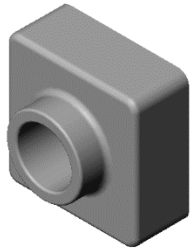
Presented by:
Mahmoud Magdy

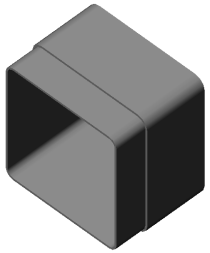
Week	Topics
1	Introduction
2	Introduction to CAD (Solid Modeling)
3	Part modeling
4	Finite element analysis (FEA)
5	**Parts assembly using SolidWorks**
6	Basic concepts of engineering drafting
7	Linear Static Analysis
8	Adaptive Analysis and Mesh Control
9	Modal Analysis
10	Design Optimization
11	Case study 1
12	Case study 2
13	Co-simulation SolidWorks and ADMS software
14	Project Discussion

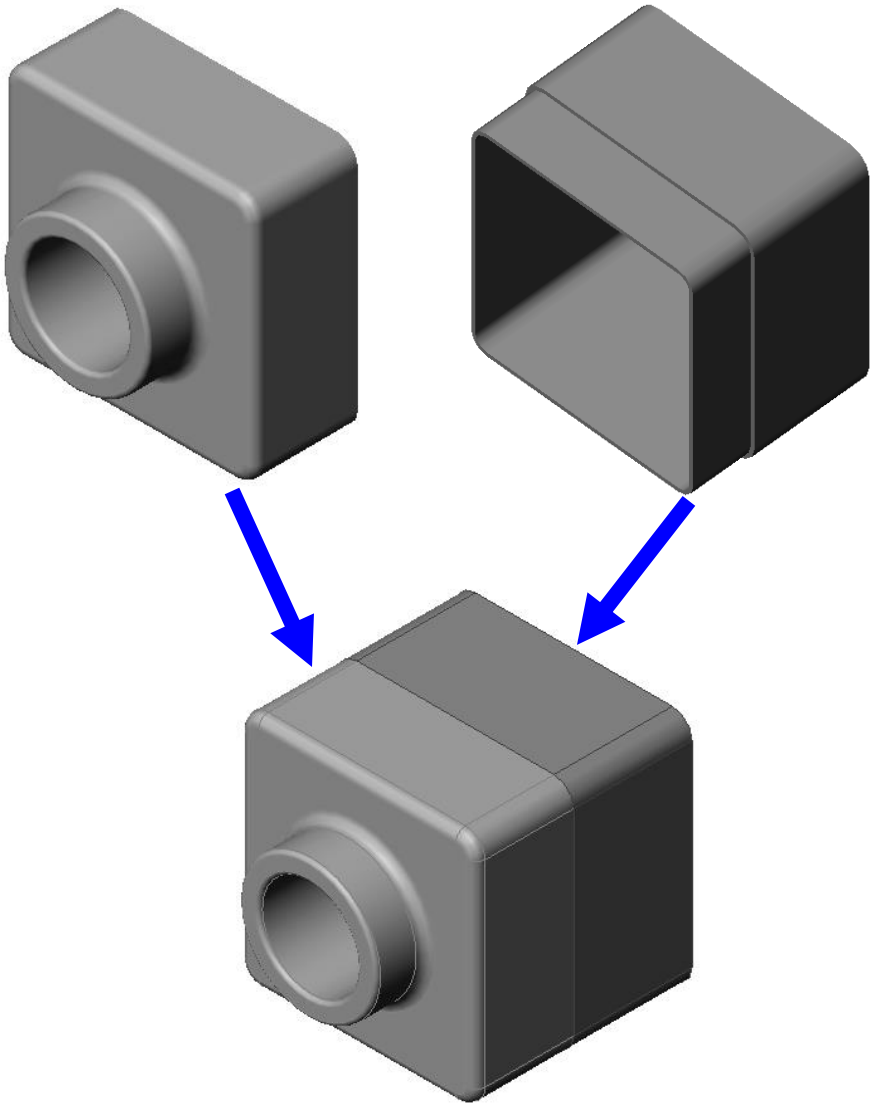
Assembly Modeling Constraints

Tutor Assembly

- **The *Tutor* assembly is comprised of two parts:**
  - *Tutor1*
  - *Tutor2*





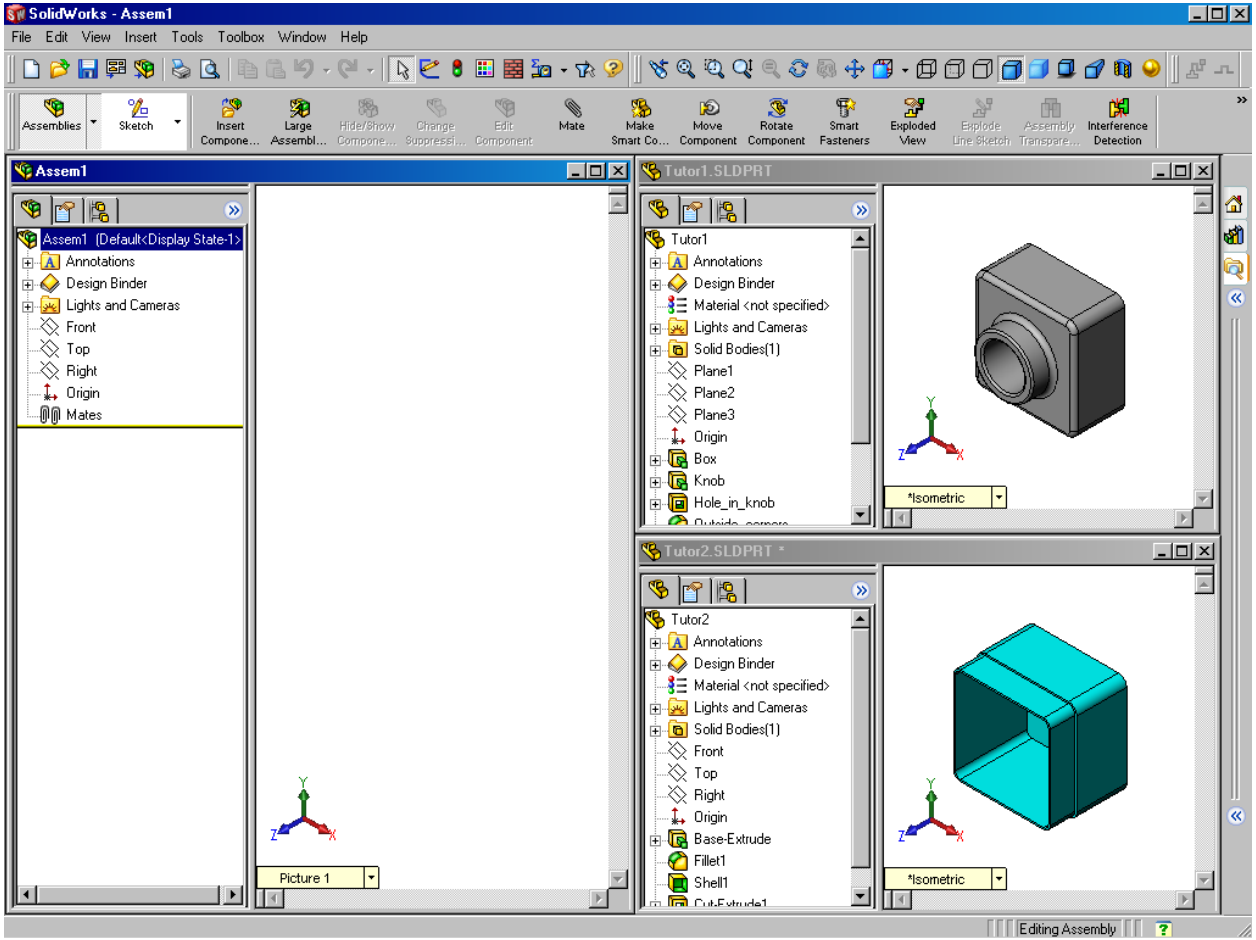


Assembly Basics

- An assembly contains **two or more parts.**
- In an assembly, parts are referred to **as *components***.
- **Mates** are relationships that align and fit components together in an assembly.
- Components and their assembly are directly related through **file linking.**
- **Changes** in the components **affect** the **assembly**.
- **Changes** in the **assembly** affect the **components**.

