

Inventor Assembly and Constraints

 mae3.eng.ucsd.edu/cad/inventor-animation-tutorial/inventor-constraints

Inventor Tutorial #2: Assemblies and Labeling Parts

This week, we will review how to use individual parts to create an assembly. The process itself is not very difficult, but if it is not done properly, it can cause quite a headache. Since we will later use the animation option within Inventor itself, it is especially important that students are comfortable with assemblies.

Here are the main points you should probably note:

To open an assembly, open a “**Standard.iam**” file

In the “Assembly Panel”, choose “*Place Component*” and find your part click to place one

It is generally good to “**Ground**” your main component (the one where most of your constraints will be made)

You can “Ground” an object by right clicking on the part and selecting the grounded option

If you look at the part on the “Model Toolbar”, you will see a pushpin next to this object

A “Grounded” object will not move – constrained objects will move with respect to this one

It is recommended to place components and constrain them one at a time

There are **three general categories of constraints** – we are only really concerned with:

Assembly – basic constraint used to constrain objects to proper orientation with respect to one another by using surfaces, edges, planes, points and axes.

Motion – used for components such as meshing gears or rack and pinions

Within the Assembly constraints tab, there are **4 types of constraints**:

Mate

‡ Used to orient chosen FLAT faces of objects in desired way

Note: to fully constrain an object so that it doesn't move using the mate option, you will have to constrain it 3 times

1 constraint each for the x, y, and z planes

SEE BELOW "Constraint Tips" for an example of using the mate option

Angle

Used to specify the angle relationship between two planes/surfaces

Similar to the mate option, except your offsets are now in angle degrees

SEE BELOW "Constraint Tips" (towards the end of the tutorial)

Tangent

‡ Used to orient ROUND face with FLAT or ROUND face

Insert

‡ Used to insert a ROUND object into another ROUND object

Offsets are used to specify the distance or angle between the two surfaces you are constraining

For Mate, Tangent, and Insert

The offset will move the objects so that they are the specified distance apart (default unit in inches)

Note: you can input a negative offset to move the object in the opposite direction

For Angle

The offset will angle your objects so that their planes are the specified degrees apart from each other

Check for problematic constraints by going to modeling toolbar and changing from "**Assembly view**" to "**Modeling view**" and look for it under the relationships folder

It is easiest to just check the constraints and you can generally see what the issue is

If not, right click and use Inventor help

The *motion constraints* are slightly more complicated – there are two options:

Two round objects – gears and pulley systems

Different approach with circles and gears:

With circles, you select the contact surface of the objects and the ratio is automatically calculated using the diameters

With gears, you select the hole of the gear and then enter the ratio of teeth

A round and a flat object – rack and pinion systems

Select the edge of the round object to highlight the rotational axis

Select the REAR EDGE of the flat object

‡ Enter the distance that the linear object moves for each round object revolution (circumference!)

Excellent resource to explain this: <http://usa.autodesk.com/adsk/servlet/item?siteID=123112&id=3028036>

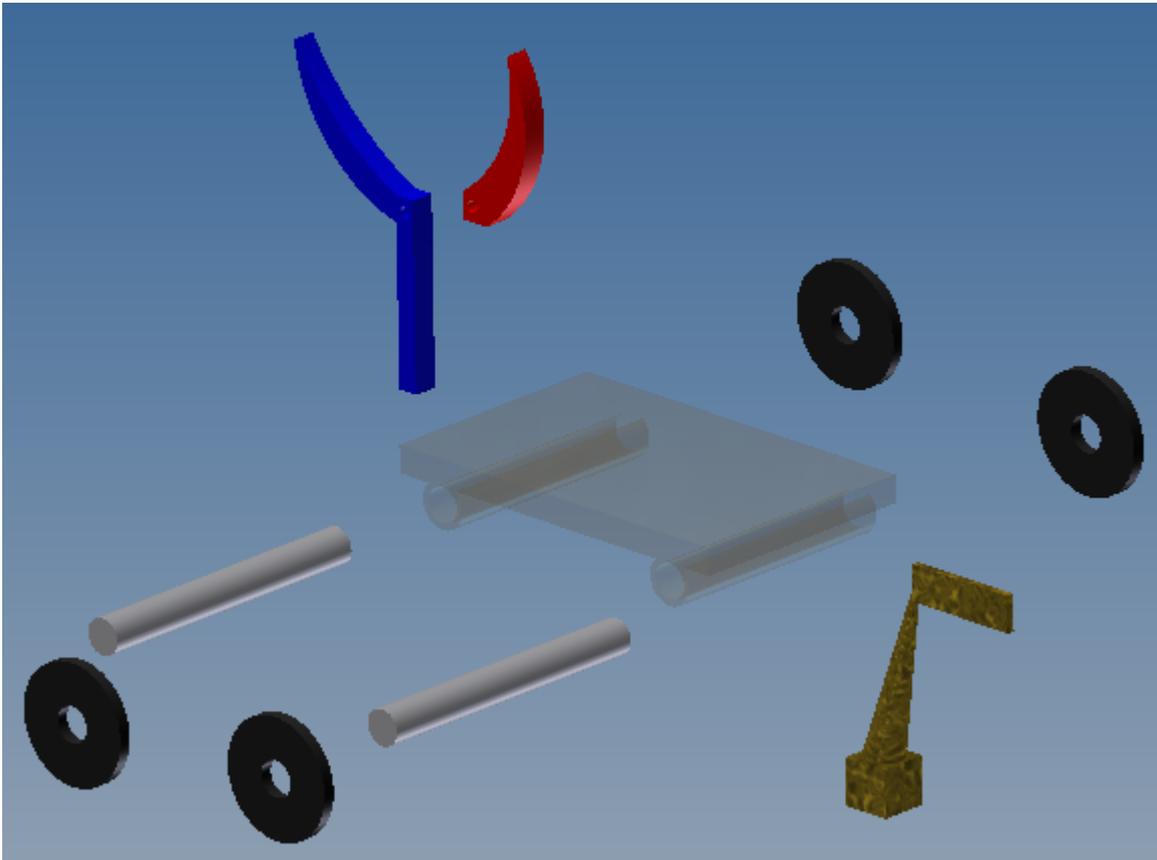
Multiple assemblies can be combined to form a more complete assembly

Once an assembly is complete, it can then be inserted onto a drawing file

Use “**Drawing Annotation Panel**” to add balloons and parts list – line up balloons!

Constraint Tips (using the Mate and Angle Constraints)

