

Chapter 2

Creating Sketches in the Sketch Mode-I

Learning Objectives

After completing this chapter, you will be able to:

- *Use various tools to create geometry.*
- *Dimension a sketch.*
- *Apply constraints to a sketch.*
- *Modify a sketch.*
- *Use the Modify Dimensions dialog box.*
- *Edit the geometry of a sketch by trimming.*
- *Mirror a sketch.*
- *Insert standard/user-defined sketches.*
- *Use the drawing display options.*



THE SKETCH MODE

Almost all models designed in Pro/ENGINEER Wildfire 5.0 consist of datums, sketched features, and placed features. For creating datums and placed features, you do not need to draw sketches. However, to create a three-dimensional (3D) feature, it is necessary to draw its two-dimensional (2D) sketch. When you enter the **Part** mode and select the options to create any sketched feature, the system automatically takes you to the sketcher environment. In the sketcher environment, the sketch of the feature is created, dimensioned, and constrained. The sketches created in the **Sketch** mode are stored in the .sec format. Then you return to the **Part** mode to create the required feature.



Note

You will learn about datums and placed features in later chapters.

In Pro/ENGINEER Wildfire, a sketch can be drawn in the **Sketch** mode or in the sketcher environment. A designer can draw a 2D sketch of the product and assign the required dimensions and constraints to it. By assigning the dimensions, the designer can make sure that the 2D sketch of the product or model is satisfying the necessary conditions; then continue to create the 3D model of the product in the **Part** mode.

Working with the Sketch Mode

To create any section in the **Sketch** mode of Pro/ENGINEER Wildfire 5.0, certain basic steps have to be followed. The following points outline the steps to draw a sketch in the **Sketch** mode:

1. Sketch the required section geometry

The different sketcher tools available in this mode can be used to sketch the required section geometry.

2. Add the constraints and dimensions to the sketched section

While sketching the section geometry, weak constraints and dimensions are automatically added to the section. The sketch can also be dimensioned and constrained manually. The dimensions that are applied manually are called strong dimensions. After adding the dimensions, you can modify them as required.

3. Add relations to the sketch if needed

The geometry of the sketch can be controlled by adding relations.

4. Regenerate the section

If the sketch is fully dimensioned and constrained, the sketch is automatically regenerated. Throughout this book, it is assumed that you are sketching in the **Sketch** mode with the **Intent Manager** on. Pro/ENGINEER has the capability to analyze the section, and if the section is not complete for any reason, the section will not be regenerated. You will learn about these reasons as you go through this chapter.



Tip: Throughout this book, the sketcher environment is referred to the environment in Pro/ENGINEER where you can draw 2D geometries. Apart from the **Sketch** mode, the sketcher environment can be accessed in other modes of Pro/ENGINEER.

Invoking the Sketch Mode

To invoke the **Sketch** mode, choose **New** from the **File** menu or choose the **New** button from the **File** toolbar; the **New** dialog box will be displayed with other Pro/ENGINEER modes. Select the **Sketch** radio button to start a new file in the **Sketch** mode, see Figure 2-1; a default name of the sketch file appears in the **Name** edit box. You can change the sketch name as required and then choose the **OK** button to enter the **Sketch** mode.

