

Module 3: Extruded Feature; V-Block

In order to demonstrate how to create extruded features step by step, a V-Block model is used in this tutorial. Its geometry and dimensions are given in Figure. 1.

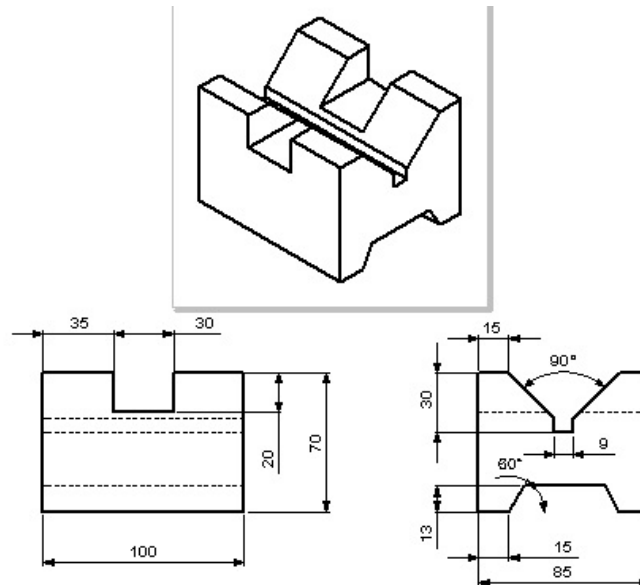


Figure 1. V-Block

Modeling Procedure

Before a model is created, a strategic plan for modeling should be done. The following points should be considered:

- Which view of the part best conveys its shape?
The **base feature** is usually the most prominent feature in that view.
- What is the most important feature of your part?
Create these features early in the modeling process so you can use them for creating subsequent features.
- Can the origin and coordinate planes be used to modeling advantage?

After the above considerations, the V-Block can be created from the following steps as shown in Figure2.

- 1) Create a **100mm x 85mm x 70mm** block using the **Extrude Boss/Base**.
- 2) Cut a **30mm x 20mm x 85mm** Rectangular Slot using **Extrude Cut**.
- 3) Cut a **V-slot** using **Extrude Cut**.
- 4) Cut a **Trapezoid slot** using **Extrude Cut**.

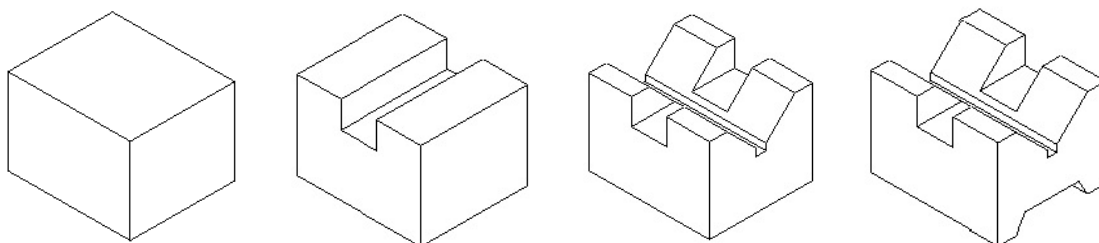




Figure 2 V-Block Modeling steps.

Start Solid Works and Set up Properties

- 1) Start Solid Works.
- 2) Click **New**  on the Standard toolbar, or select **File, New** on the menu bar.
- 3) Select **Part**  from the Tutorial tab in the dialog box and then click **OK**.
- 4) Click **File, Properties** on menu bar.
- 5) Fill in the necessary properties in the dialog box, and click **OK** to accept the properties and close the dialog box.
- 6) Select **Tools, Options** on the menu bar to open the Options dialog box.
- 7) Select the **Document Properties tab**, and click **Unit** in the properties tree text box.
- 8) Select **Millimeter** and set the decimal places to **2** as shown in Figure 3. The available units are Millimeters, Centimeters, Meters, Inches, Feet, Feet, Inches, etc.

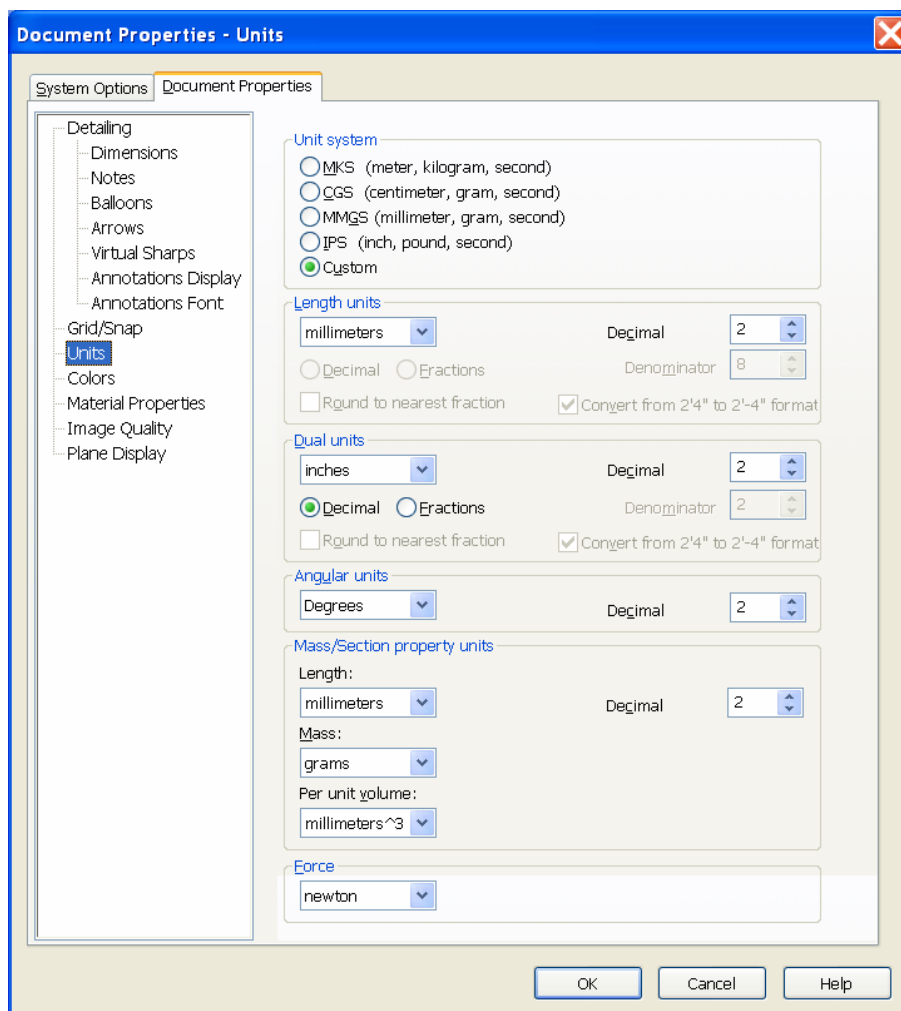


Figure 3 Units selection

- 9) Click **Material Properties** in the properties tree box. Change the density to **0.0078 g/mm³** as shown in Figure 4.