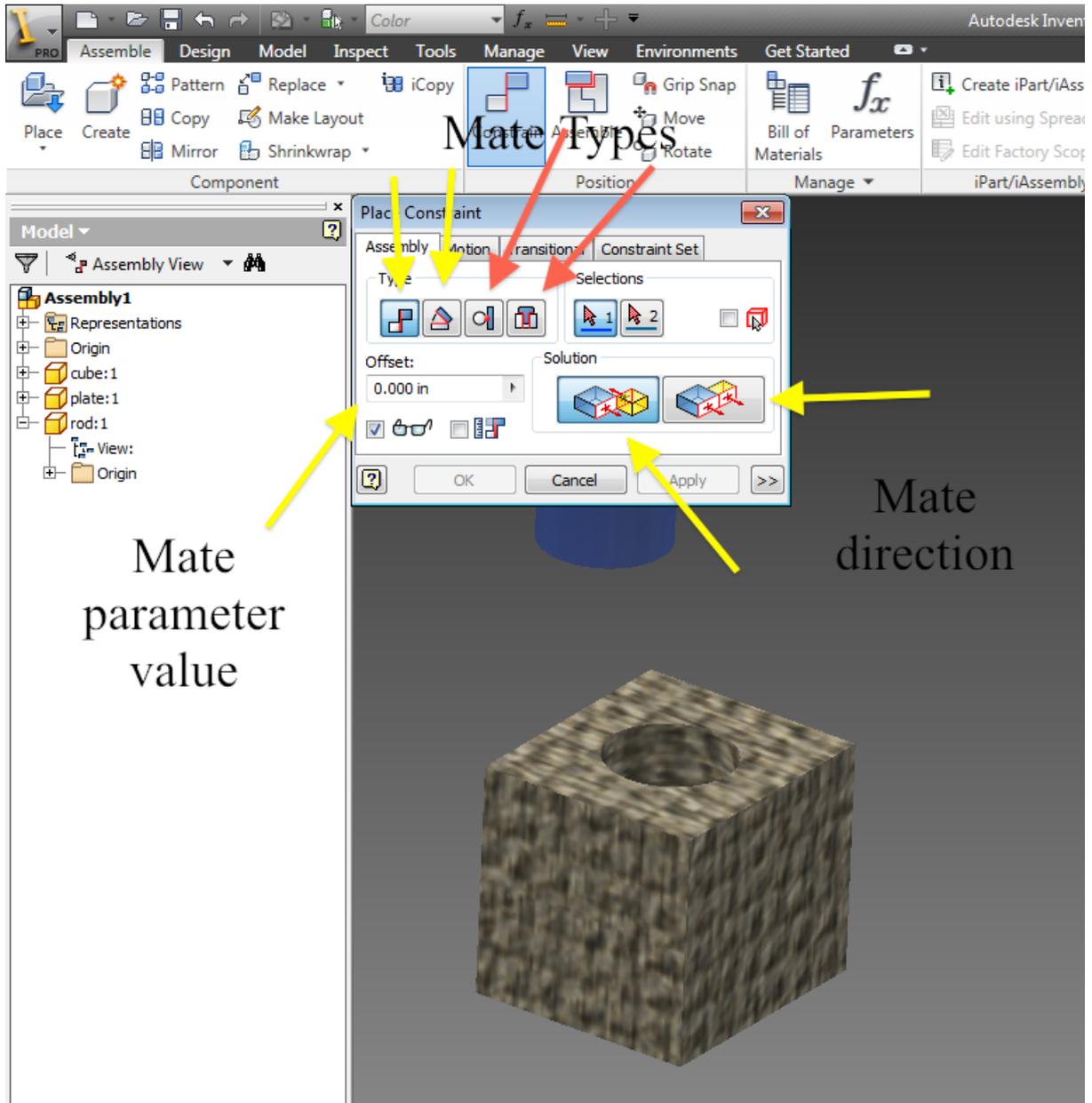
Constraining your parts can make all the difference when you are preparing for your presentation and construction your animations. Because of the difficulty in doing these constraints, here are a few tips and solutions to problems you may face



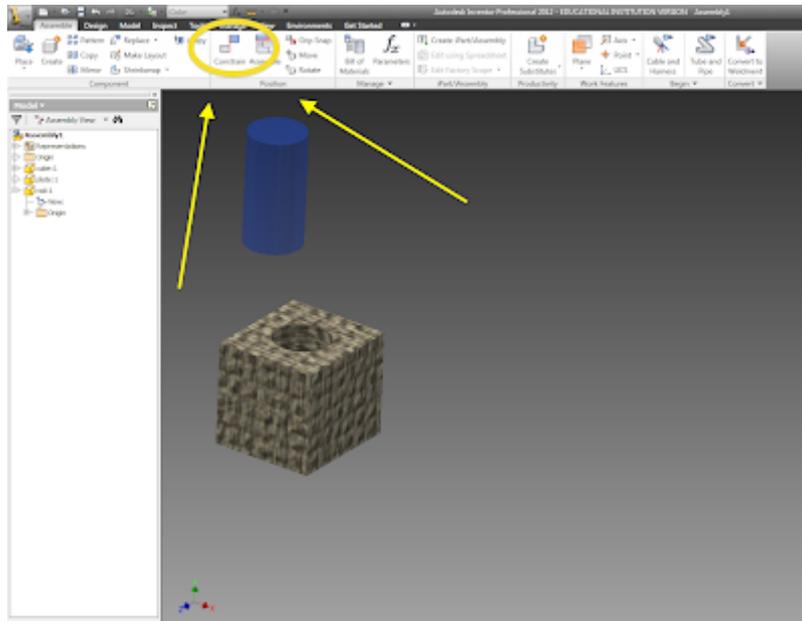
When doing constraints, you often need to consider each dimension that is a factor, i.e./ you will often need 3 constraints to cover your x-y-z axis.

So with that out of the way, lets look at some part configurations and decide how to constrain them:

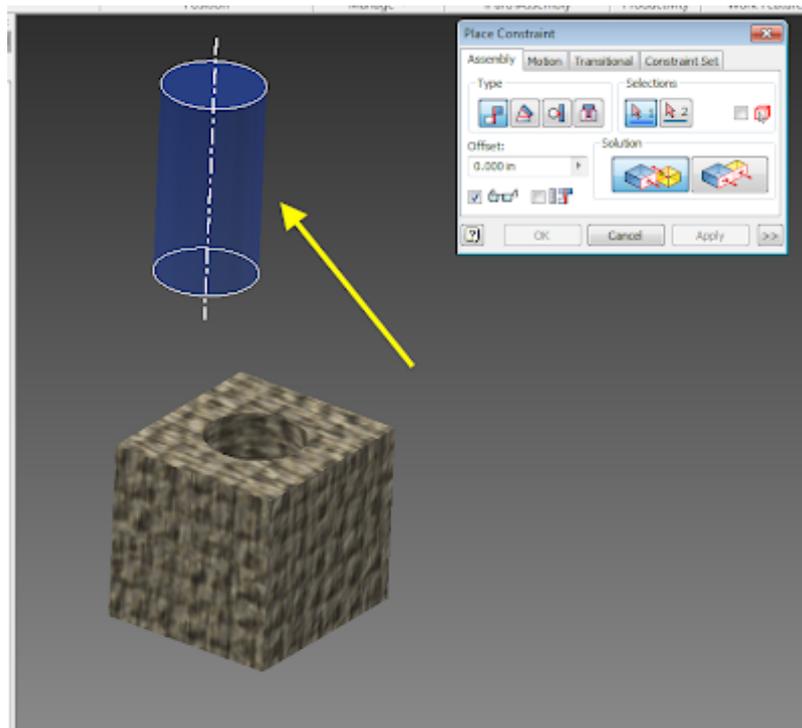
Start by opening up the constraint window in Inventor. Notice the Part constraint window appears. On it are the constraint types, the directionality of the constraints, and the value of deviation of that constraint type.



1. Putting the peg/axle in the hole
 - a. So we start with our parts. As you can see, there is a rod and a hole. Lets put the rod in the hole.
 - i. To start, lets select our constraint window. Then we will select our constraint type (MATE as always).