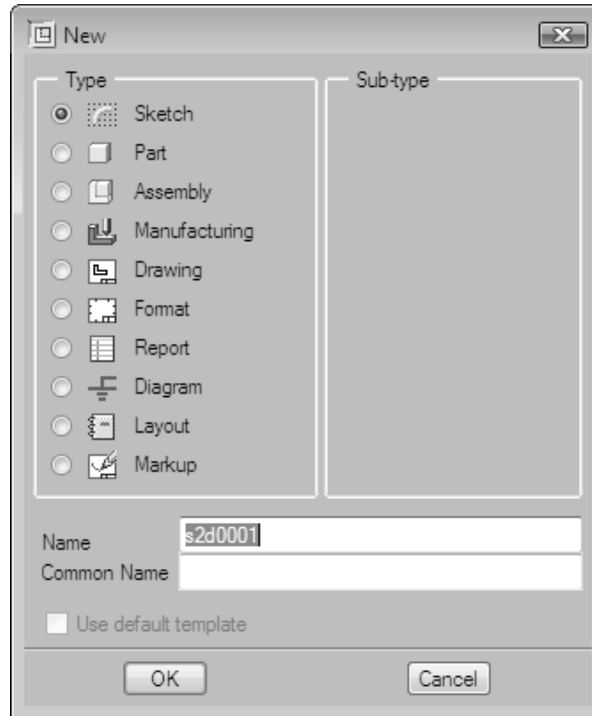


Figure 2-1 The New dialog box

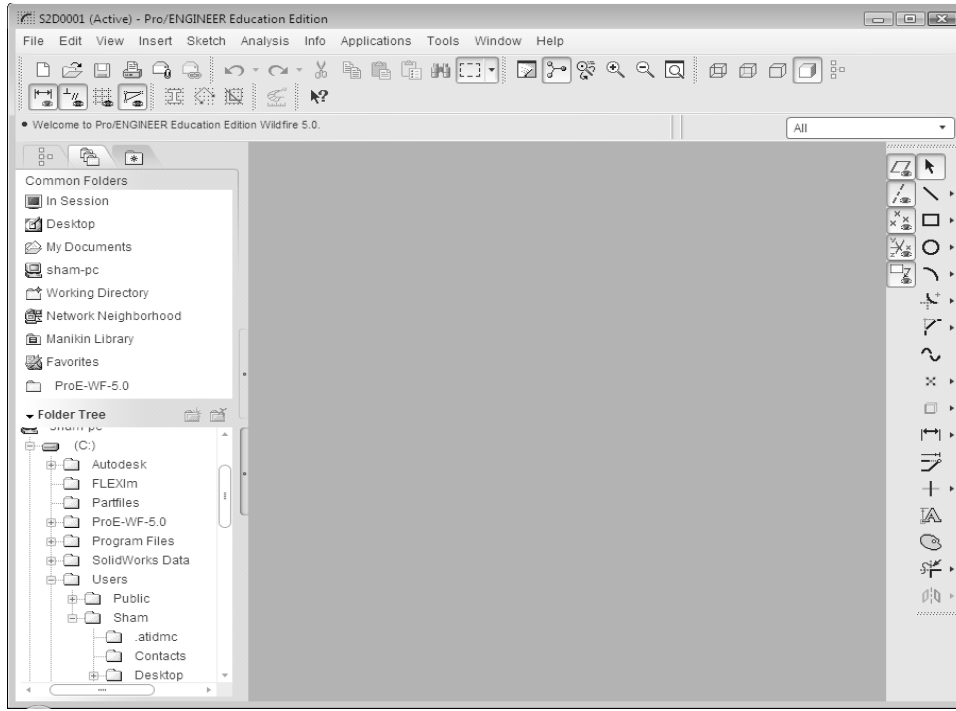
THE SKETCHER ENVIRONMENT

When you invoke the **Sketch** mode, the initial screen appeared is similar to the one shown in Figure 2-2. This figure also shows the **Sketcher Tools** toolbar that will be displayed on the right side of the drawing area. The buttons in this toolbar are used to draw sketches. The drawing tools are also available in the **Sketch** menu in the menu bar. When you enter the sketcher environment, the **Intent Manager** is turned on by default. Also, when you are in the selection mode, shortcut menus can be invoked by holding down the right mouse button in the drawing area. The options in these shortcut menus vary depending on the item selected. These shortcut menus also contain the tools to draw the sketches.



Note

*Datum planes are not displayed in the **Sketch** mode.*



*Figure 2-2 Initial screen appearance in the **Sketch** mode*

The navigator is displayed on the left of the drawing area. In navigator, the **Folder Browser** tab is activated by default. It covers a part of the drawing area and therefore, the drawing area is decreased. You can increase the drawing area by clicking on the navigator sash, which is present on the right edge of the navigator.