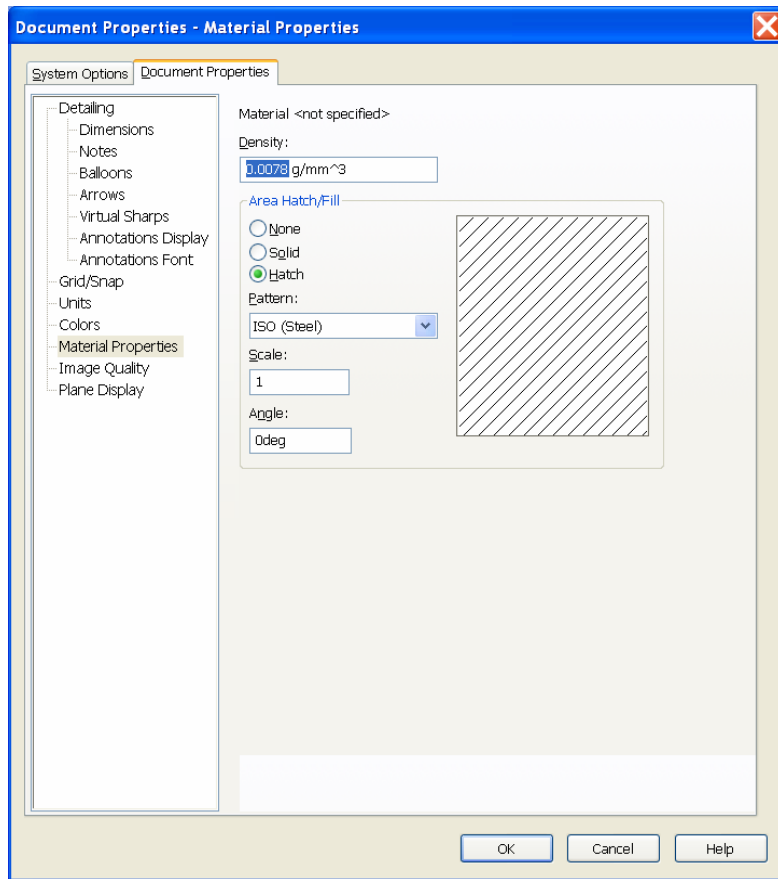


Figure 4 Material properties

- 10) Click **Grid/Snap** in the properties tree box. Check the **Display grid** check box in the grid frame to display the grid in the sketch environment as shown in Figure 5.

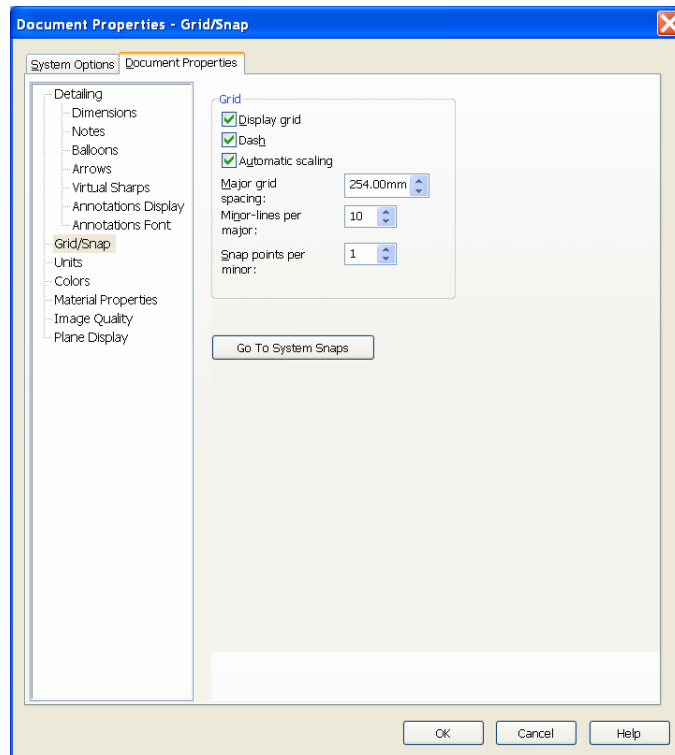



Figure 5 Grid/Snap

- 11) Click **OK** to accept the changed properties and close the dialog box.

Create Extruded Base Feature

- 1) Click **Sketch**  on the Sketch toolbar.
- 2) Bring cursor closer to **Front** plane, when highlighted, Click on it to open a new sketch on **Front** Plane.


- 3) Select **Rectangle**  on the Sketch Tools toolbar.

- 4) Click the origin as one corner of the rectangle.

- 5) Move the mouse up and right, and click to locate the other corner of the rectangle. A rectangle is created. The left vertical line and the bottom horizontal line change the color to black (black is the default color. It could be a different color) because the left lower corner is coincident with the origin, and a coincident relation is applied between the origin and the lower left corner automatically as shown in Figure 6. The top horizontal and right vertical lines are blue (default color) because they need some dimensions to define them.



Figure 6 Partially constrained Rectangle

- 6) Select **Dimension**  on the Sketch Relation toolbar.
- 7) Click the bottom line. Move the mouse below the bottom line. Click to place the dimension.
- 8) Change the dimension to **100 mm**.
- 9) Click the right line. Move the mouse to the right. Click to place the dimension.
- 10) Change the dimension to **70 mm**. The sketch is fully constrained, and turns to black (default color) as shown in Figure 7.