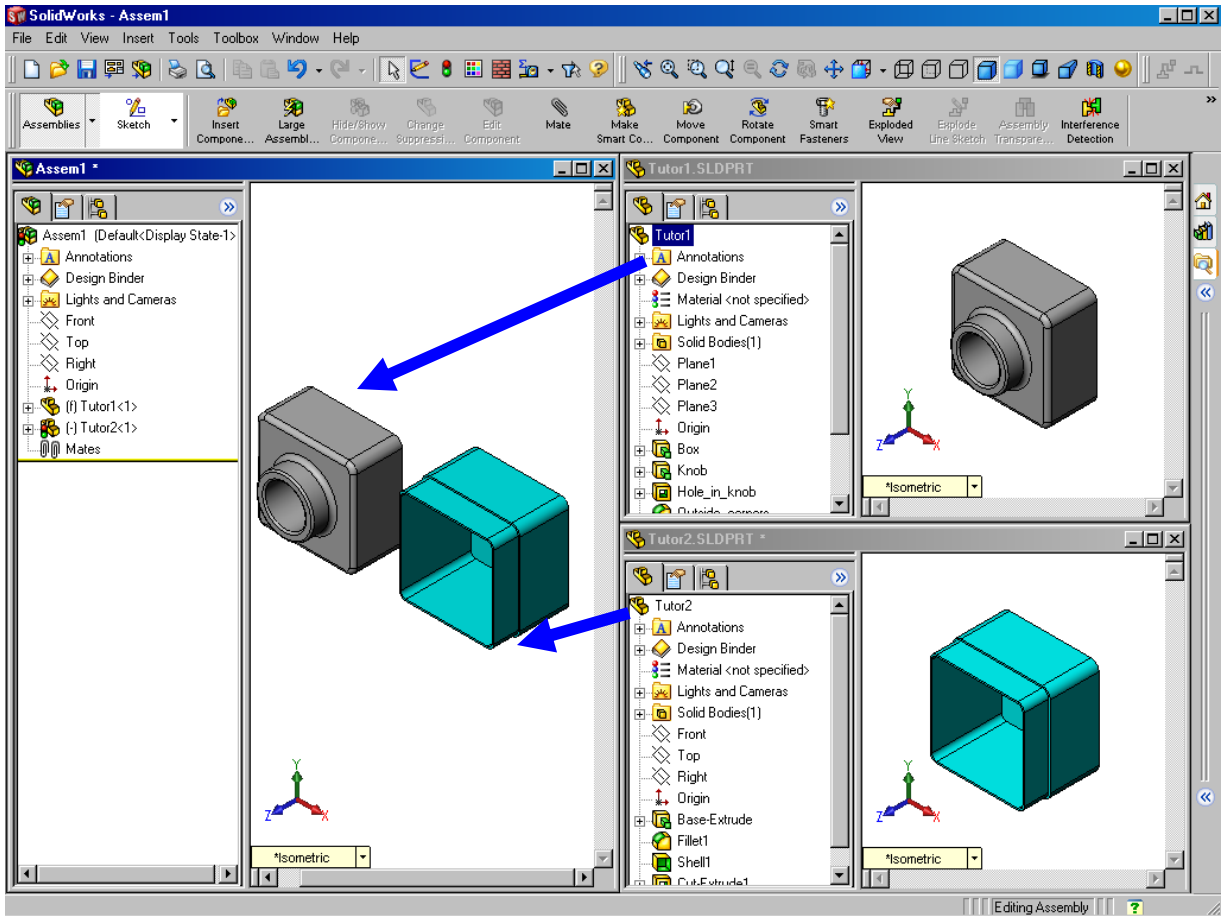
To create the Tutor assembly

1. Open a new assembly document template.
2. Open ***Tutor1***.
3. Open ***Tutor2***.
4. Arrange the windows.



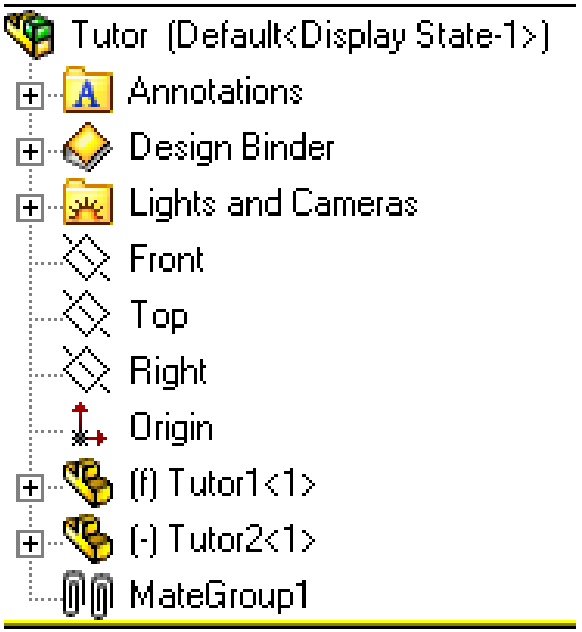
Creating the Tutor assembly

5. Drag and drop the part icons into the assembly document.



Assembly Basics

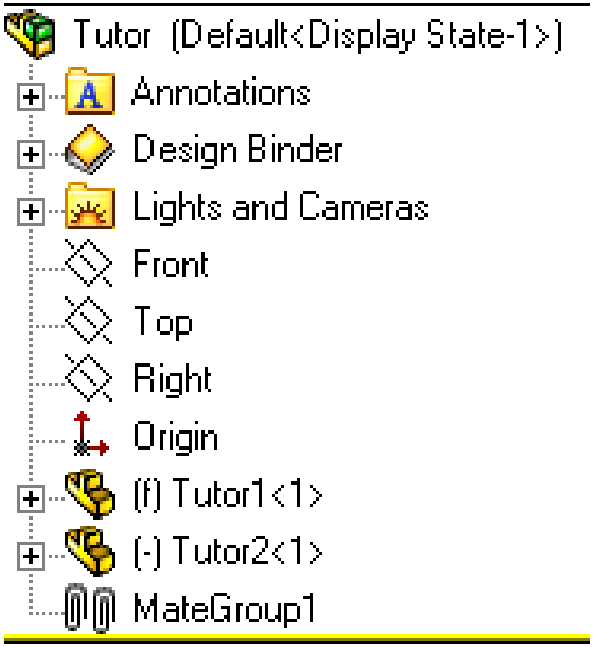
- The first component placed into an assembly is **fixed**.
- **A fixed** component cannot move.
- If you want to move a fixed component, you must **Float** (unfix) it first.



- Tutor1 is added to the Feature Manager design tree with the symbol (f).
- The symbol (f) indicates a fixed component.

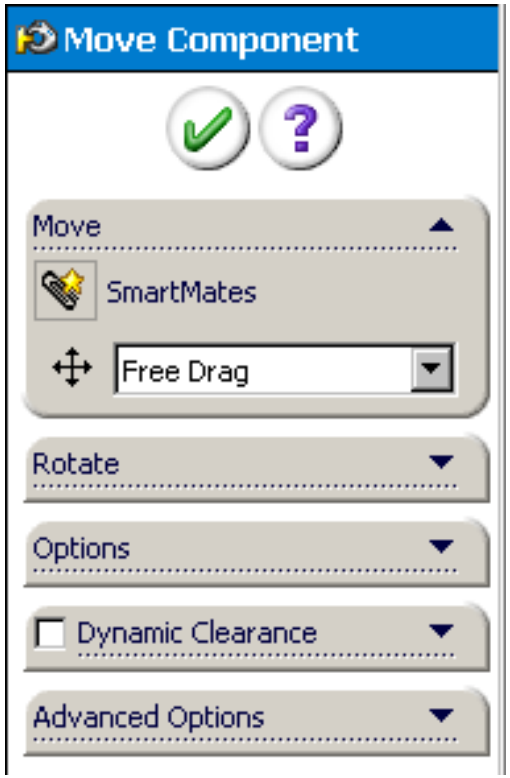
Assembly Basics

- Tutor2 is added to the Feature Manager design tree with the symbol (-).
- The symbol (-) indicates an under defined component.
- Tutor2 is free to move and rotate.



Manipulating Components

- Move components by dragging.
- Move components with a triad.
- Move Component – translates (moves) the selected component according to its available degrees of freedom.



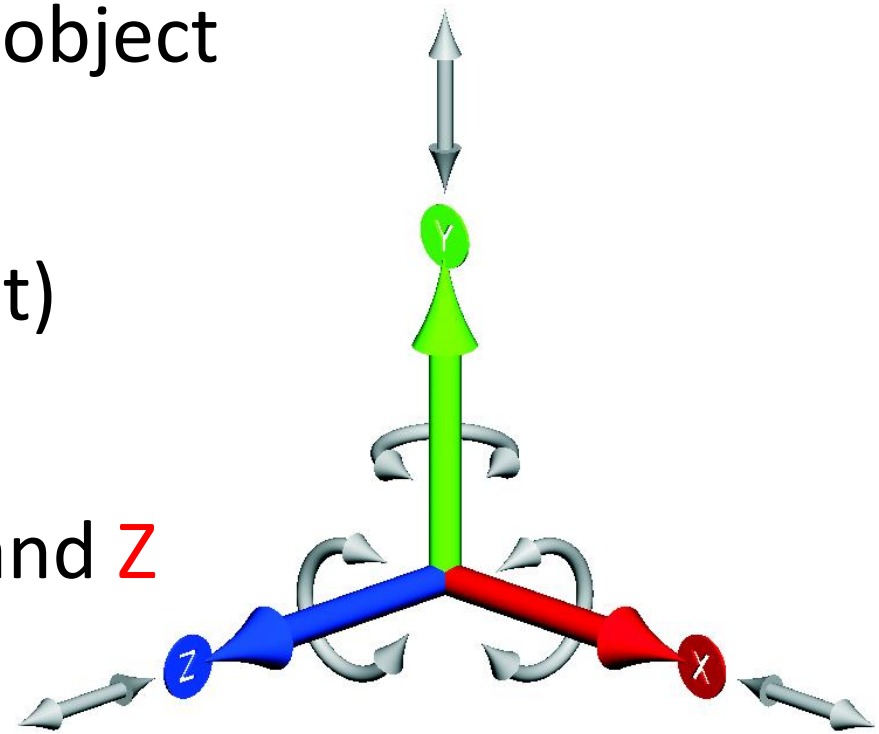
Manipulating Components

- Rotate components by dragging.
- Rotate components with a triad.
- Rotate Component  – rotates the selected component according to its available degrees of freedom.

Degrees of Freedom

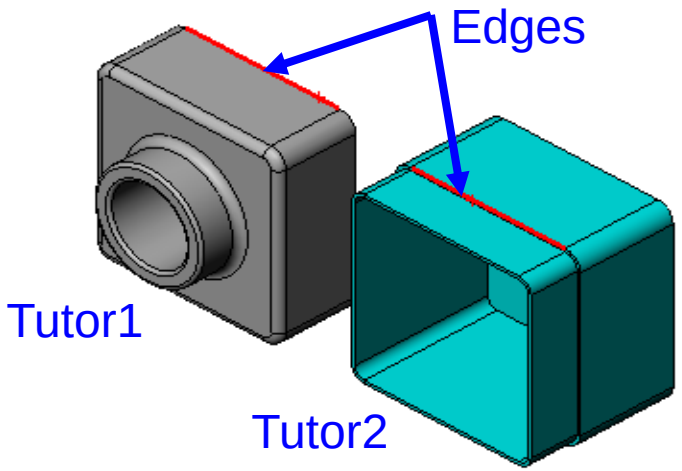
6 - DOF

- They describe how an object is free to move.
- Translation (movement) *along* X, Y, and Z axes.
- Rotation *around* X, Y, and Z axes.