Note

The **Folder Browser** tab is divided into two sections, **Common Folders** and **Folder Tree**. The functions of the **Common Folders** and the **Folder Tree** sections have already been discussed in Chapter 1.

WORKING WITH A SKETCH IN THE SKETCH MODE

When you invoke the sketcher environment, the **One-by-One** button is chosen by default, in the **Sketcher Tools** toolbar. If this button is chosen, the sketcher environment is said to be in the selection mode. In the selection mode, you can select entities of the sketch to edit or to invoke the shortcut menu. The options in the shortcut menu can be used to apply various operations on the selected item.



Note

The sketch is saved with a **.sec** file extension.

You can create a simple sketch by using the options available in the shortcut menu. To invoke

the shortcut menu, hold down the right mouse button in the drawing area. Note that, once the shortcut menu will be displayed, the right mouse button can be released.

DRAWING A SKETCH USING THE SKETCHER TOOLS TOOLBAR

When you are in the sketcher environment, the **Sketcher Tools** toolbar, available on the **Right Toolchest**, contains the buttons to draw a sketch, dimension it, and modify the dimensions. In this section, you will learn how to draw sketched entities using the button available in the **Sketcher Tools** toolbar.

Placing a Point



Points are generally used for dimensioning the vertices that are removed while applying fillets. For example, if the sketch is to be dimensioned using these vertices, you need to place points on them before applying fillets. Now, since a point is placed at the vertex, you can easily use it for dimensioning the sketch. The following steps explain the procedure to sketch a point:

1. Choose the **Point** button from the **Sketcher Tools** toolbar; the system prompts you to select a location for the point.
2. As soon as you select the location of the point by clicking, the point is placed at the desired location in the drawing area.



Note

To increase the number of visible command prompt lines in the message area, select the bottom sash of the message area using the left mouse button and drag it downward, toward the screen.

When you place a single point, no dimensions appear. But, when you place two points, they are dimensioned with respect to each other.

Drawing a Line

To draw lines, there are four buttons in the **Sketcher Tools** toolbar. To view these buttons, choose the black arrow on the right of the **Line** button; a flyout will appear with four buttons. The first button is the **Line** button. This button is used to create a line by selecting two points in the drawing area. The second button in the flyout is the **Line Tangent** button. This button is used to create a tangent line between two entities. The third button is the **Centerline** button, which is used to create a centerline by selecting two points in the drawing area. Centerline is used for creating revolved features, mirroring, and so on. The fourth button is the **Geometry Centerline** button that enables you to create a centerline that can be referenced outside the sketcher environment.

The procedure to create lines by using these buttons is discussed next.

Drawing a Line Using the Line Button



The following steps explain the procedure to create a line using the **Line** button:

1. Choose the **Line** button. Click in the drawing area to start the line; a rubber-band line appears from the selected point with the other end attached to the cursor. The symbols **V** and **H** that appear while drawing the vertical and horizontal lines are called constraints. Constraints are discussed later in this chapter.
2. After specifying the start point for the line, move the cursor in the drawing area to a desired location and click to specify the endpoint of the line; the line appears in yellow color. The rubber-band line continues and you can draw the second line.
3. Repeat step 2 until all lines are drawn. You can end the line creation by pressing the middle mouse button. To abort the line creation, press the middle mouse button again.



Note

If you draw a single line, the color of the line drawn is red. If you draw multiple lines, the color is yellow.

*After drawing a line, when you press the middle mouse button to end the line creation, the line drawn is highlighted in red color. In the sketcher environment, the red color of an entity indicates that it is selected. If you press the **DELETE** key, the line will be erased from the drawing area. After drawing a line, weak dimensions are applied to the sketch and they appear in gray color. These weak dimensions are applied automatically to the sketched entities as you draw them. The concept of weak dimensions is discussed later in this chapter.*

Drawing a Line Using the Line Tangent Button



The **Line Tangent** button is used to draw a tangent line between two entities such as arcs, circles, splines, or a combination of these. The following steps explain the procedure to draw a tangent using this button:

1. Choose the black arrow on the right of the **Line** button and then choose the **Line Tangent** button from the **Sketcher Tools** toolbar; you will be prompted to select the start location on an arc or circle.
2. Select the first entity from where the tangent line will be drawn; a rubber-band line appends with the cursor. Also, you will be prompted to select the end location on an arc or circle. As soon as you select the second entity, a line that is tangent to both the selected entities is drawn.