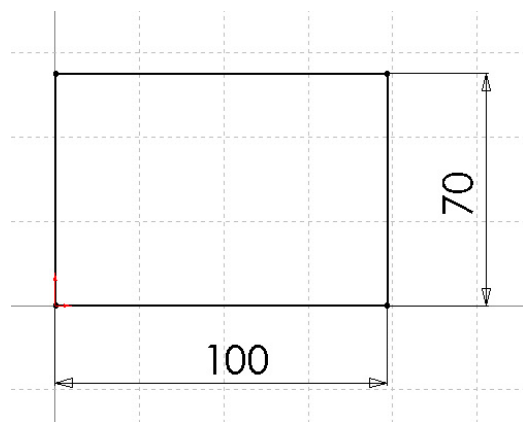





Figure 7 Base sketch of the Block

- 11) Select **Extruded Boss/Base**  on the Features toolbar. The profile changes its orientation to isometric. The PropertyManager appears.
- 12) Move the mouse to the left side of the sketch, and click to accept the extrude direction.
- 13) In the **Depth**  text box, type **85 mm** as shown in Figure 7. Click **OK**  to finish the extruded base feature.

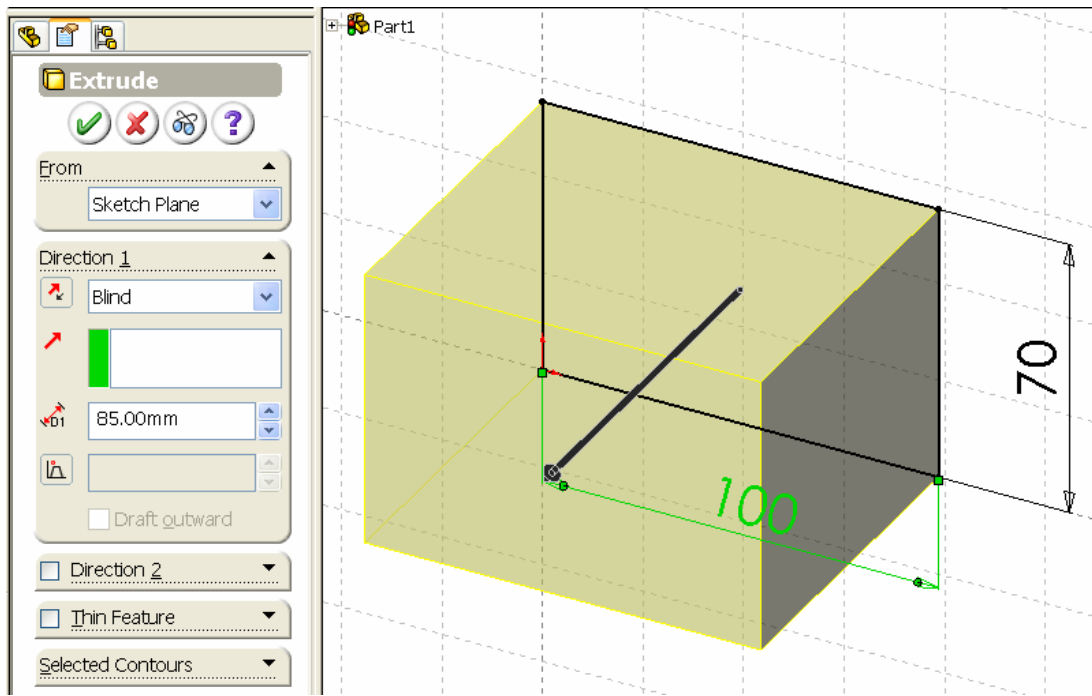




Figure 7 Extruded Base Feature

Cut Rectangular Slot

- 1) Select the front surface of the base feature as shown in Figure 8.
- 2) Select **Sketch**  on the Sketch toolbar to open a sketch on the front surface.
- 3) Select **Normal To**  on the Standard Views toolbar to make the sketch parallel to the screen. (If the Standard Views toolbar is not displayed, select **View, Toolbar, Standard Views** on the menu bar to open the Standard Views toolbar.)

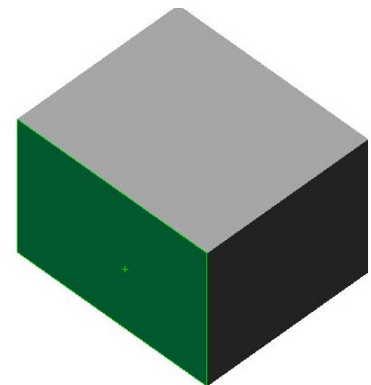




Figure 8 Sketch Plane for Rectangular Slot

- 4) Select **Wireframe**  on the Views toolbar to change the model display to wireframe from the shaded mode.
- 5) Select **Line**  on the Sketch Tools toolbar to draw 3 lines as shown in Figure 9.

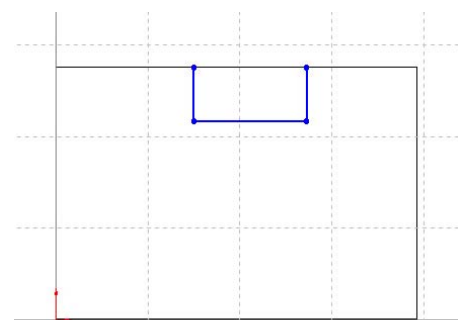




Figure 9 Rectangular Cut Sketch

- 6) Select **Dimension**  on the Sketch Relation toolbar.
- 7) Dimension the sketch as shown in Figure 10. The sketch is fully constrained and turns to black. If not, apply coincident constraints to the endpoints of the vertical lines with the top edge of the part.

- 8) Select **Extruded Cut**  on the Feature toolbar.

- 9) Select **Through All** from the end condition drop down list box in the Cut-Extrude PropertyManager as shown in Figure 11.

- 10) Click **OK**  to finish the cut.

- 11) Click **Shaded**  on the View toolbar to change the model to Shaded mode to check the cut.