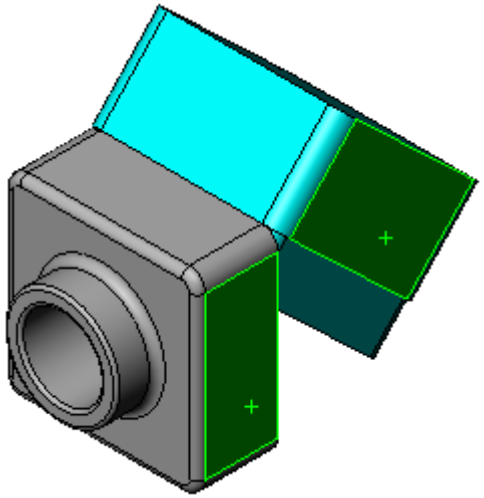
Mate Relationships

- Mates relationships align and fit together components in an assembly.
- The ***Tutor*** assembly requires three mates to fully define it. The three mates are:
- **First Mate** : Coincident between the top back edge of *Tutor1* and the edge of the lip on *Tutor2.*

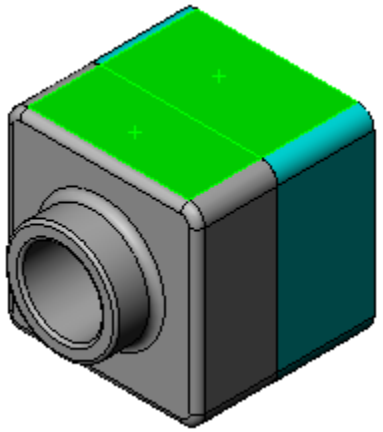


Mate Relationships

- **Second Mate:** Coincident mate between the right face of Tutor1 and the right face of Tutor2.



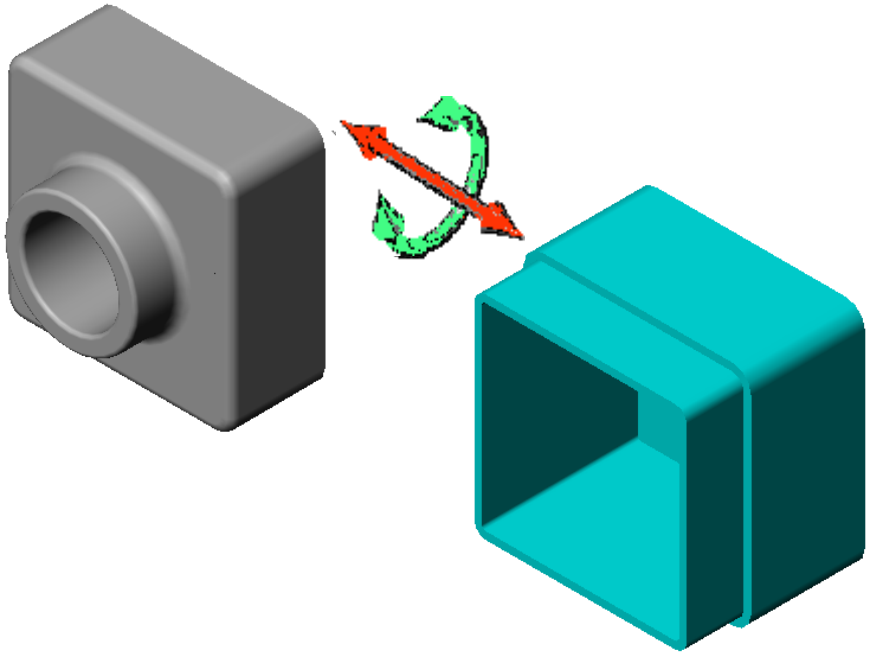
- **Third Mate:** Coincident mate between the top face of Tutor1 and the top face of Tutor2.



Mates and Degrees of Freedom

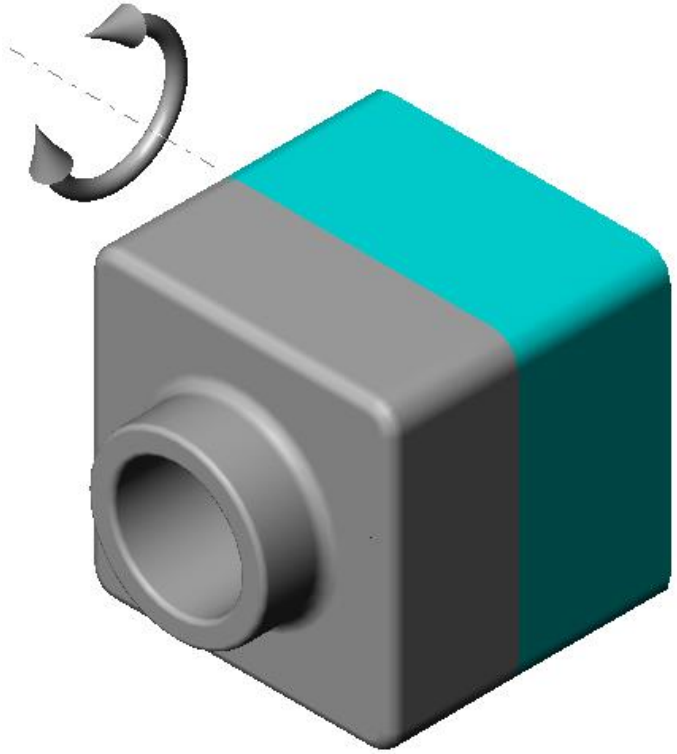
- The first mate removes all but **two degrees** of freedom.

- The remaining degrees of freedom are:
  - **Movement *along* the edge.**
  - **Rotation *around* the edge.**



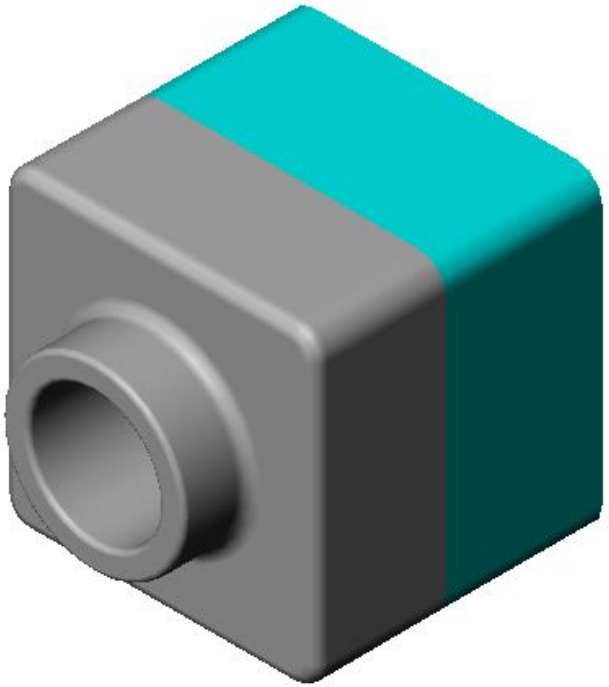
Mates and Degrees of Freedom

- The second mate removes one more degree of freedom.
- The remaining degree of freedom is:
  - Rotation *around* the edge.



Mates and Degrees of Freedom

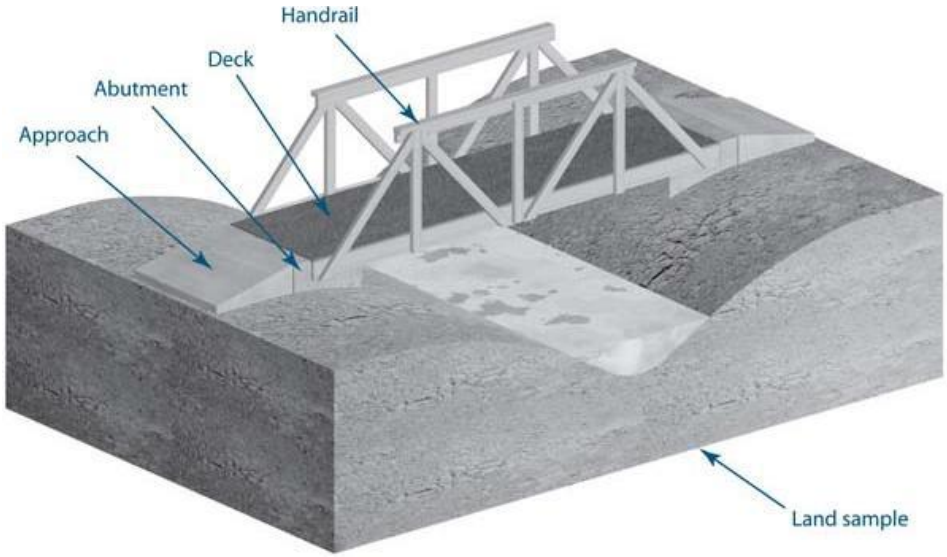
- The third mate removes last degree of freedom.
- No remaining degrees of freedom.
- The assembly is fully defined.



