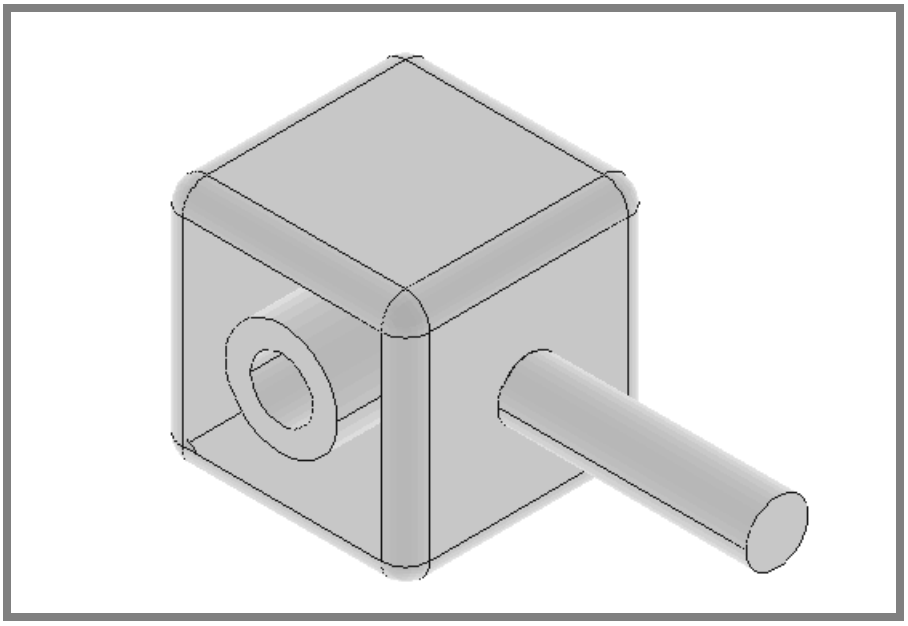
WORKSHOP 5

Solid Modeling (Part I)



Objectives:

- Use the solid modeling feature of MSC.N4W to create three dimensional geometry.
- Apply the loads and boundary constraints.
- Mesh the geometry.

Model Description:

Consider a steel block fixed on a rigid rod with a cylindrical protrusion on the sides. The material properties of the block are shown in Table 5.1 below. A picture of the block with basic dimensions is supplied below in Figure 5.1.

Figure 5.1 - Dimensions

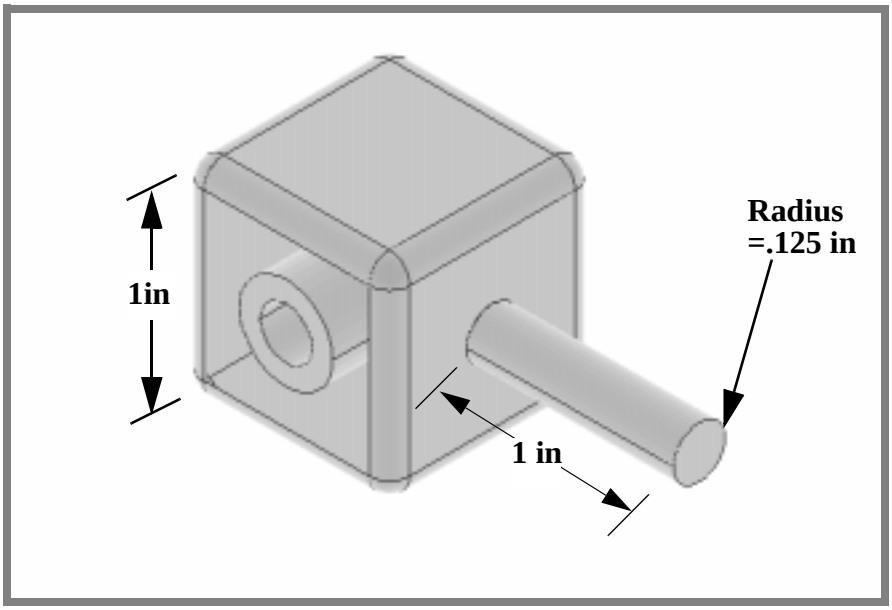


Table 5.1 - Material Properties

Youngs Modulus:	**30E+06 psi**
Poisson's Ratio:	**0.3**
Density:	**0.282 lb/in^3**

Suggested Exercise Steps:

- Define a material: steel.
- Define a solid property using the newly defined material.
- Create a 1 in cube using the primitive solid form with 1 in edge length.
- Create a cylinder inside the block using the new solid feature in the primitive solids form.
- Use a boolean operation to subtract the cylinder from the cube.
- Rotate the workplane onto a face of the cube to create the protrusion.
- Using the solid primitives form, create the protrusion as a new solid.
- Fillet the edges of the cube with 1 in radius fillets.
- Shell the cube. It is important to pick the correct surface to remove. Not excluding a face will create a hollow box. The wall thickness is 0.1 in.