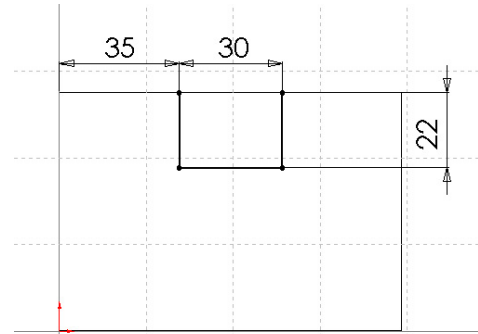


Figure 10 Rectangular Slot Dimensions

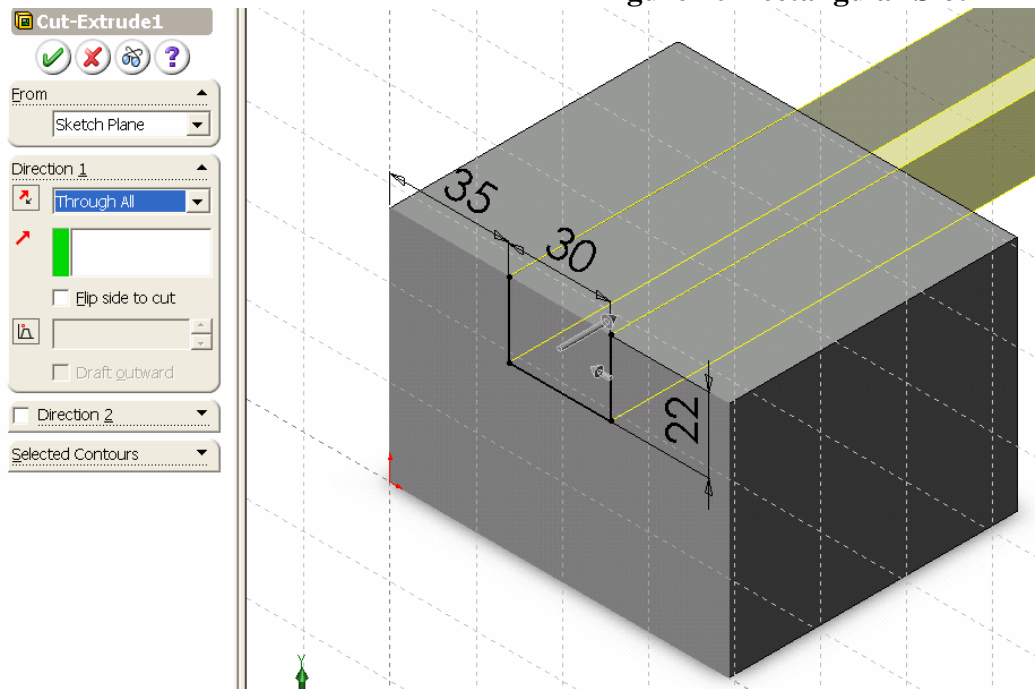





Figure 11 Rectangular Slot Cut

Cut V-Slot

- 1) Select the right surface of the part as the V-Slot sketch plane as shown in Figure 12.
- 2) Select **Sketch**  on the Sketch toolbar to open a new sketch.
- 3) Select **Normal To**  on the Standard Views toolbar to make the sketch parallel to the screen.
- 4) Select **Line**  on the Sketch Tools toolbar.
- 5) Draw five lines to form the geometric V-slot shape as shown in Figure 13.

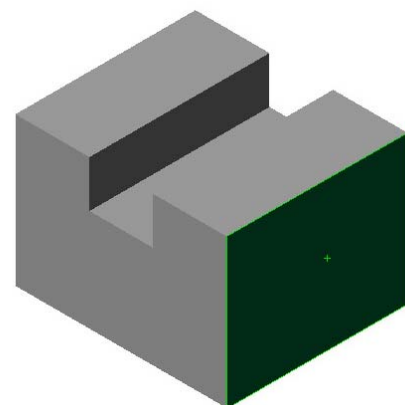


Figure 12 Sketch plane for V-Slot Cut

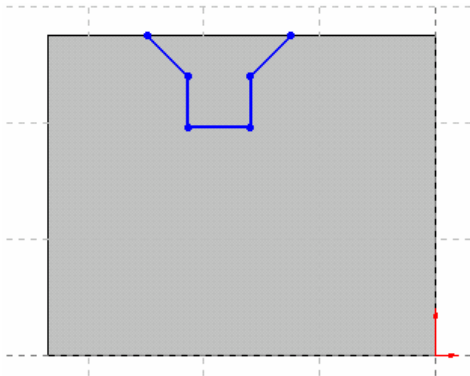


Figure 13 V-Slot Sketch

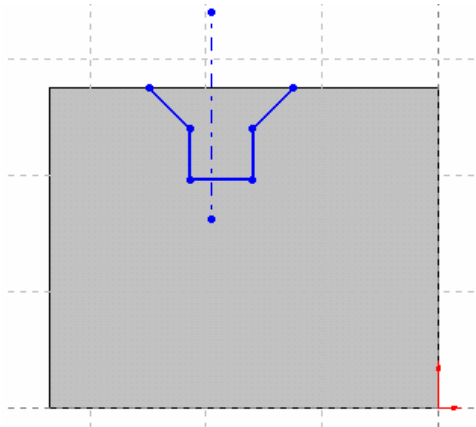






Figure 14 Centerline for V-Slot Sketch

- 6) Select **Centerline**  on the Sketch Tools toolbar.
- 7) Draw a vertical centerline within the V-slot sketch as shown in Figure 14.
- 8) Select **Add Relation**  on the Sketch Relation toolbar.
- 9) Select two angled lines and the centerline.
- 10) Select **Symmetric**  in the *Add Relation PropertyManager* as in Figure 15 to make two angle lines symmetric about the centerline.
- 11) Select two vertical lines and the centerline.
- 12) Select **Symmetric**  in the *Add Relation* dialog box as shown in Figure 16 to make two vertical lines symmetric about the centerline.

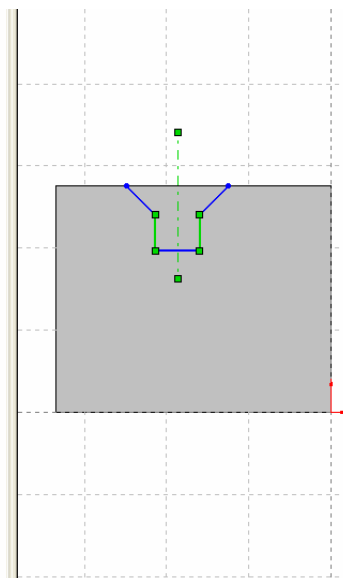
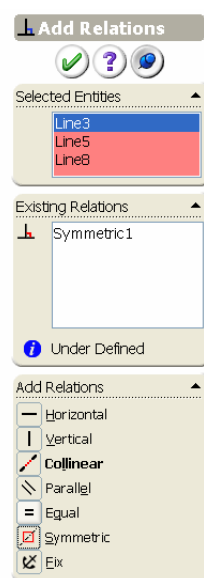
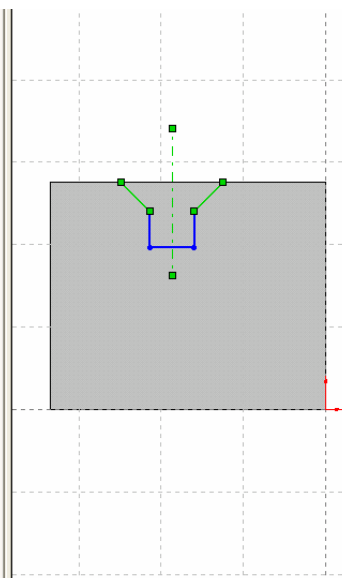
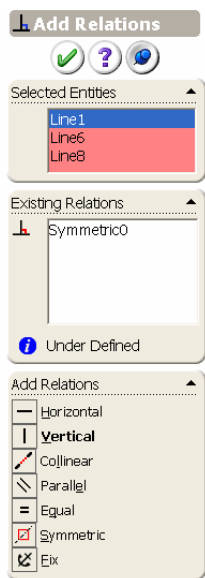