Assemblies

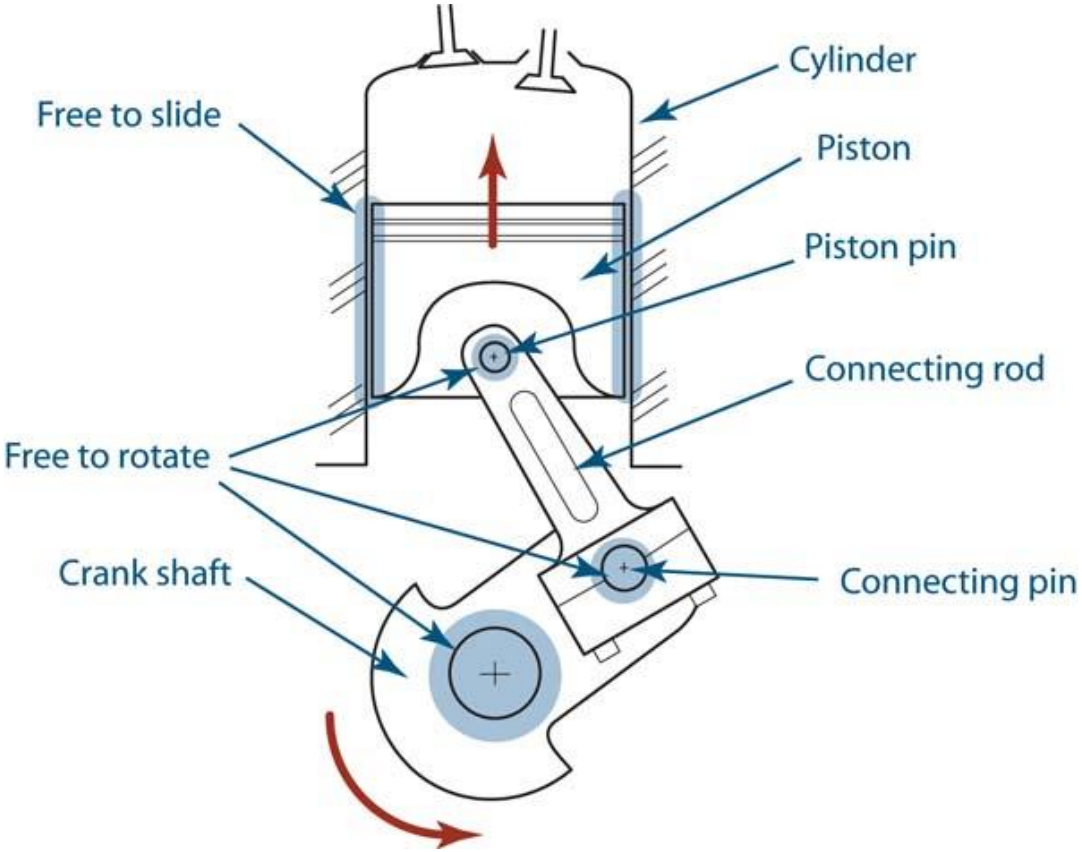
Assemblies are collections of 3D parts that form one engineering system

1. Modeled to Fit Together
2. Location defined by 6 degrees of freedom
   - 3 translational (x,y,z)
   - 3 rotational (about x,y,z axes)
3. Assembly Constraints
   - Concentric
   - Mating Surfaces
   - Coincident
   - Distance



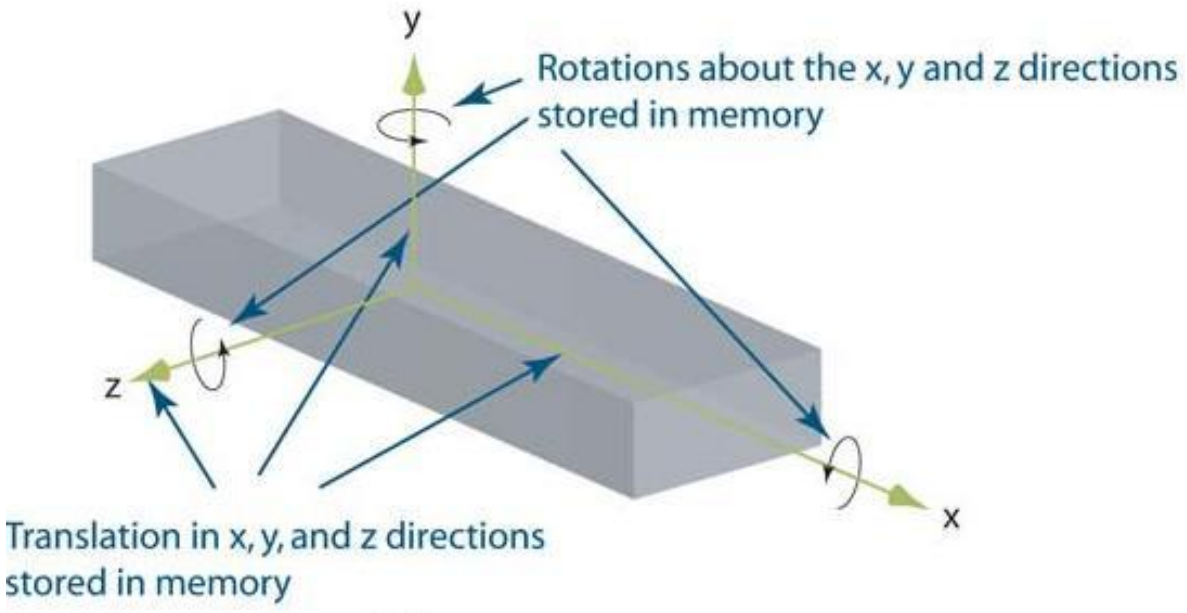
Modeled to Work Together

- Compatible Components
  - Dimensional constraints
- Assembly Constraints
- Operational Requirements



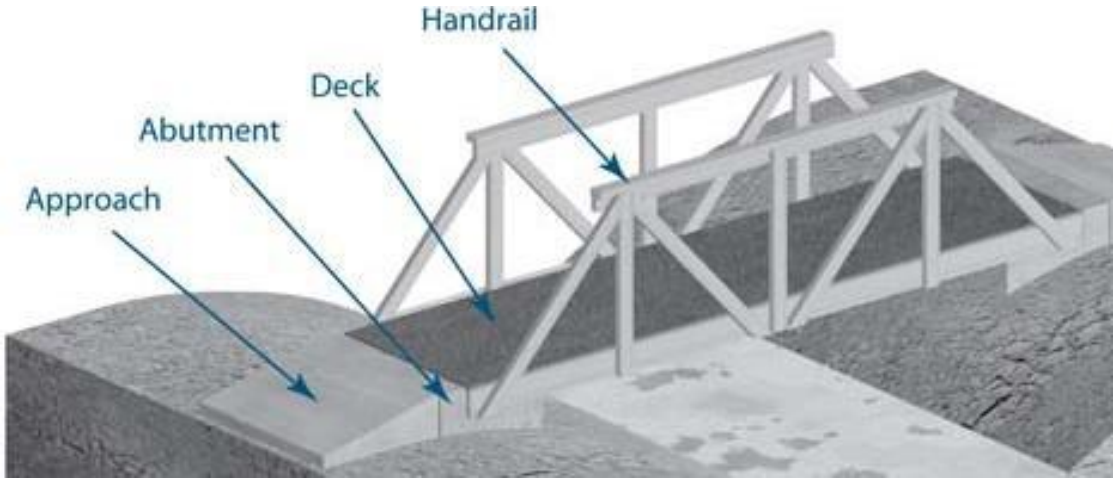
Defining Location

- 6 degrees of freedom constrain an instance of a part file
- X,Y,Z Translation
- X,Y,Z Rotation



Assembly Constraints

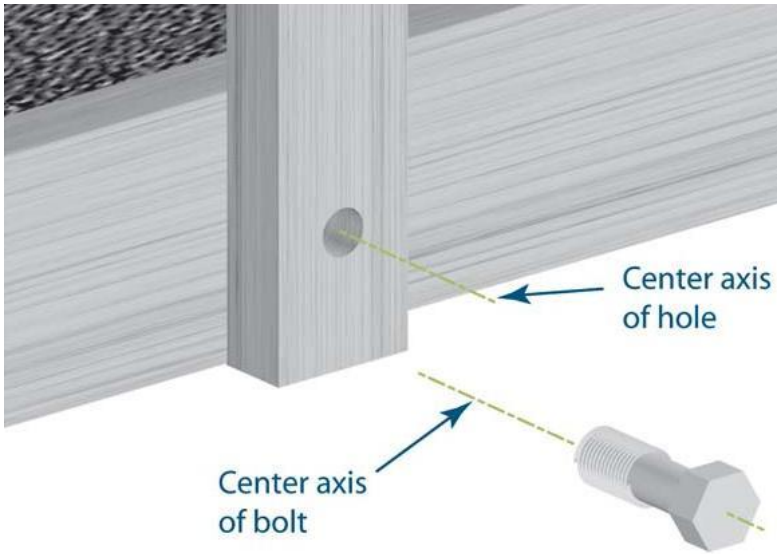
- Concentric
- Mating Surfaces
- Coincident
- Distance



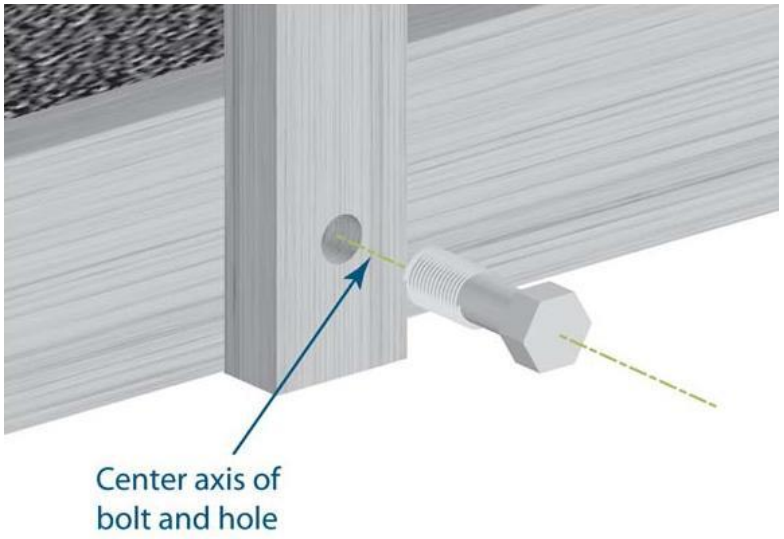
The bridge example will be used to demonstrate these core concepts