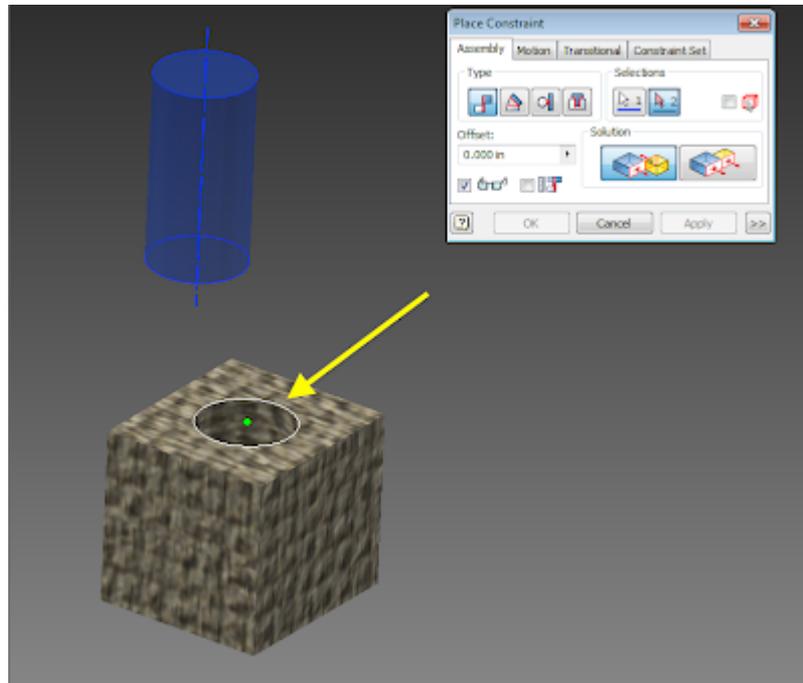


ii. Now let's select the geometry of the part we're going to mate. Because we want to mate the axis or center of this cylinder with the axis of the box, move the cursor over the part until the dashed line appears.

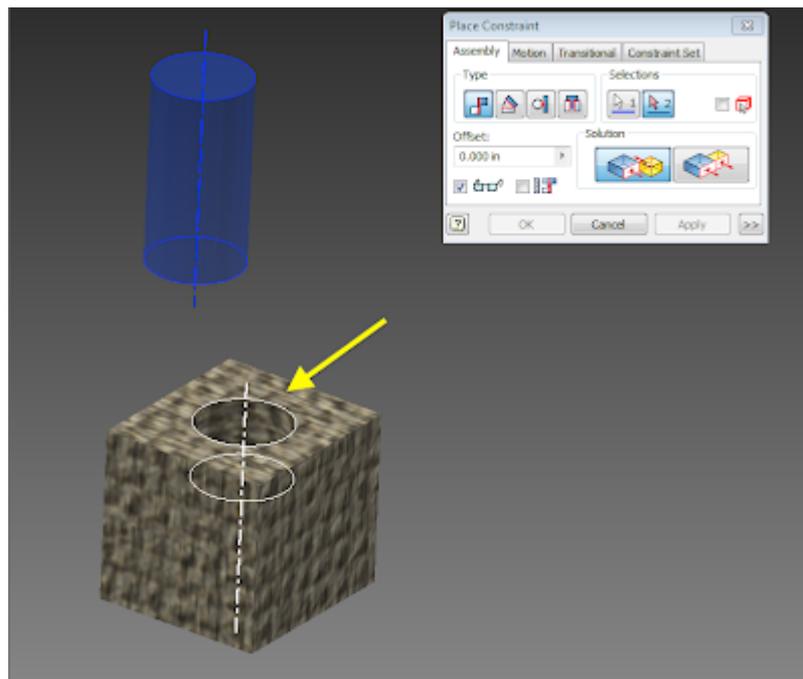


iii. Next, let's select the hole where we are putting the part.

1. Note, if the cursor is not in the right place, you will be mating to the edge of the hole. If the holes are of unequal size, this can create problems



2. As before, move the cursor to the inside of the hole until the dashed line appears. Press enter to confirm the constraint.



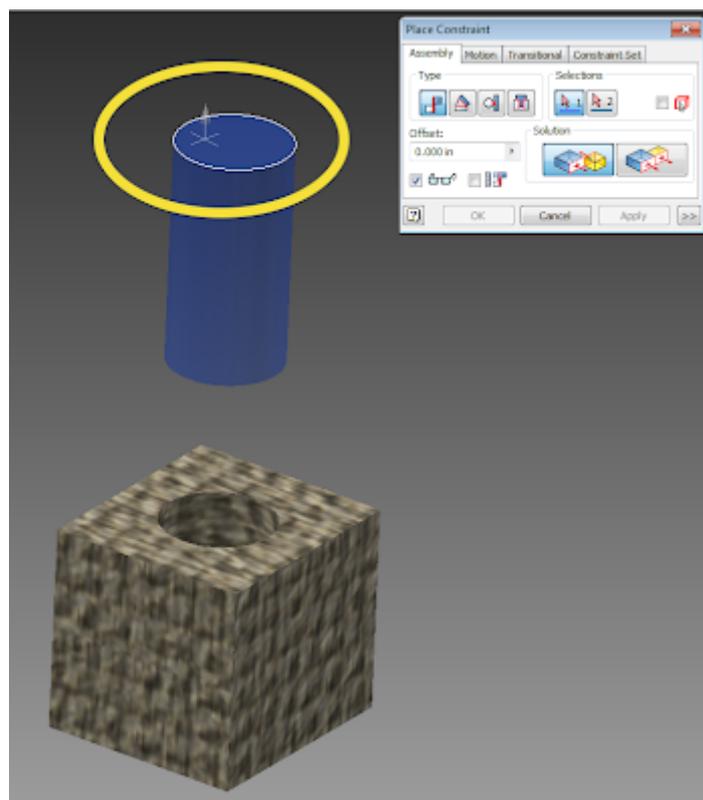
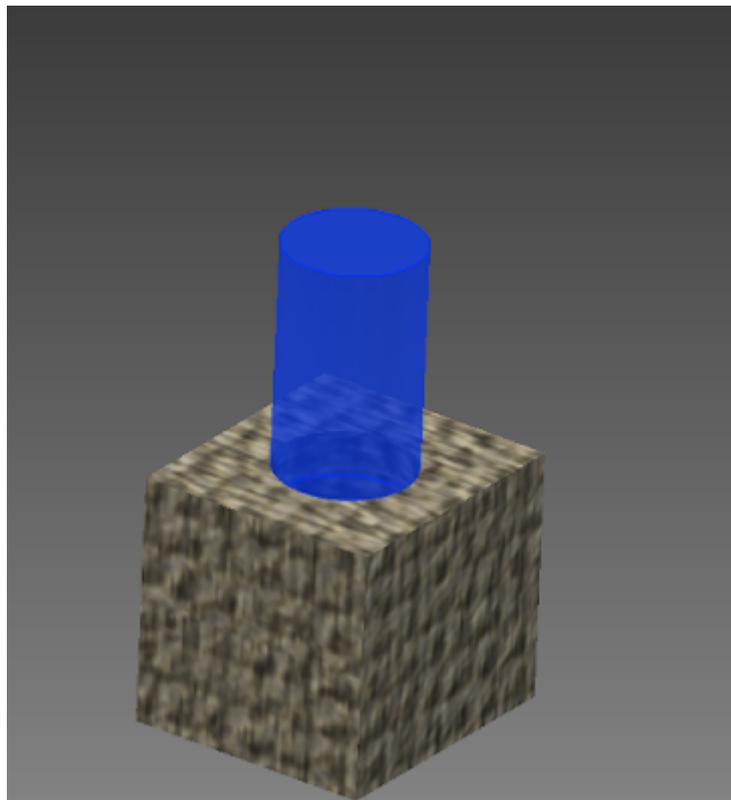
b. So the rod is constrained inside the rod but as you can see it still slides in and out, so lets put on the next constraint. Controlling the depth of the rod in the hole.