Figure 15 Symmetric Constraints for Two Angled Lines

Figure 16 Symmetric Constraints for Two Vertical Lines

- 13) Select two vertical edge lines on the face and the centerline.
- 14) Select **Symmetric**  in the Add Relation dialog box as shown in Figure 17 to make centerline at the center of face.

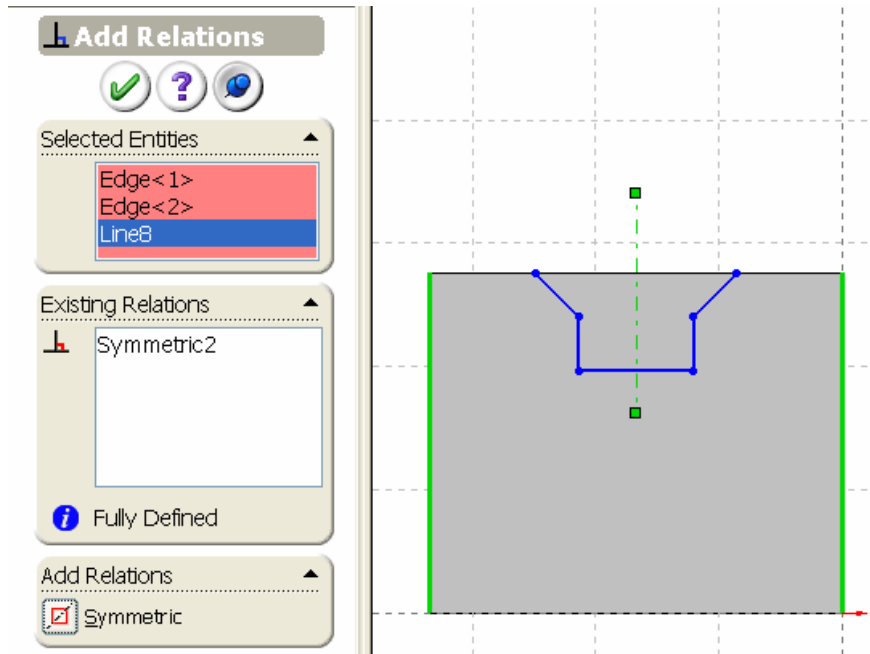



Figure 17 Symmetric Constraints for the centerline at the center of the face

- 15) Click on the **OK**  button to close the Add Relation PropertyManager.
- 16) Select **Dimension** on the Sketch Relation toolbar.

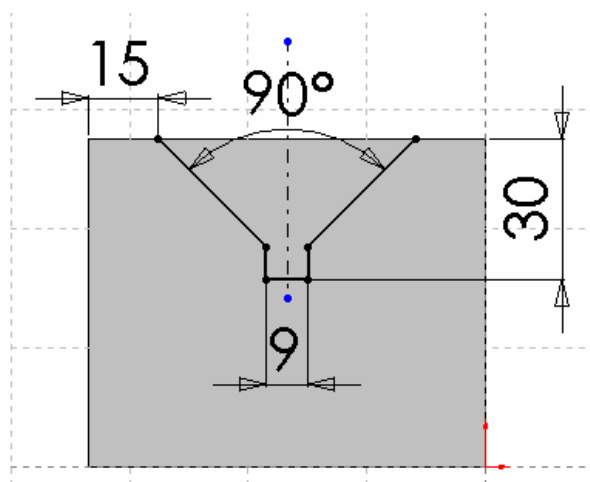



Figure 18 V-Slot dimensions

- 17) Dimension the sketch as shown in Figure 18. The sketch is fully constrained. If not, apply coincident constraints to the two endpoints of the vertical lines with the top edge of the part. You may also drag the end point of the angled line to make it coincident with the top horizontal edge of the part.
- 18) Select **Extruded Cut**  on the Features toolbar
- 19) Select **Through All** from the end condition drop down list box in the Cut-Extrude PropertyManger.
- 20) Uncheck **Direction 2** as shown in Figure 19.

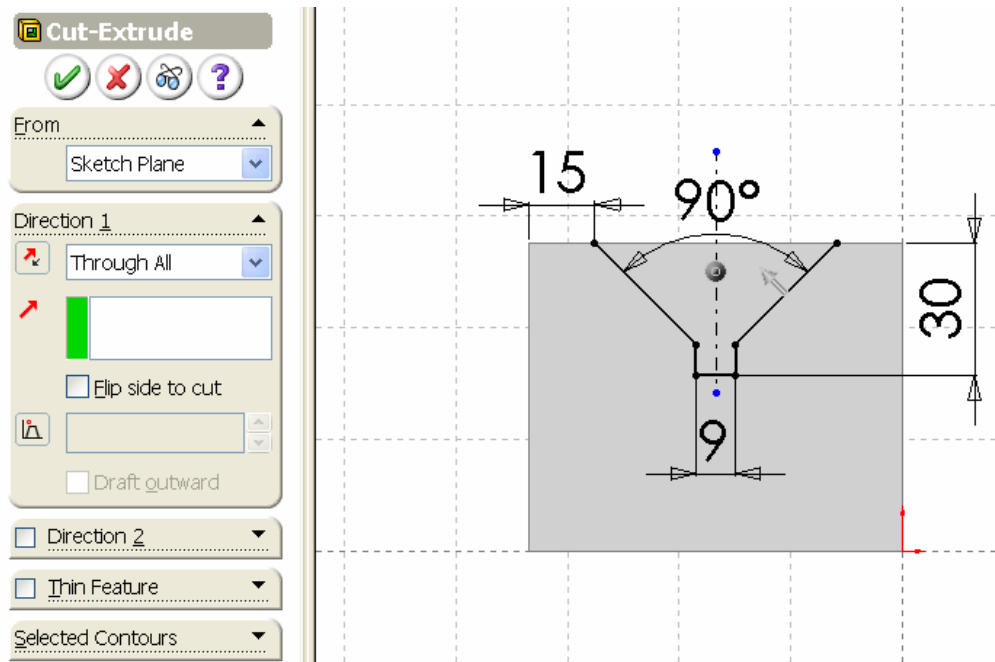






Figure 19 V-Slot Cut.