Concentric Constraints

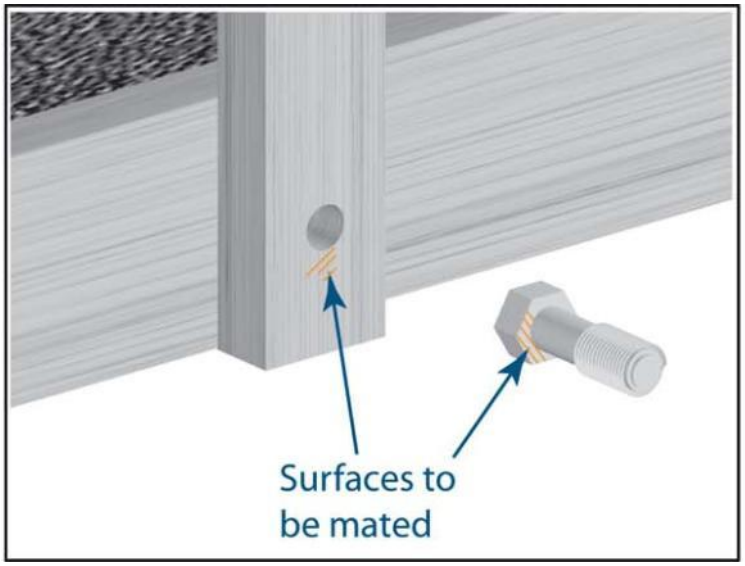
Axes of cylindrical features and holes can be selected



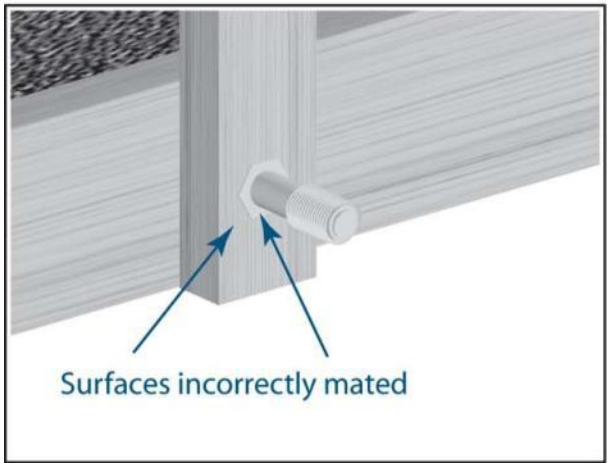
Concentric constraints align centerline axes

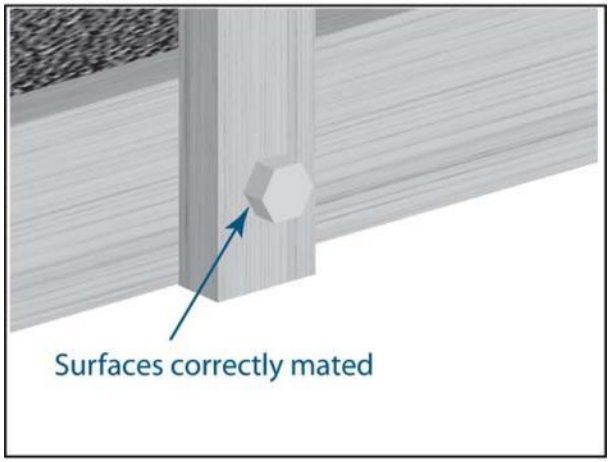


Mating Surfaces



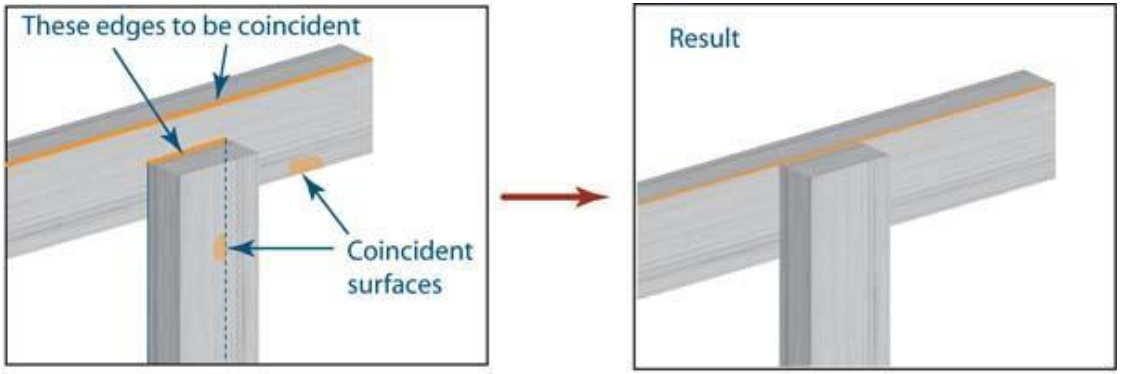
2D surfaces can be mated to become flush with one another but the correct direction must be given to the computer



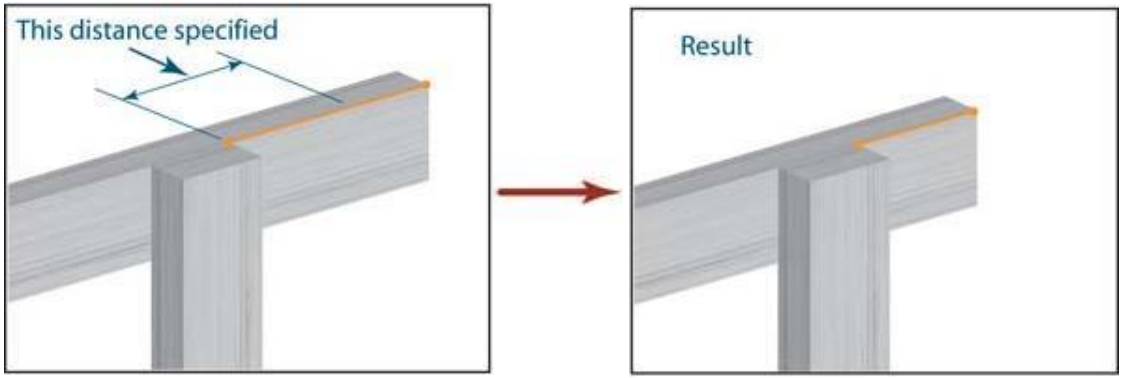


Additional Constraints

Coincident Lines or Vertices

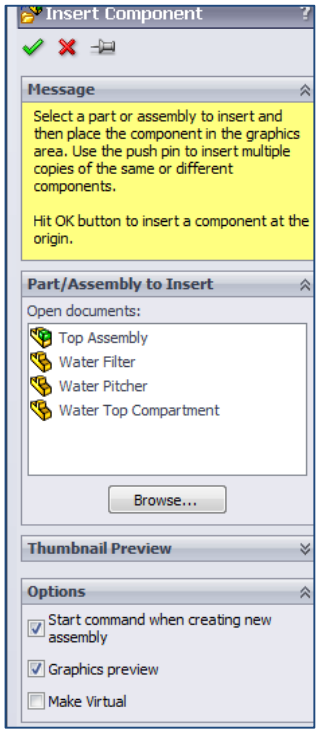


Distance between entities if not flush



Solid Works Adding Components

In the Assembly tab (similar to the Features tab of a Part file) use the Insert Components button to add part files to this assembly

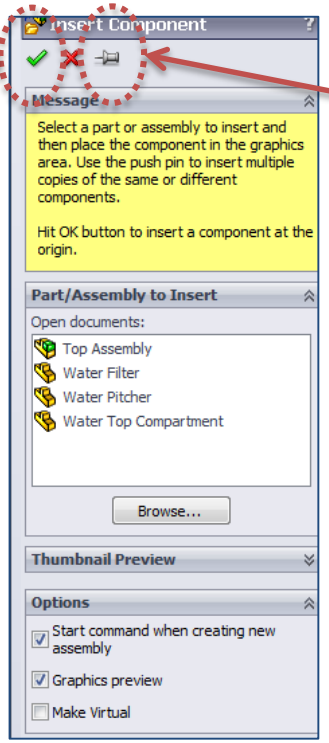


Select from the open parts listed or use the Browse to find saved files

Solid Works Adding Components

The first part inserted will become fixed in space and should be placed at the origin as a base for the assembly.

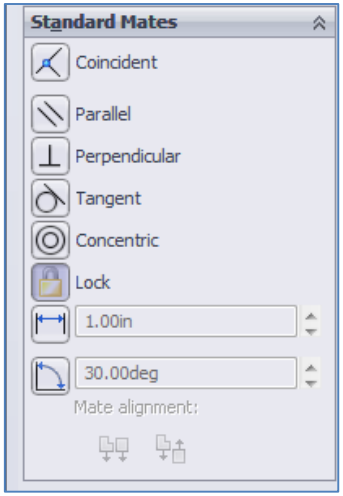
This is done by selecting the part and then clicking the **green check mark** to default to the origin instead of just clicking in space.