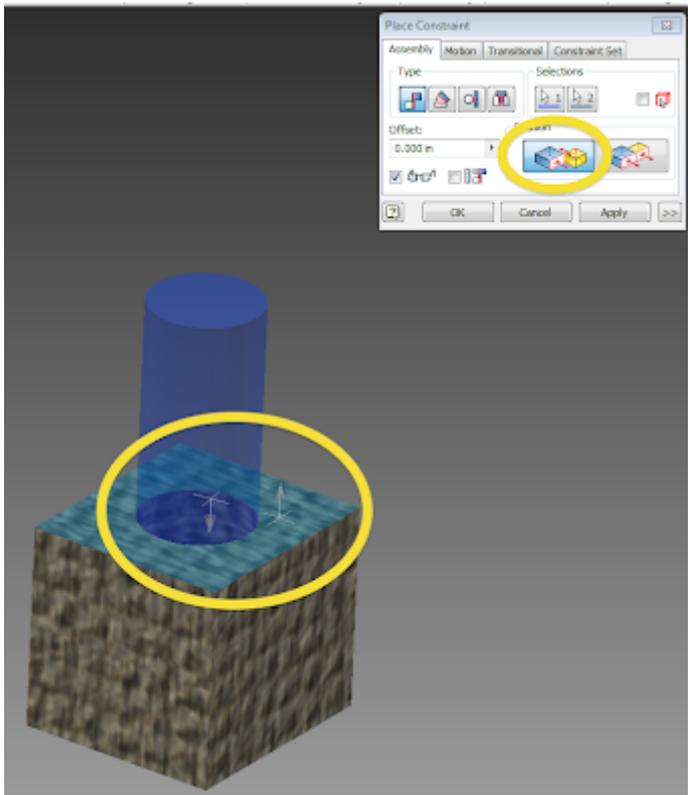
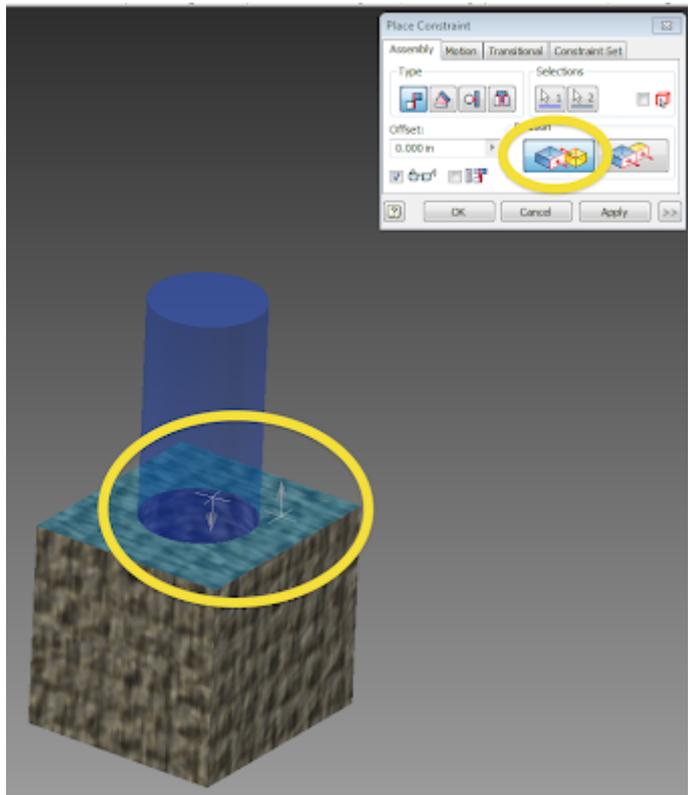
i. To start, lets select our constraint window. Then we will select our constraint type (MATE as always).

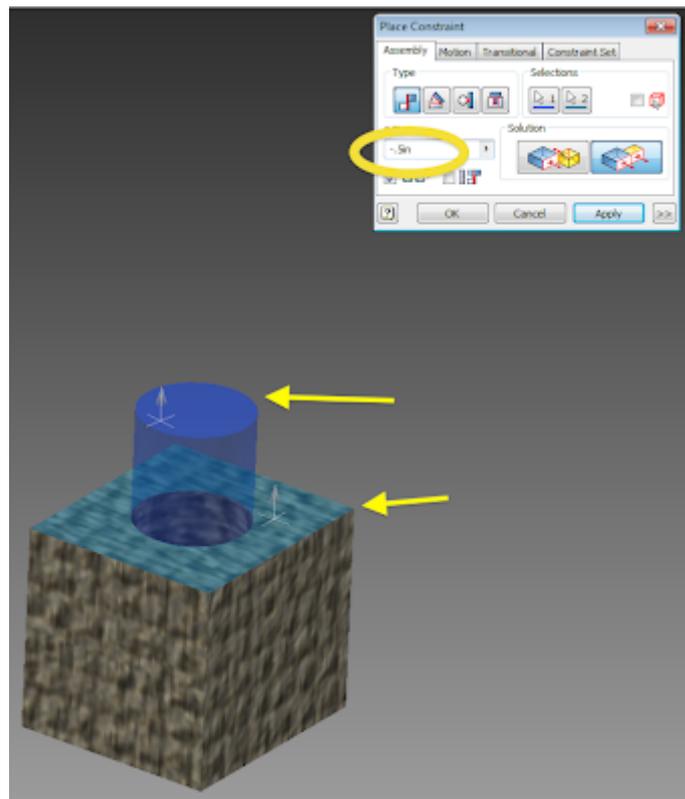
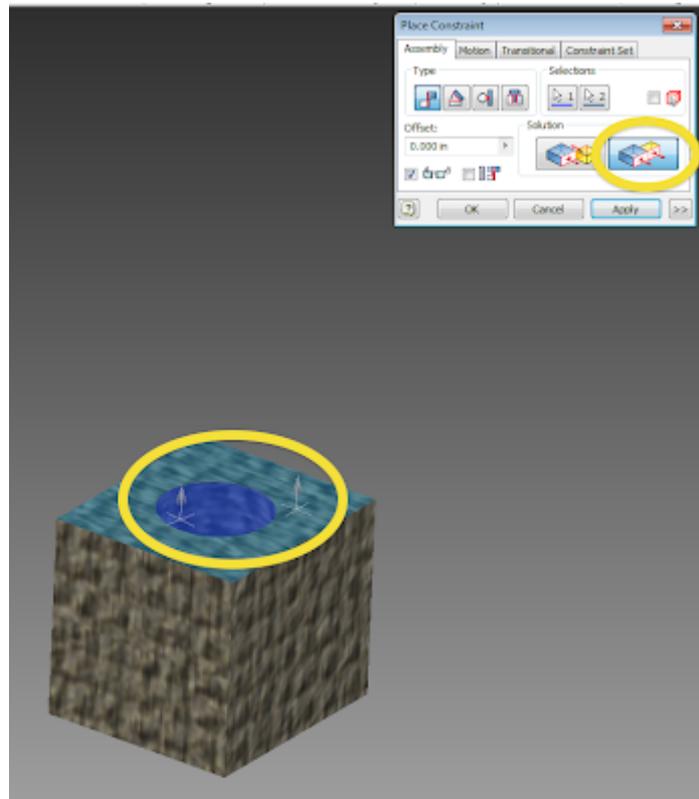
ii. Now lets select the faces that we will be constraining. Because of the nature of this constraint, there are several options available