- 21) Click **OK**  to finish the cut.
- 21) Click **Rotate View**  on the View toolbar, and drag the mouse to rotate the model. Right click and select **Rotate View** from the context menu to end the rotate view command.
- 22) Select **Isometric**  on the Standard Views toolbar to set the part orientation to Isometric.

Cut a Trapezoid Slot

- 1) Select the same surface as the V-Slot cut as the sketch plane for the trapezoid cut as shown in Figure 20.
- 2) Select **Sketch**  on the Sketch toolbar to open a new sketch.

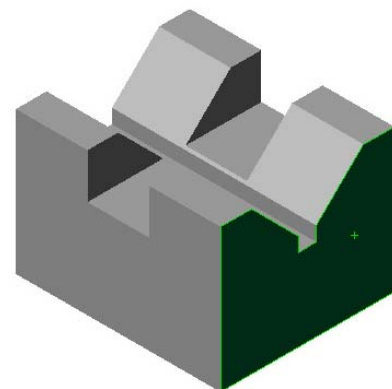





Figure 20 Sketch plane for Trapezoid Slot cut


3) Select **Normal To**  on the Standard Views toolbar to make the sketch parallel to the screen.


4) Select **Line**  from the Sketch Tools toolbar.


5) Draw three lines to form the trapezoid slot sketch as shown in Figure 21.

6) Select **Centerline**  on the Sketch Tools toolbar.

7) Draw a vertical centerline starting from the mid-point of the lowest horizontal edge as the symmetric axis for the trapezoid slot.

8) Select **Add Relation**  on the Sketch Relation toolbar.

9) Select the two angled lines and the centerline. Select **Symmetric**  in the PropertyManager as shown in Figure 22.

10) Click **OK**  to close the PropertyManager.

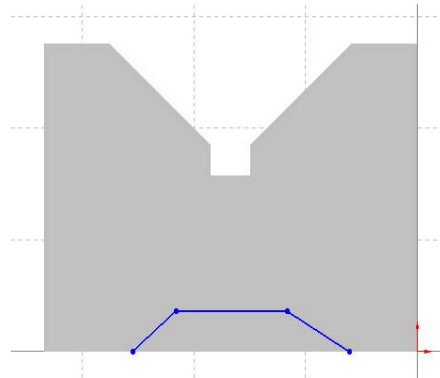


Figure 21 Trapezoid Slot Sketch

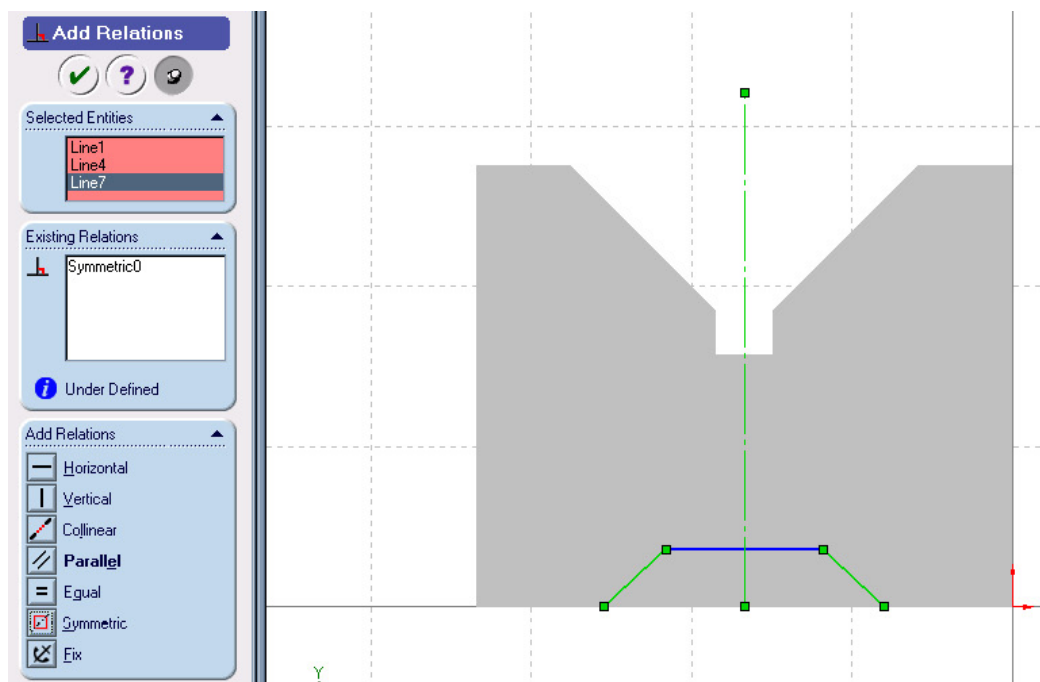




Figure22 Symmetric constraint for Angled lines

- 11) Select **Dimension**  on the Sketch Relation toolbar.
- 12) Dimension the sketch as shown in Figure 23.
- 13) Select **Extruded Cut**  on the Features toolbar.
- 14) Select **Through All** from the end condition drop down list box in the Cut-Extrude PropertyManger.
- 15) Check **Flip side to cut** to change the cut direction toward inside.
- 16) Uncheck **Direction 2** as shown in Figure 24.