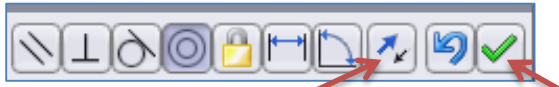
Select the pin to keep the Insert Component dialog box open after a component is added

Solid Works Constraints

In Solid Works these are the Standard Constraints used in Assemblies



In the figure window it will show a preview of the mating and a smaller dialog box will appear

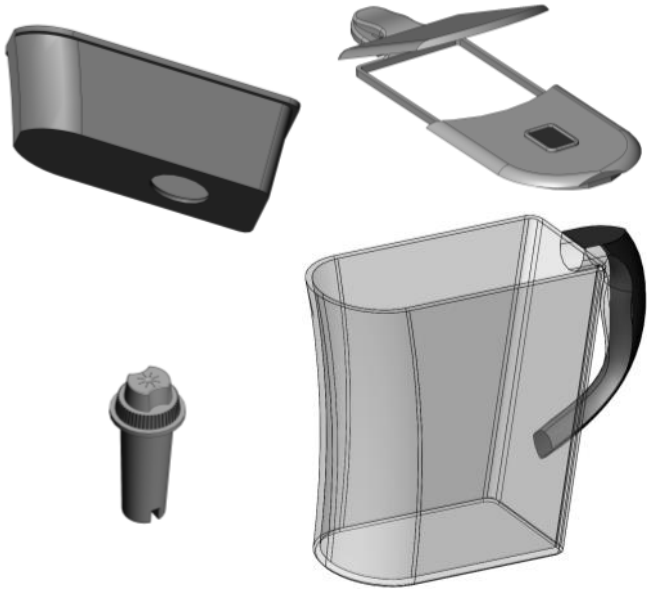


Change Direction

Confirm Mate

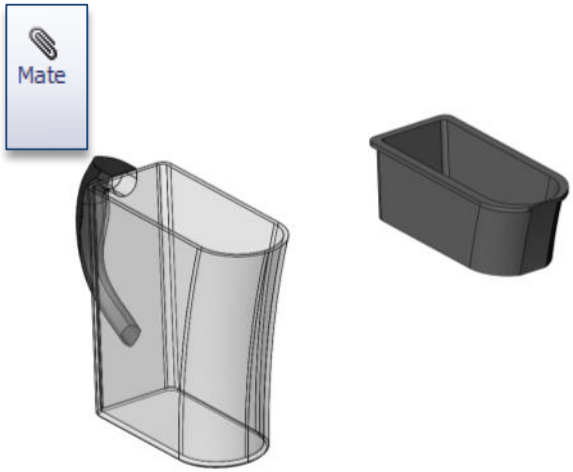
Solid Works Example

Assembly of a water filtering pitcher

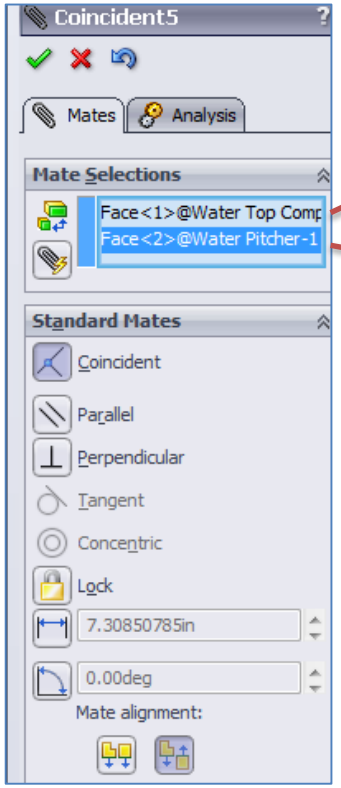


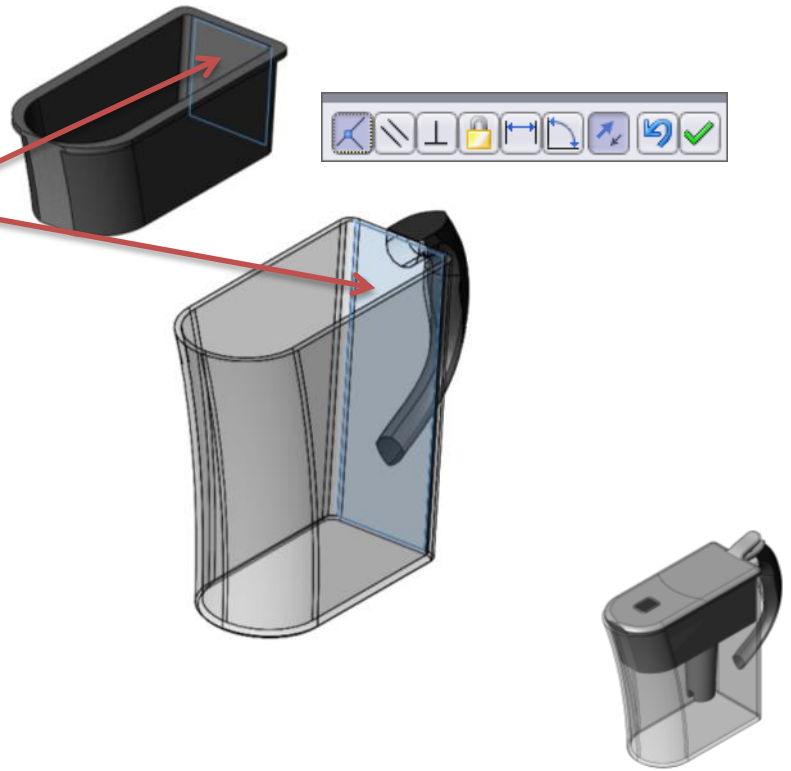
- http://youtu.be/1s-1CUoq1zE

Water Pitcher Example

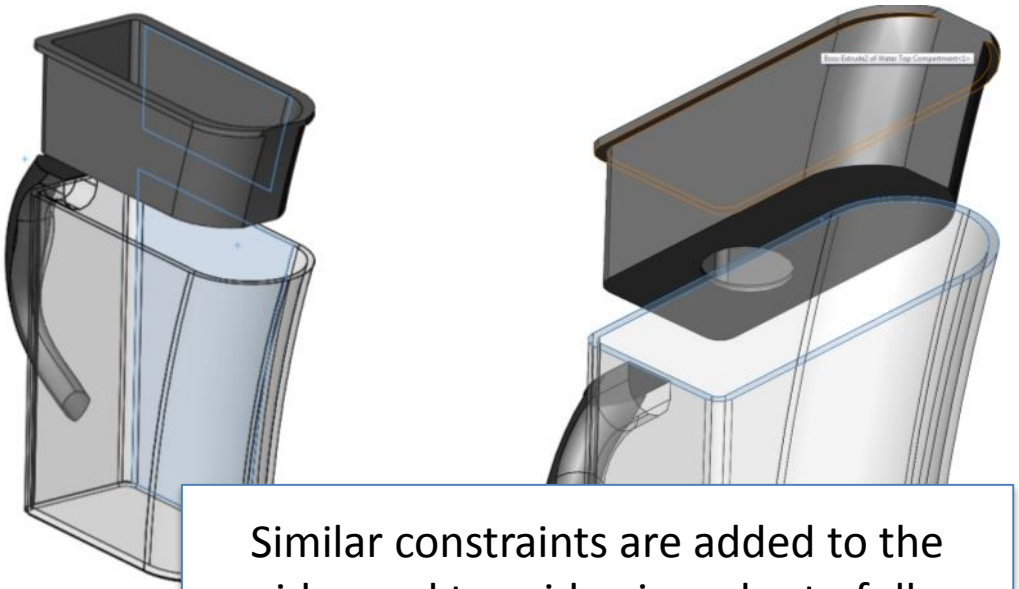


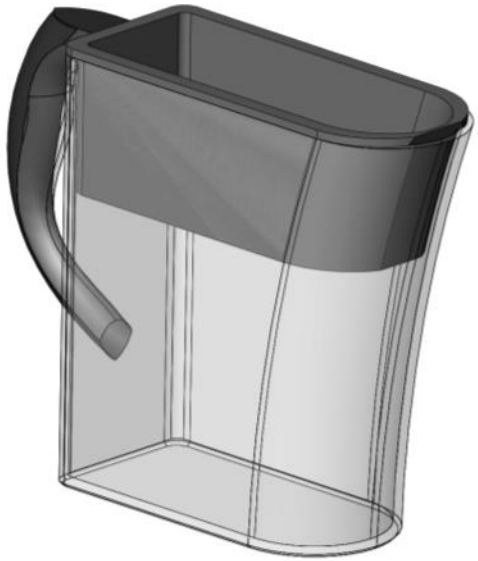
To start lets bring in the pitcher and top compartment and mate their two back surfaces

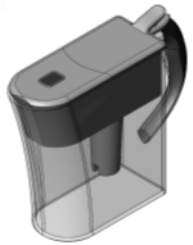




Water Pitcher: Top Compartment

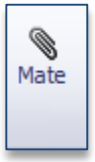


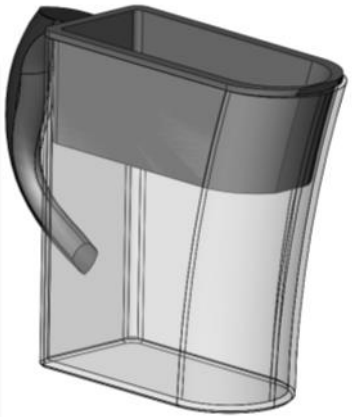


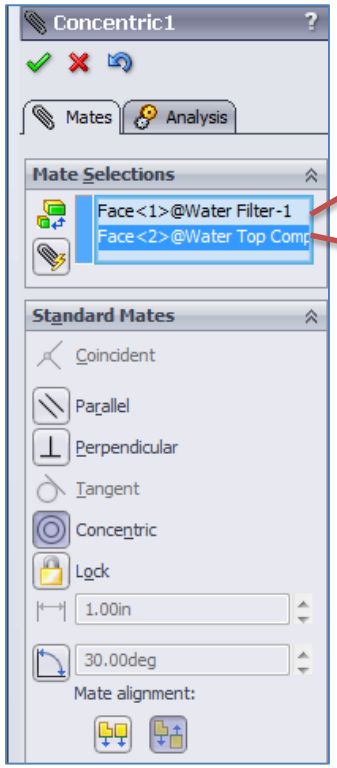


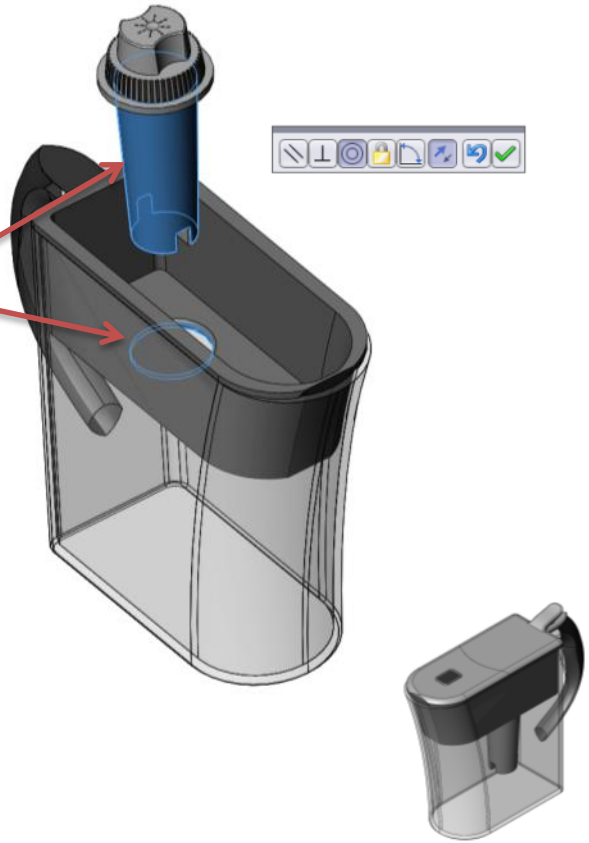
Similar constraints are added to the sides and top ridge in order to fully constrain the top compartment