Exercise Procedure:

1. Start up MSC.Nastran for Windows V4.0 and begin to create a new model.

   Double click on the icon labeled **MSC.Nastran for Windows V4.0**.

   On the *Open Model File* form, select **New Model.**

Open Model File:	**New Model**

2. Create a material called **mat_1**.

   From the pulldown menu, select **Model/Material.**

   Model/Material...

Title:	**mat_1**
Youngs Modulus:	**30E6**
Poisson's Ratio:	**0.3**
Mass Density:	**0.282**

   OK

   Cancel

3. Create a property called **solid** to apply to the members of the model.

   From the pulldown menu, select **Model/Property**.

   Model/Property...

Title:	**prop_1**

   Elem/Property Type...

   Volume Elements: ● **Solid**

   OK

   To select the material, click on the **List** icon next to the databox and select **mat_1**.

Material:	**1..mat_1**

   OK

Cancel

4. Create the block using the **block-corner** option, and name the solid **block**.

Geometry/Solid/Primitives...

Title:	**block**
Material:	● **New Solid**
Direction:	● **Positive**

Under *Origin* input the following:

X:	**0.0**
Y:	**0.0**
Primitive:	● **Block-Corner**
X:	**1.**
Y:	**1.**
Z:	**1.**

OK

5. To better view the solid, fit the view in the window.

View/Autoscale <Ctrl+A>

6. To give perspective on the geometry, switch to a solid-shading mode.

Click on the **View Style** icon on the toolbar.

From the Pop-up menu: ☒ **Solid**

7. Rotate to an isometric view.

View/Rotate... **<F8>**

Isometric

OK

8. The next step is to create the hole. This is done by creating a cylinder through the solid and subtracting it from the block. Although MSC/N4W4.0 lets you create the hole directly using the subtract command, the method displayed here reinforces the boolean geometry capabilities of MSC/N4W4.0.

Geometry/Solid/Primitives...

Material: ● **New Solid**

Title: **hole**

Under *Origin* input the following:

X: **0.5**

Y: **0.5**

Primitive: ● **Cylinder**

Radius: **0.125**

Height: **1.**

OK

Now subtract the hole.

Geometry/Solid/Remove...

Select the base solid.

Entity ID: **1..block**

OK

Select the solid to remove.

<Select Solid 2>

OK

9. In order to create the protrusion on the face using the **primitives** form, it will be necessary to rotate the workplane onto that face of the cube.

Tools/Workplane... **<F2>**

Under *Move Plane* select **Rotate**.

Rotate...

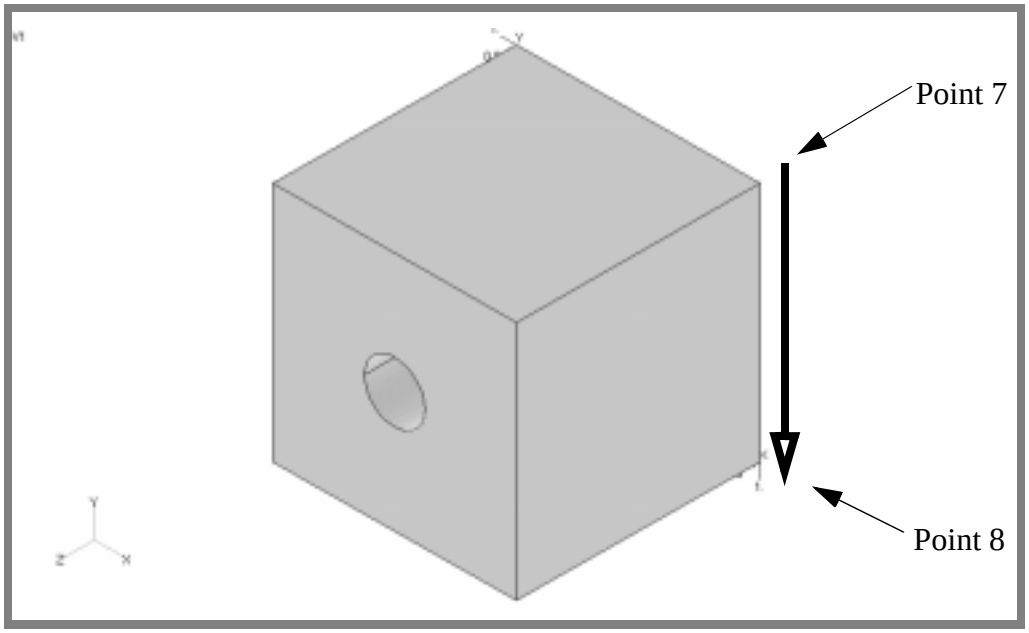
Now select the axis of rotation.