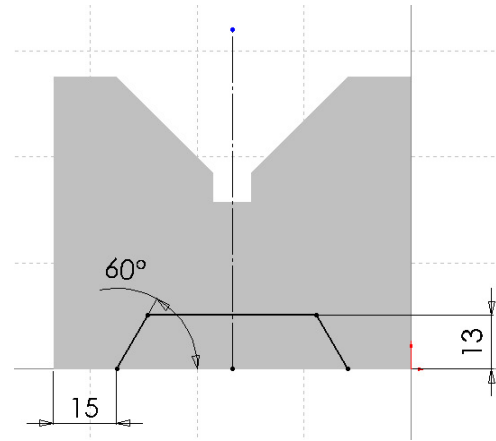


Figure 23 Trapezoid Slot Dimensions

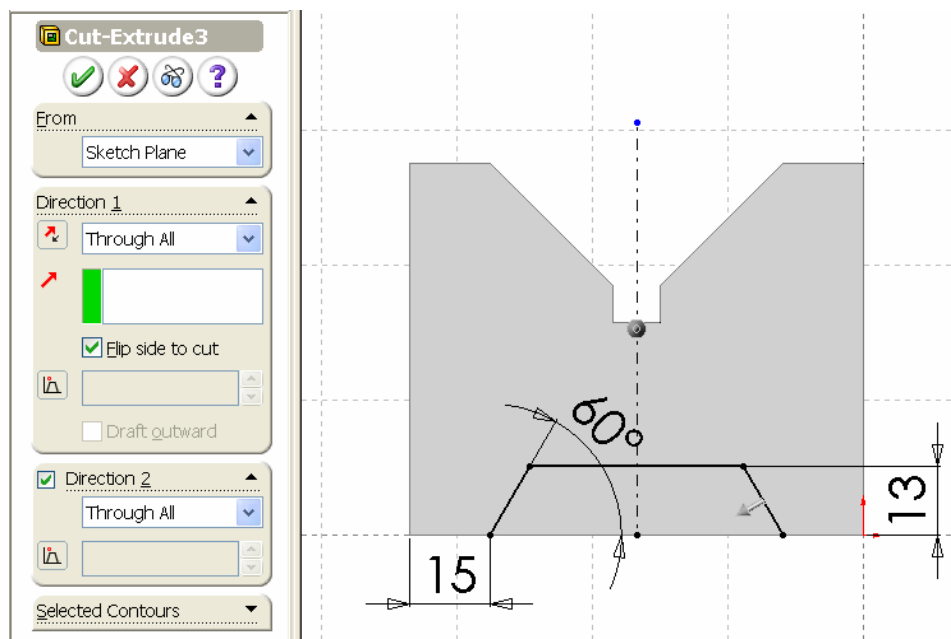



Figure 24 Trapezoid Slot Cut

- 17) Click **OK**  to finish the cut. The final part is shown as in Figure 25.

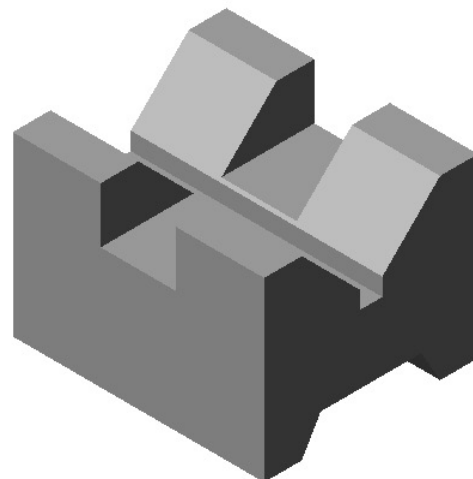


Figure 25 V-Block Model

Change Feature Names and Check Model Mass Properties

Once features are created, they are listed in the *FeatureManager Design Tree* as shown in Figure 25 with default names. You may have slightly different default names. Those names could remain as they are, but, it is recommended to change the default names to make the features recognized easily:

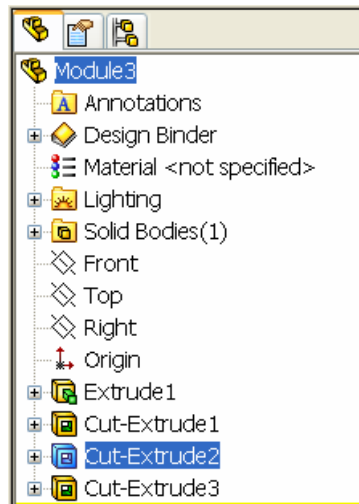


Figure 26 FeatureManager Design Tree

To change the default names:

- 1) Click **Extrude1** twice (not double click) in the FeatureManager Design Tree.
- 2) Type **Block** as the new name.
- 3) Click **Cut-Extrude1** twice, and change it to **Rectangular-Slot**.
- 4) Click **Cut-Extrude2** twice, and change it to **V-Slot**.
- 5) Click **Cut-Extrude3** twice, and change it to **Trapezoid-Slot**.

The new FeatureManger Design Tree is as shown in Figure 27.

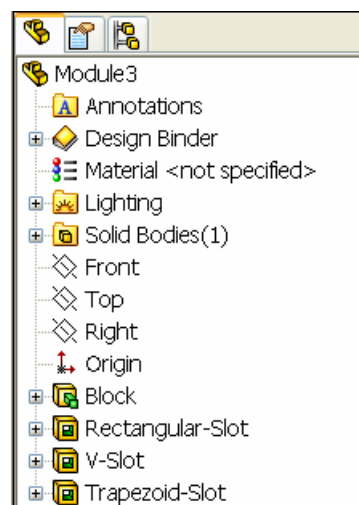


Figure 27 Updated FeatureManager Design Tree

To check the model mass properties:

- 1) Select **Tools, Mass Properties** on the menu bar.
- 2) The Mass Properties dialog box appears. The Measurement Options dialog box appears, and the mass properties are calculated automatically as in Figure 28. **Note:** in the dialog box, the mass density is displayed as 0.01 gram per cubic millimeter because the decimal places format is set as 2. It does not influence the mass properties.