Water Pitcher: Filter



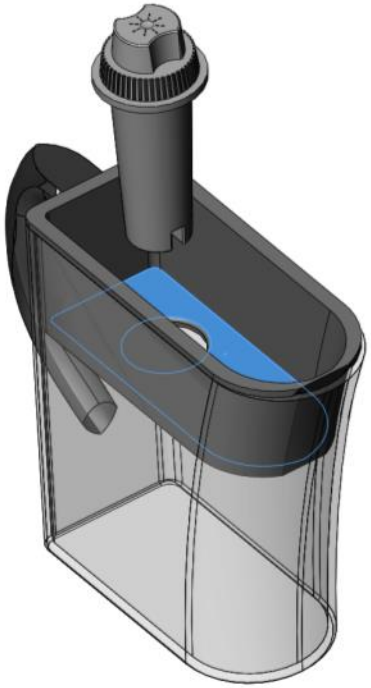


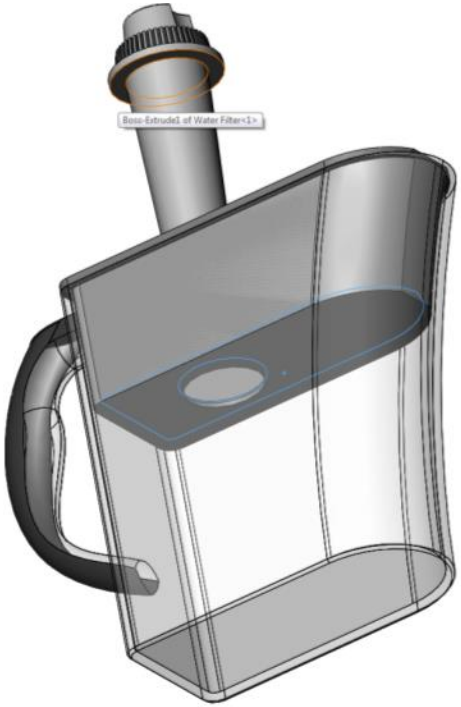


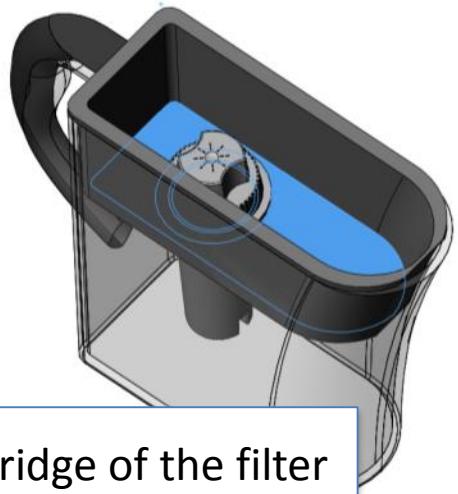


Now lets add to our assembly the water filter which fits into the circular hole of the top compartment

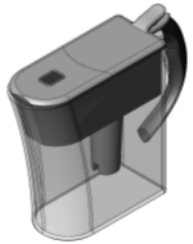
Water Pitcher: Inserted Filter





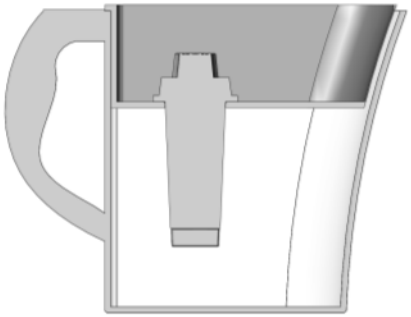


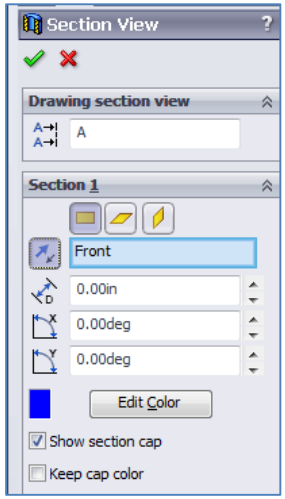
The bottom ridge of the filter and the top of the compartment are selected and the faces are constrained to be flush



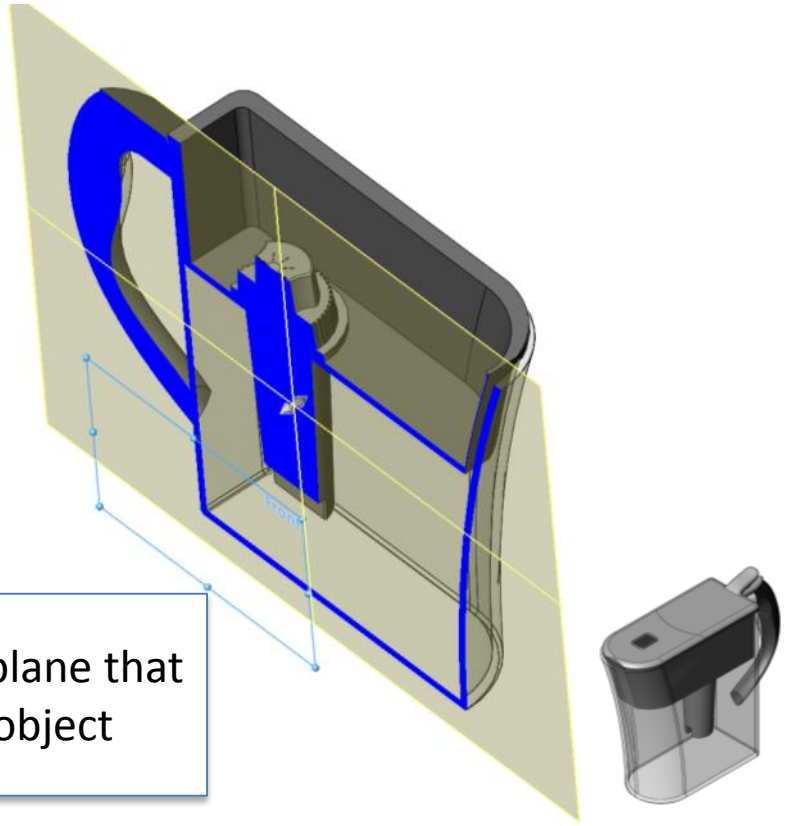
Water Pitcher: Section View

A section view can be used in order to see that the mates are correct

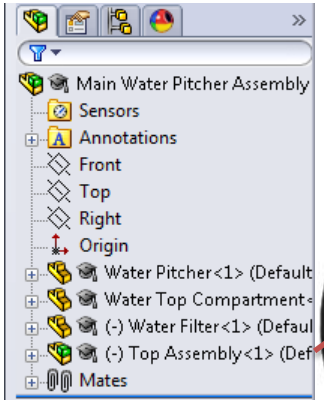


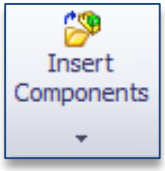


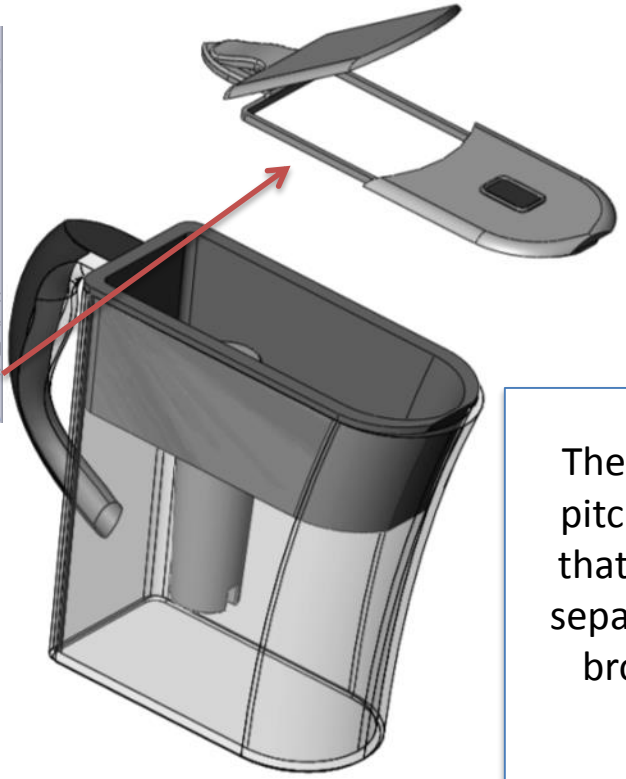
Choose the correct plane that cuts through an object