Note

*Whenever you will be prompted to select an entity in the sketcher environment, the **Select** message box will be displayed. You can ignore this dialog box because it appears automatically and disappears without any confirmation.*

Drawing a Line Using the Centerline Button



You can draw horizontal, vertical, or inclined centerlines using the **Centerline** button. This button is available in the flyout that will be displayed when you choose the black arrow on the right of the **Line** button. The centerline in a sketch is used as an axis of rotation, for mirroring, aligning, and dimensioning entities.

The steps discussed next explain the procedure to draw a centerline:

1. In the **Sketcher Tools** toolbar, choose the black arrow on the right of the **Line** button and then choose the **Centerline** button; you will be prompted to select the start point.
2. Click in the drawing area to specify the start point. Now, you will be prompted to select the end point.
3. Click in the drawing area to specify the endpoint; a centerline of infinite length is drawn.

Drawing a Line Using the Geometry Centerline Button



The **Geometry Centerline** button is used to create centerlines as a part of the geometry. The centerline created by using this button can be referenced outside the sketcher environment. The steps to create a geometry centerline by using the **Geometry Centerline** button are the same as that of using the **Centerline** tool. To invoke the **Geometry Centerline** tool, choose the black arrow on the right of the **Line** button and then choose the **Geometry Centerline** button from the flyout displayed. Next, specify the start and end points of the geometry centerline; a centerline of infinite length will be created in the drawing area.



Drawing a Rectangle



The following steps explain the procedure to create a rectangle using the **Rectangle** button:

1. Choose the **Rectangle** button from the **Sketcher Tools** toolbar; you will be prompted to select two points to indicate the diagonal of box. Click to specify the first point; a yellow rubber-band box appears with the cursor attached to the opposite corner of the box.
2. Move the cursor to the desired location in the drawing area and then click to specify the second point for the diagonal of the rectangle.

Drawing a Circle

In the **Sketcher Tools** toolbar, there are four buttons to draw a circle and two buttons to draw an ellipse. To view these buttons available for drawing circles and ellipses, choose the black arrow on the right of the **Center and Point** button; a flyout will appear with six buttons. The procedures to create a circle and an ellipse by using various buttons are discussed next.

Drawing a Circle Using the Center and Point Button



As the name suggests, the **Center and Point** button is used to draw a circle by specifying the center of the circle and a point on it. The following steps explain the procedure to draw a circle using this button.

1. Choose the **Center and Point** button; you will be prompted to select the center of a circle.

2. Click in the drawing area to specify the center point of the circle; you will be prompted to select a point on the circle. Also, a yellow rubber-band circle appears with the center at the specified point and the cursor attached to its circumference.
3. Move the cursor to specify the size of circle. Click to complete the creation of the circle; you will be prompted again to select the center of the circle.
4. Repeat steps 2 and 3 until you have drawn all required circles. If you want to abort the process of circle creation, press the middle mouse button.

Drawing a Construction Circle

A construction circle is a circle that is used to align entities, create diametrical or radial dimensions, and to reference the entities. Figure 2-3 shows an application of a construction circle. In the sketch of a flange, centers of the circles lie on a particular bolt circle diameter (BCD) that is defined using a construction circle.

To create a construction circle, draw a circle or select a previously drawn circle. Then, hold the right mouse button to invoke the shortcut menu, as shown in Figure 2-4. Choose the **Construction** option from the shortcut menu; the circle will appear dotted in yellow color, indicating that it is a construction circle.