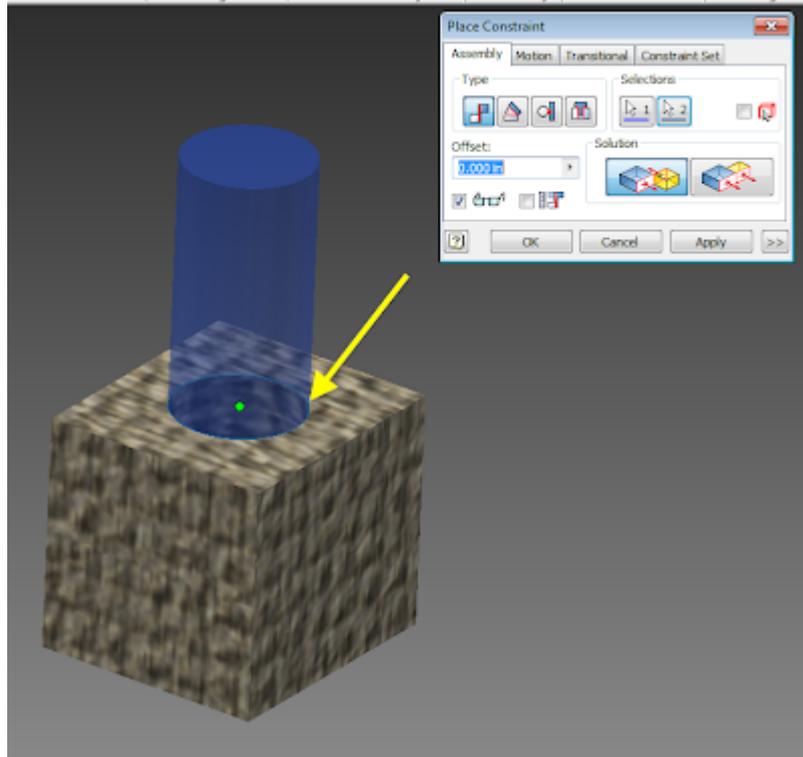
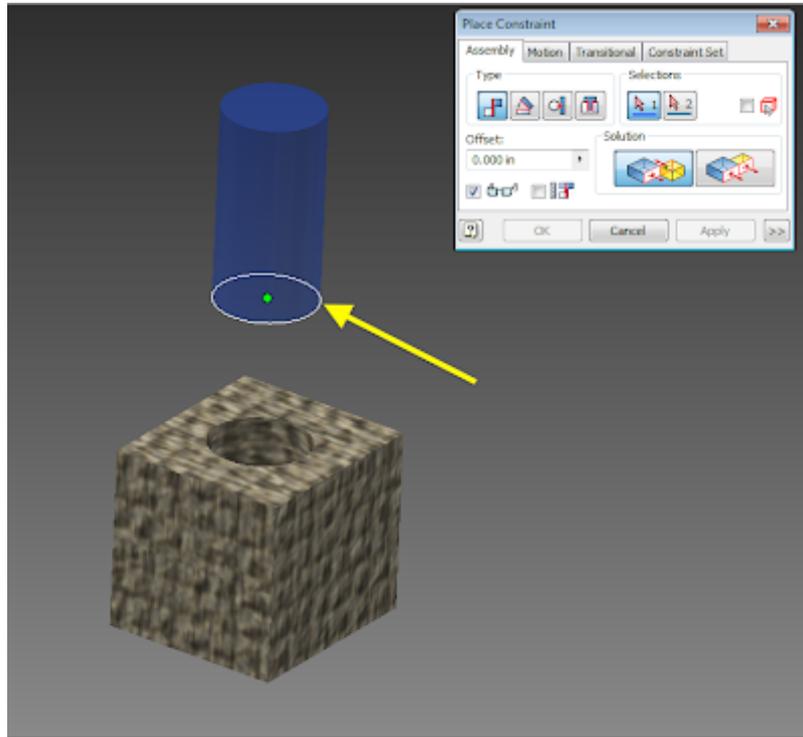
1. The more robust option is to use the top surfaces of the rod and the hole or parallel flat plain (i.e. the box top). Also note that you can alter the directions of the selected faces, as well as control the separation between the two plains.

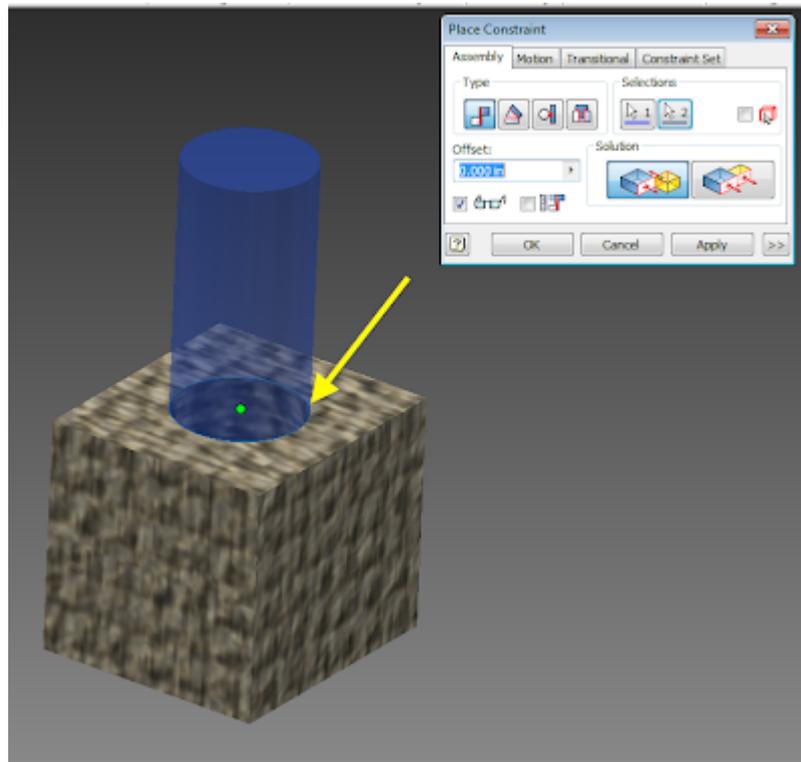
2. The limited option is to mate the edge of the rod with the edge of the hole. Again this can create problems if the holes are of unequal size.











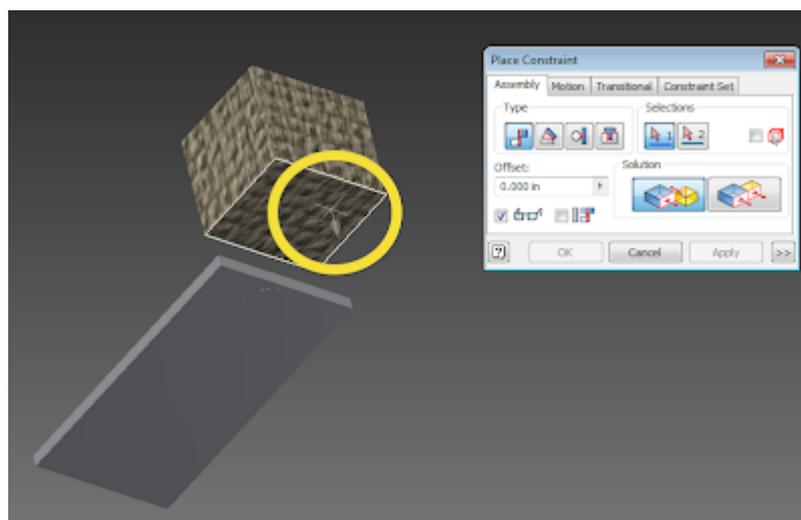
c. Congratulations, the part is sufficiently mated

2. Putting the flat part on the other flat part.

a. So as mentioned before, a fully constrained object is bound in 3 dimensions. So lets start by constraining the cube to the board of the plank.

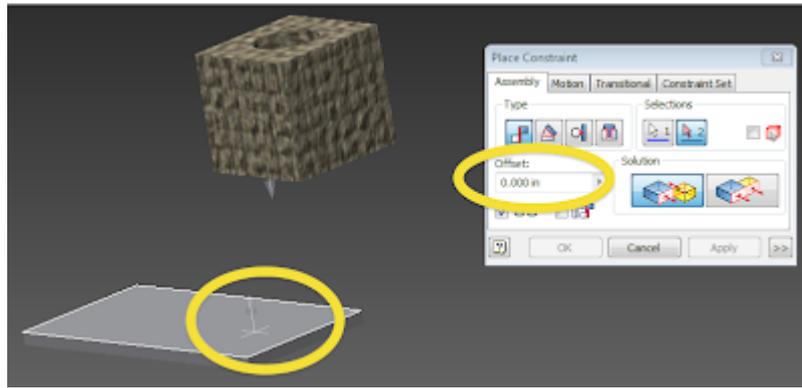
i. As before, lets open the constraint window and select mate.

ii. Often, you will need to pan or rotate your view to see the surface of interest. Lets turn the part to select the bottom of the cube.