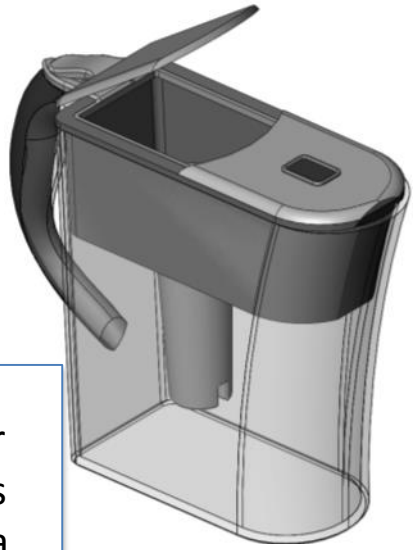


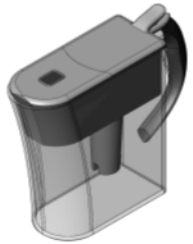
Water Pitcher: Sub-Assembly





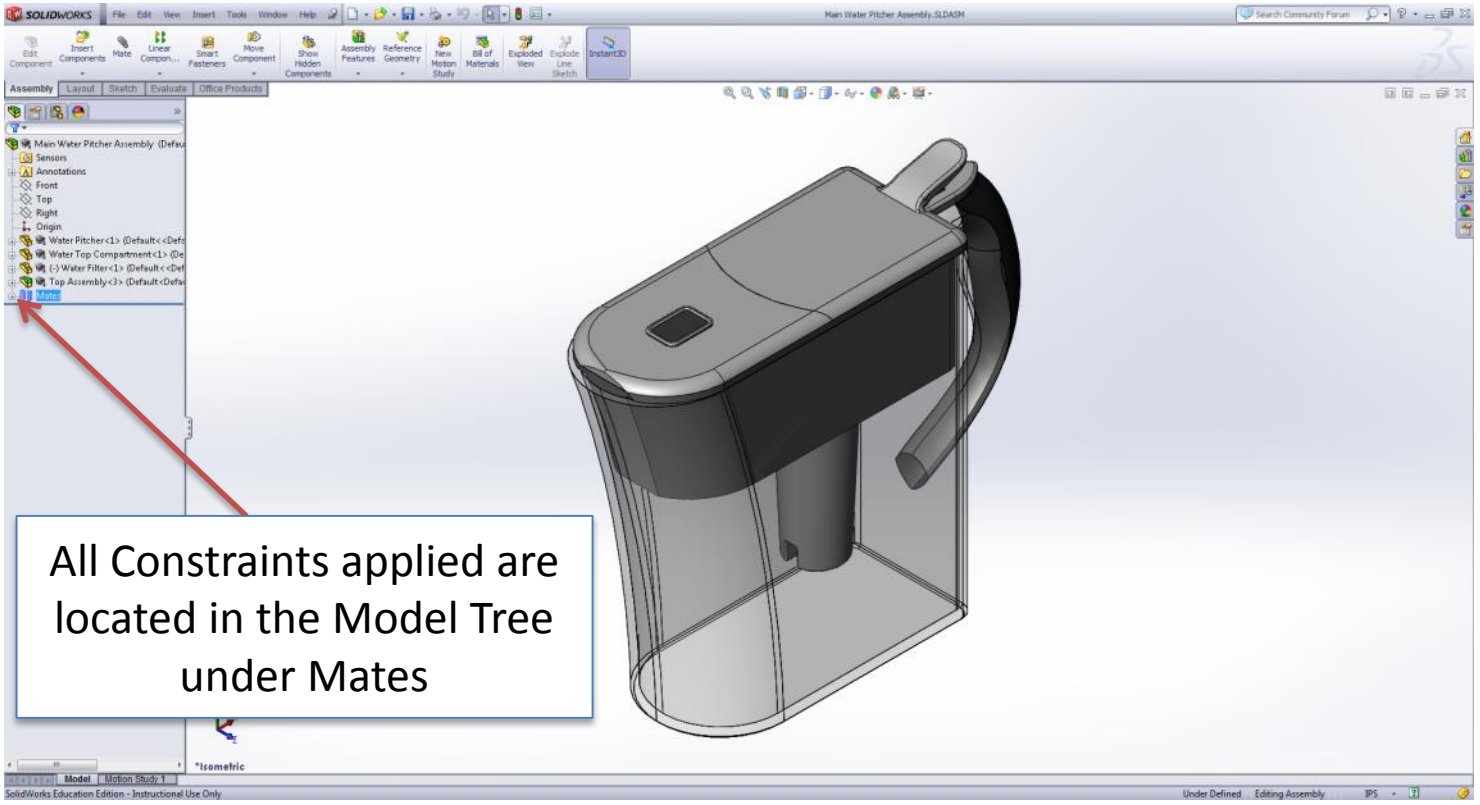




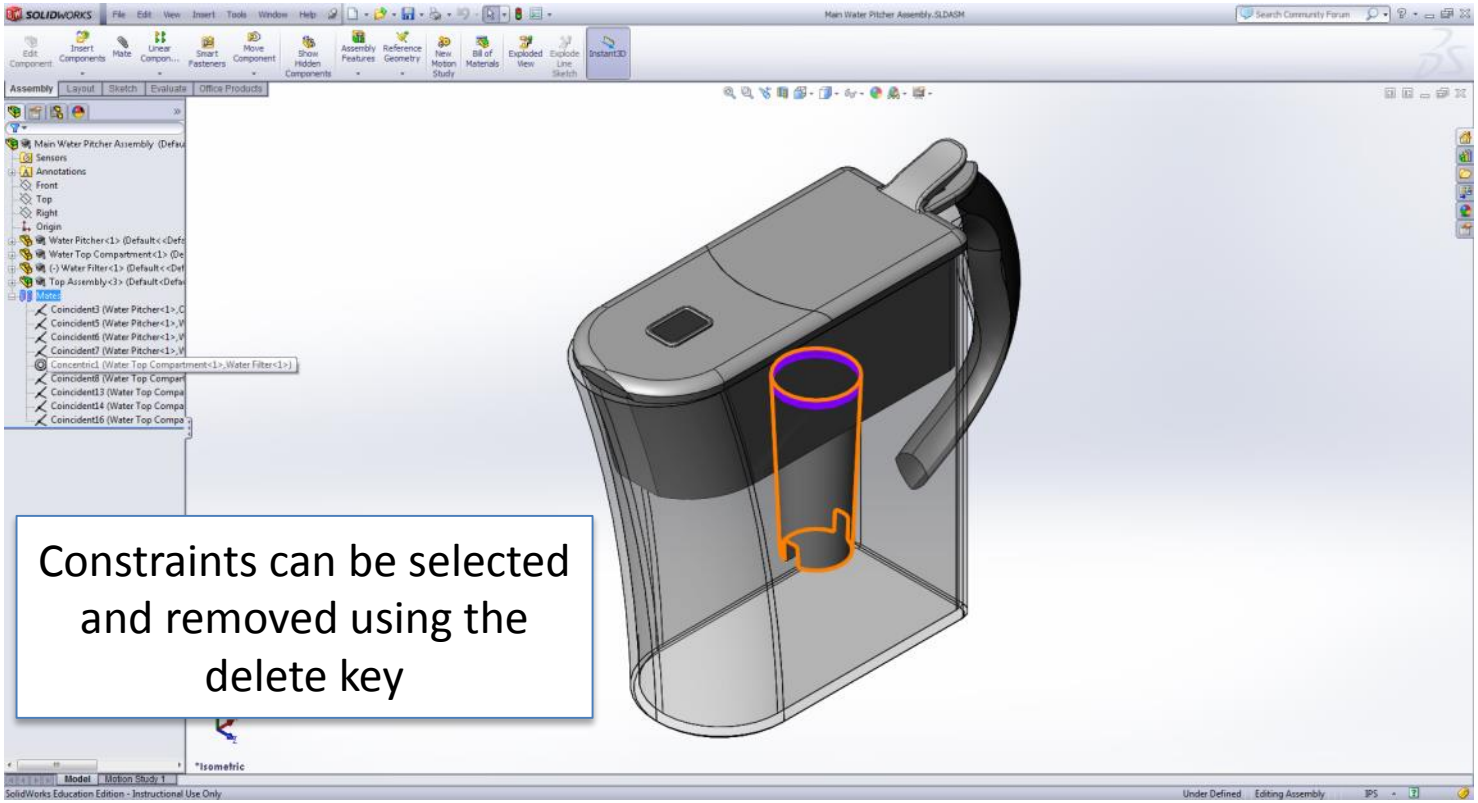


The top cover of the water pitcher consists of 2 pieces that were put together in a separate assembly and then brought into the current assembly

Deleting Constraints



Deleting Constraints



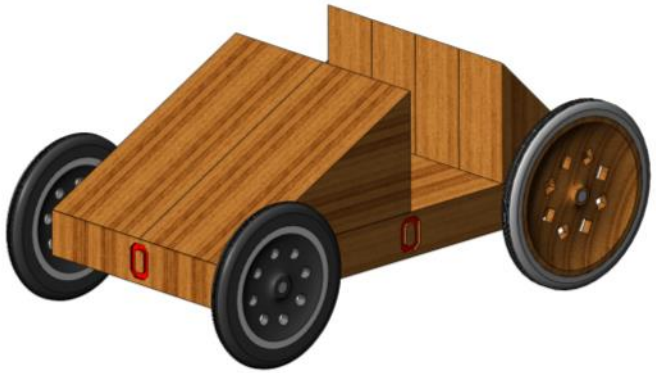
Assemblies Wrap-Up

- **Assemblies** – collection of 3D parts that form a system
- **6 Degrees of Freedom**
  - XYZ Translation
  - XYZ Rotation
- **Assembly Constraints**
  - Concentric
  - Mating Surfaces
  - Coincident
  - Distance

Homework Assignment:

A starter assembly is provided that is the basis for the In Class exercise

Using the pre-made blocks and wheels construct a pinewood derby racer using assembly constraints



Thank You for Attention !!

Any Questions