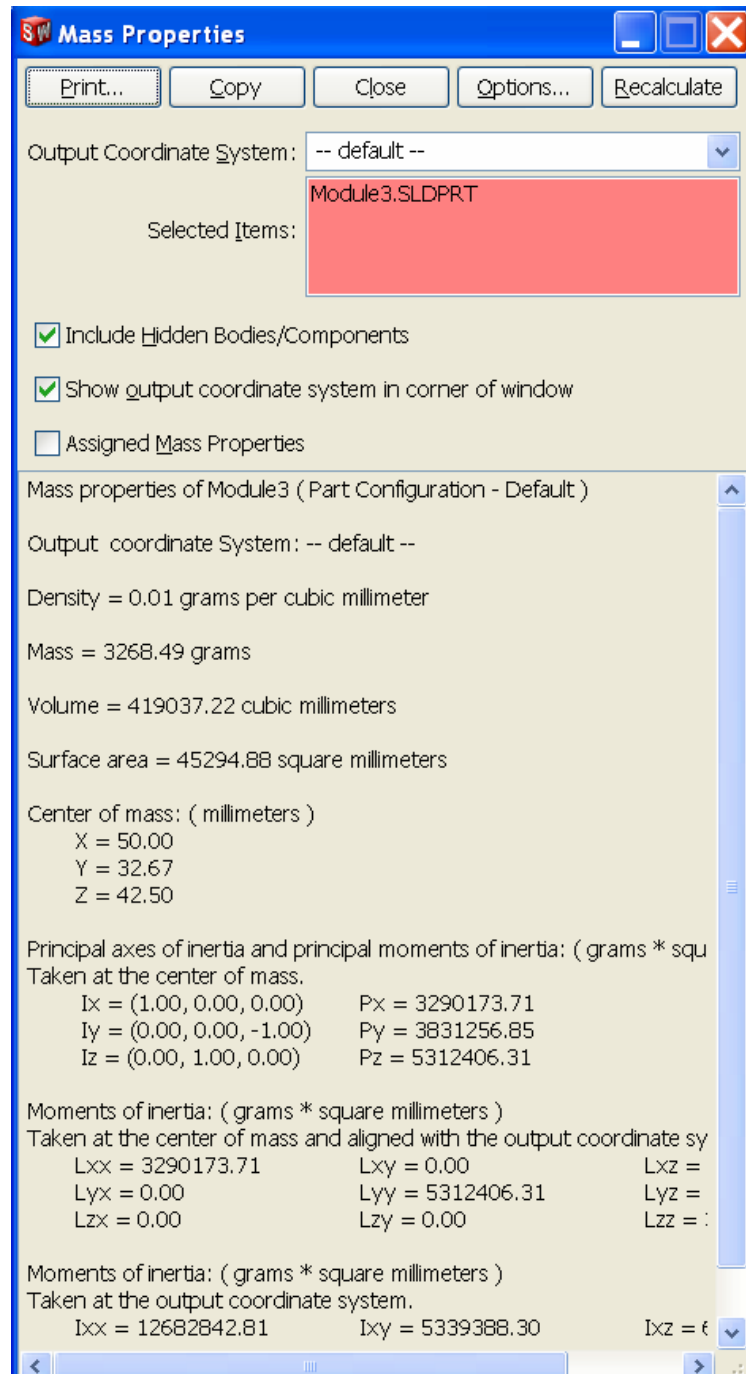


Figure 28 Mass Properties

- 3) To display the correct value of the mass density, select the **Options** button. The **Mass/Section Property Options** dialog box appears as shown in Figure 29. Change the **Decimal Places** to 4, the mass density is displayed as **0.0078 g/mm³** in the Density text box as shown in Figure 30.

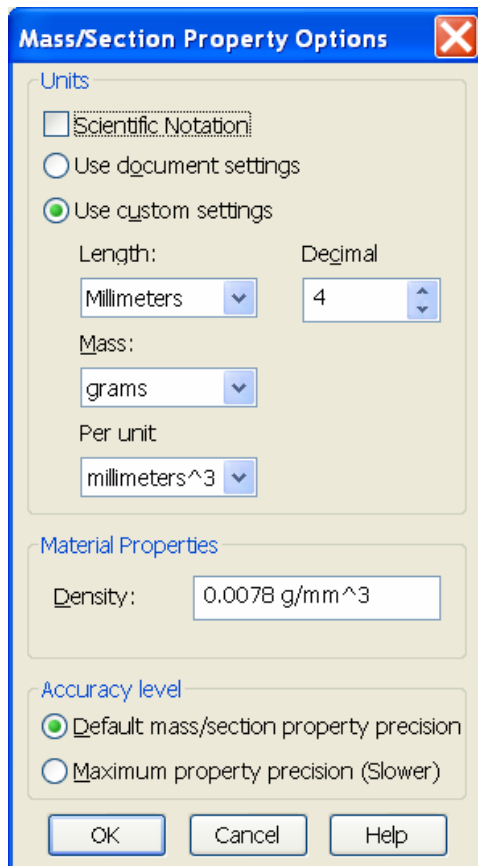


Figure 29 Mass/Section Property Options

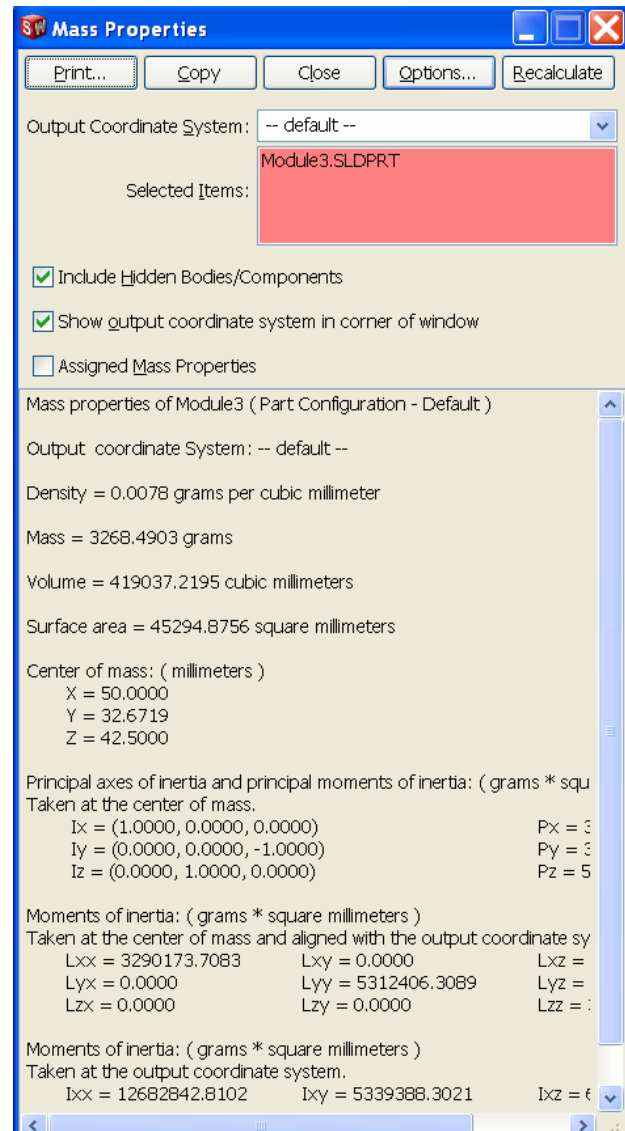



Figure 30 Mass Properties

- 4) Click the **OK** button to close the Options dialog box.
- 5) Click on the **Print** button to print the mass properties, or click **Copy** to copy them into the clipboard. Then they can be copied to other programs.
- 6) Click **Close** to close the Mass Properties dialog box.
- 7) Choose the **Save**  button from the Standard toolbar to save the model.