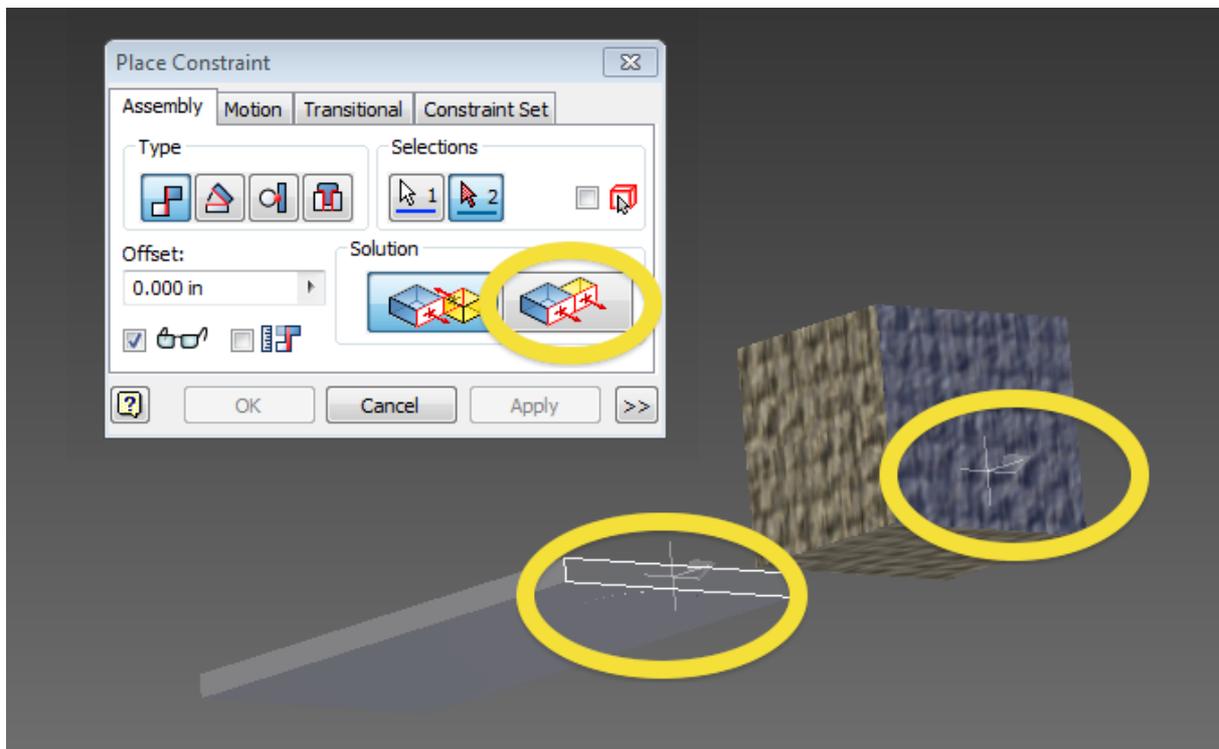
iii. Rotating the view, we can see the top of the board we wish to constrain to. By having a 0 offset, the cube will now be bound to the top surface of the board. Moving like a computer mouse on a desk, the cube can still

move forward/back and side to side, but it can no longer move up off the board (Z-axis).



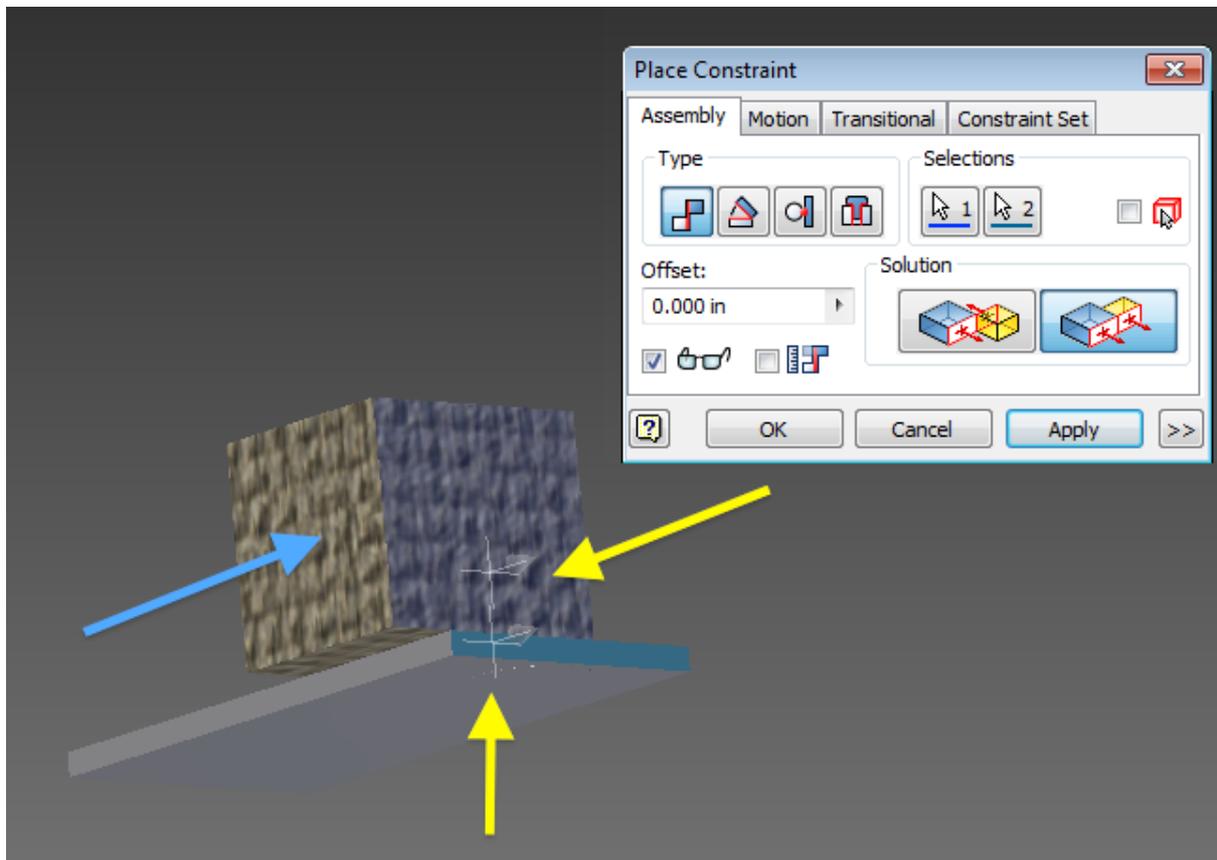
b. Next, let's put the second bound on the cube so that it cannot move in the Y-axis.

i. As before, enter the constraint window, select constraint and select the surfaces of interest.