Methods^

☒ **Points**

Select the points as shown in Figure 5.2.

Figure 5.2 - Moving the workplane



Base Point ID: **7**

Tip Point ID: **8**

OK

Rotate the workplane. The direction of the rotation is found using the right hand rule. Point your right thumb along your axis of rotation and the direction your fingers curl is the positive rotation.

Rotation Angle: **90**

OK

10. Regenerate the display.

View/Redraw **(or double click left mouse button)**

11. Create the protrusion.

Geometry/Solid/Primitives...

Material: ● **New Solid**

Title: **protrusion**

Direction: ● **Negative**

Under *Origin* input the following:

X: **1.5**

Y: **0.5**

Primitive: ● **Cylinder**

Radius: **0.125**

Height: **1.**

OK

12. Since we are no longer creating geometry, turn off the workplane. These are the two methods:

View/Options...

In the *View Options* menu select the following:

Category: ● **Tools and View Style**

Under *Options*, highlight **Workplane and Rulers.**

Workplane and Rulers

Uncheck the **Draw Entity** box.

☐ **Draw Entity**

OK

Or, right mouse click on screen,

Workplane...

☐ **Draw Workplane**

Done

View/Regenerate **<Ctrl+G>**

13. In real life, parts generally do not have sharp corners. To model this, fillet the edges.

Geometry/Solid/Fillet...

Select the curves to fillet.

ID: **1** *to:* **12** *by:* **1**

(Or, select all edges of the block)

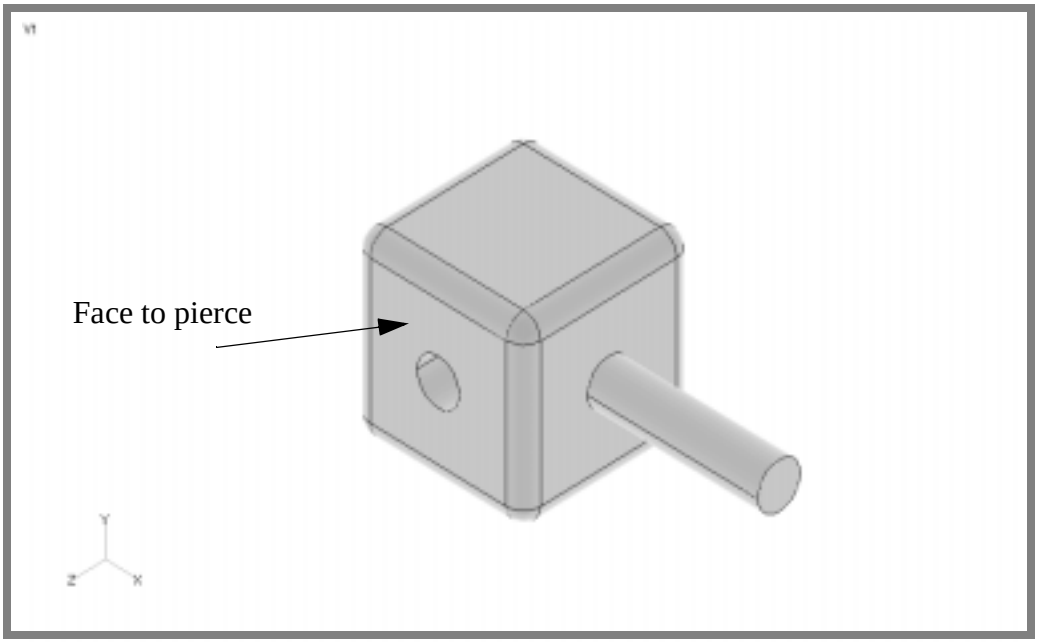
OK

Radius: **0.1**

OK

Your model should look like Figure 5.3.

Figure 5.3 - Block with edge fillets



14. Hollow out one face of the cube using the shelling feature.

Geometry/Solid/Shell...

Select the base solid.

Entity ID: **1..block**

OK

Select surfaces to pierce.

ID: **1** *to:* **1** *by:* **1**

(*Or* select face shown in Figure 5.3*)*

OK

Thickness: **0.1**

OK

Your completed model should look like Figure 5.1.

15. Join the shelled block with the protrusion.

Geometry/Solid/Add

Select All

OK

16. Mesh the complete solid with a 0.1 default element size.

Mesh/Mesh Control/Default Size...

Size: **0.1**

Min Elem: **1.**

OK

Mesh/Geometry/Solids...

● **Tet Meshing**

OK

Property: **1..solid**

OK

This concludes the exercise.

File/Save

File/Exit