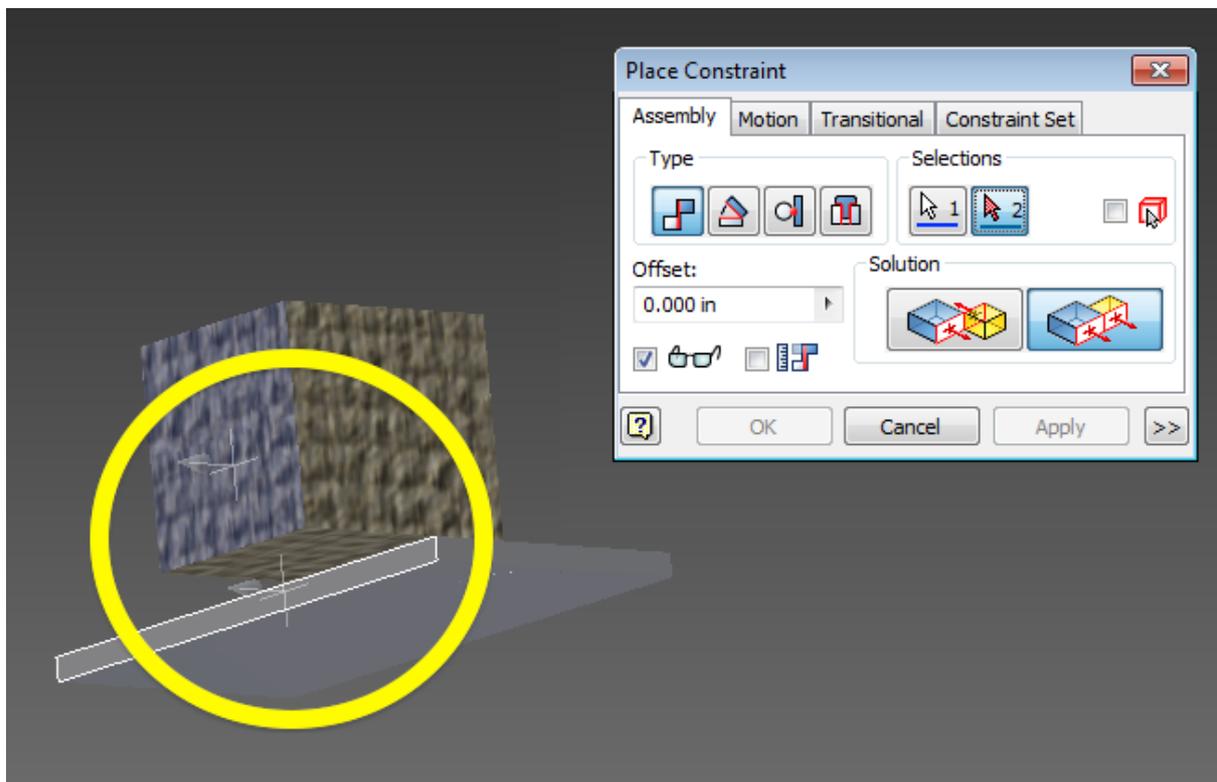


ii. This time, note that the directionality has been undated. This becomes important with more complex geometries.

c. With the constraint approved, you can see that the block is constrained in 2 of 3 directions and can only move in the x direction. Applying the final constraint fully bonds the object.



i. Repeating the same process as before.



3. Having the rotating tank head

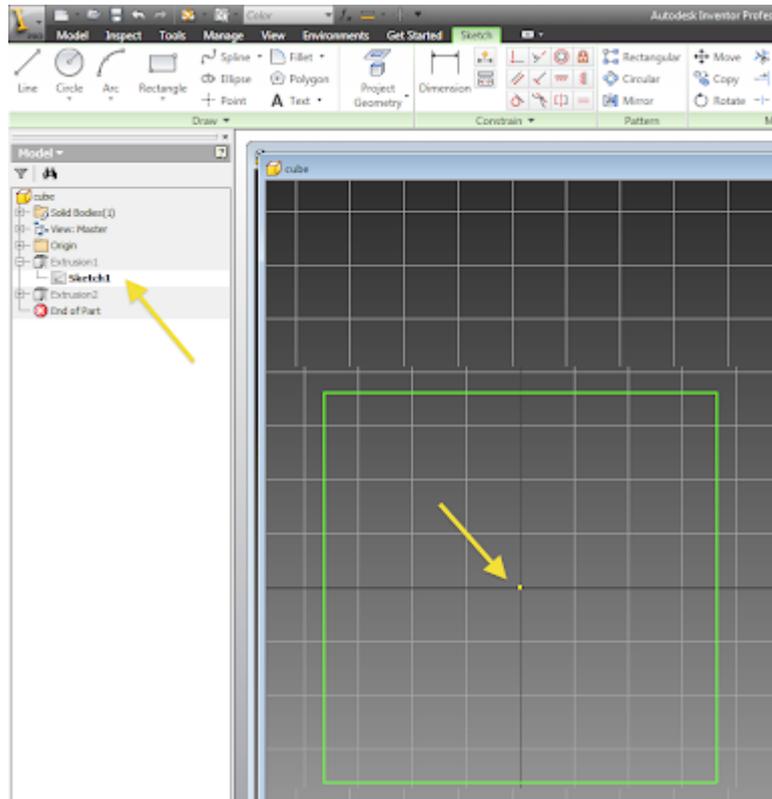
a. Quite often, you will have one part rotating in relation to another. Whether it is a gear or an axle, having constraints easy to manipulate will ensure that when it comes time to animate things are easy to work.

b. Before we start, because of the requirements of animation, some pre-processing may be required

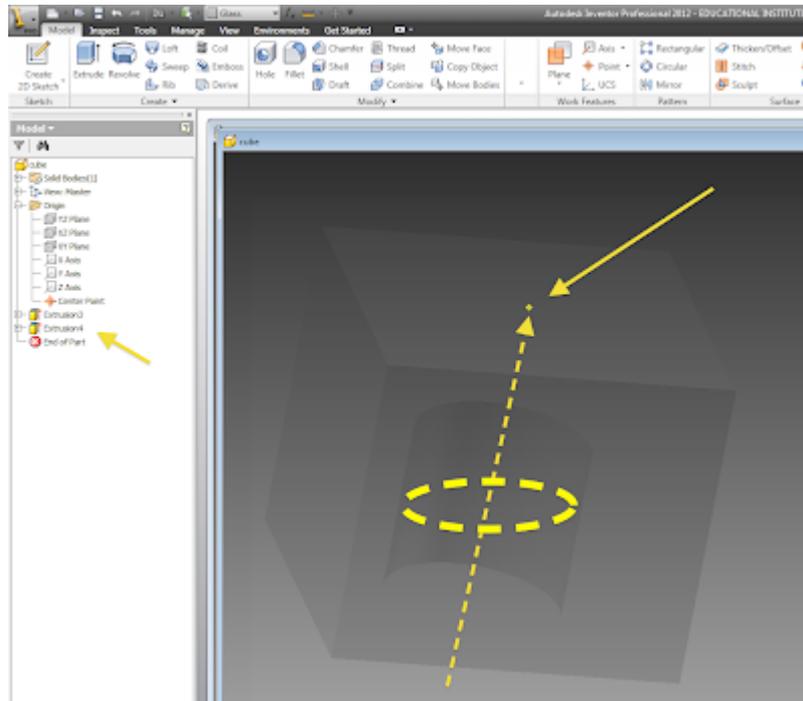
i. First, the point of rotation should be defined.

Because the cube will be rotating about that central axis, let's prepare the part.

1. Observe that the origin of the part is not along the point of rotation. Moving the sketch to move the origin's location on the surface.

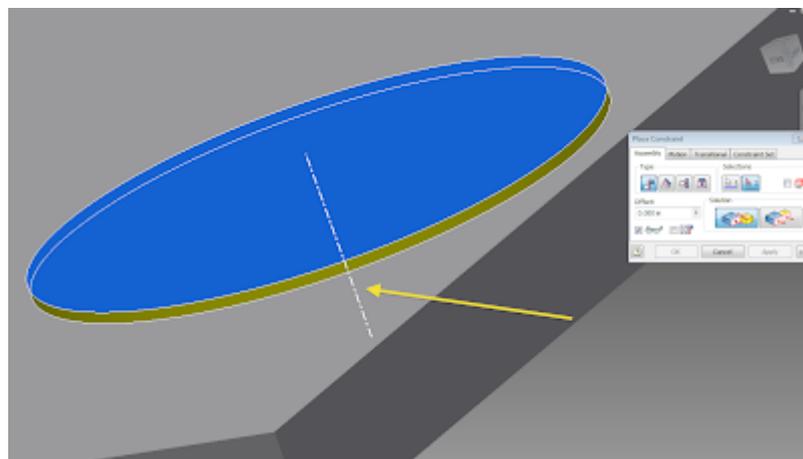


2. Repeating this on all directions, we can control the position of the origin. As you can see, the origin is now set along the axis of rotation, as well as it is set to the top of the cube for easy access.



ii. Now note that there is no axis or rod set on the flat board. Because we want the block to rotate, an easy way to do this is to artificially put a cylinder for rotation.

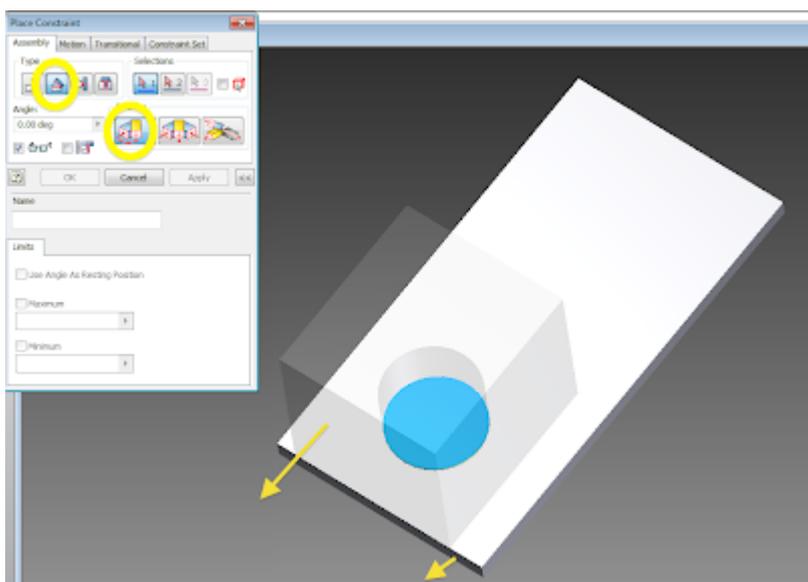
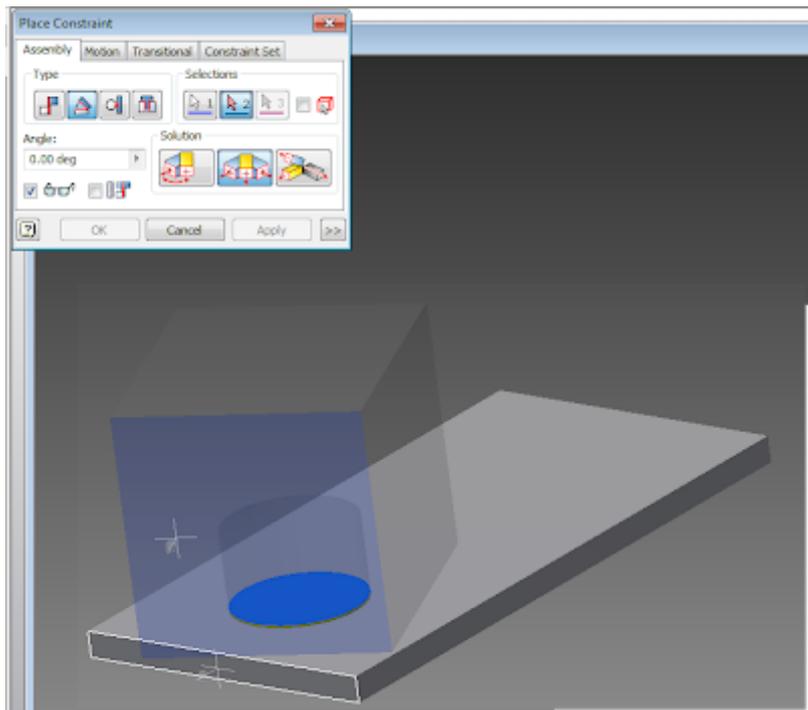
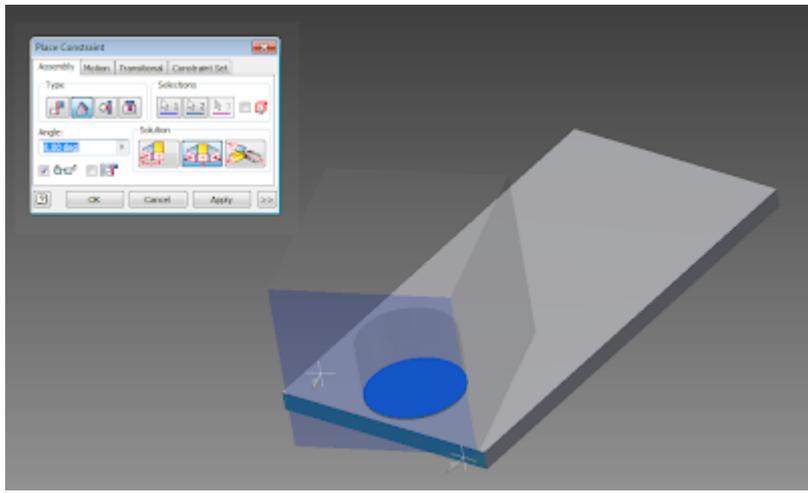
1. Extruding the region creates an axis that we can rotate about. To keep things looking nice, the extrusion can be on such small scale that it is nearly invisible, 0.01in. I have highlighted the regions so that you may observe them.

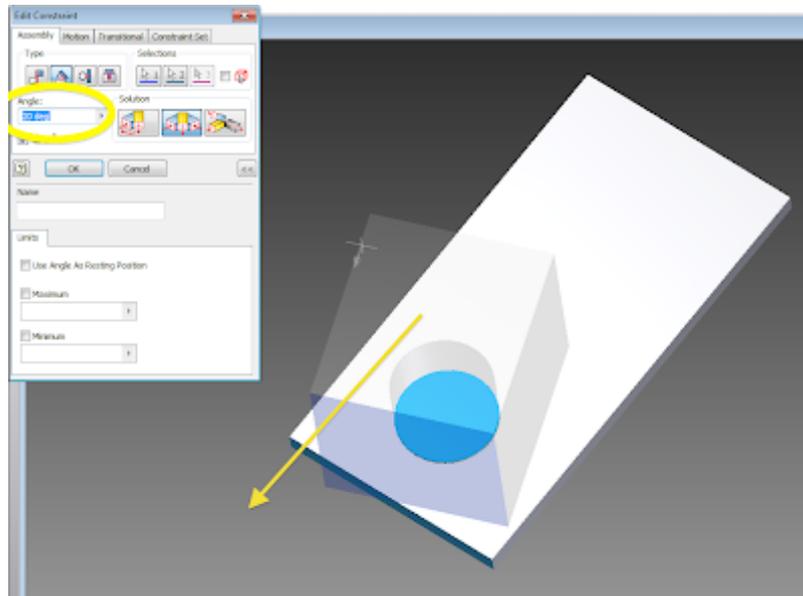


c. So lets make out assemble

i. Repeat the normal constraint steps. Lock the hole to the cylinder;

ii. For the final step, we will use the angle constraint. Much like the mate constraint we select the faces of interest and set some displacement value. However, unlike mate where the displacement is a distance, here the displacement is an angle. This will be very helpful when it comes to animation as we can comment the angle to change, this rotating the part.





4. Congratulations, you can now constrain like a pro

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