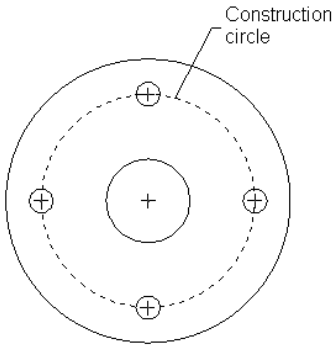


Figure 2-3 Sketch of a flange

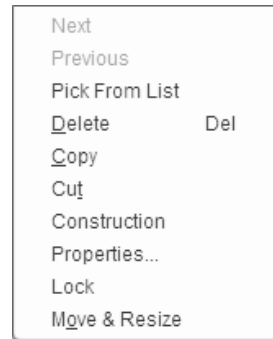


Figure 2-4 The Construction option in the shortcut menu

Drawing a Circle Using the Concentric Button



The following steps explain the procedure to draw a concentric circle using the **Concentric** button:

1. Choose the **Concentric** button from the flyout in the **Sketcher Tools** toolbar; you will be prompted to select an arc to determine the center. You can select an arc or a circle to specify the center point.
2. Click on an arc or a circle to determine the concentricity of the circle to be drawn. Move the mouse and click at the required location to specify the size of circle.
3. To finish the creation of the circle, press the middle mouse button.



Tip: To convert a construction circle back to a geometric entity, select the construction circle and hold the right mouse button to invoke the shortcut menu. From the shortcut menu, choose the **Geometry** option.

Drawing a Circle Using the 3 Point Button



The following steps explain the procedure to draw a circle using the **3 Point** button:

1. Choose the **3 Point** button from the flyout in the **Sketcher Tools** toolbar; you will be prompted to specify the first point on the circle.
2. Click to specify the first point at the desired location in the drawing area; you will be prompted to select the second point on the circle. Move the cursor and click to specify the second point in the drawing area.
3. As you select the second point, a yellow rubber-band circle appears with the cursor attached to it and you are prompted to select the third point. Move the mouse to size the circle and click to specify the third point; a circle is drawn and you are prompted again to select the first point on the circle to draw the next circle.
4. You can press the middle mouse button to finish the creation of the circle. Also, you can press the middle mouse button at any stage in the circle creation to abort it.

Drawing a Circle Using the 3 Tangent Button



The **3 Tangent** button is used to draw a circle tangent to three existing entities. This button references other entities to draw a circle. The circle created using this button is drawn irrespective of the points selected on the entities. The following steps explain the procedure to draw a circle using the **3 Tangent** button:

1. Choose the **3 Tangent** button from the flyout in the **Sketcher Tools** toolbar; you will be prompted to select the start location on an arc, circle, or line.
2. Select the first entity; the color of the entity changes to red and you will be prompted to select the end location on an arc, circle, or line. Select the second tangent entity; you will be prompted to select the third location on an arc, circle, or line. Select the third tangent entity; a circle tangent to these three entities is drawn.
3. To end the process of creating the circle, press the middle mouse button.

Drawing an Ellipse Using the Axis Ends Ellipse Button



The following steps explain the procedure to draw an ellipse by using the **Axis Ends Ellipse** button:

1. Choose the **Axis Ends Ellipse** button from the flyout in the **Sketcher Tools** toolbar; you will be prompted to select the start point of the major axis of the ellipse.
2. Click in the drawing area to specify the start point of the major axis; you will be prompted to select the endpoint of the major axis.



3. Click in the drawing area to specify the endpoint; a yellow rubber-band ellipse will appear with the cursor attached to it. Also, you will be prompted to select a point on the minor axis to define the ellipse.
4. Click to specify the point; an ellipse will be created. You can press the middle mouse button to end the creation of the circle.

Drawing an Ellipse Using the Center and Axis Ellipse Button



The following steps explain the procedure to draw an ellipse by using the **Center and Axis Ellipse** button:

1. Choose the **Center and Axis Ellipse** button from the flyout in the **Sketcher Tools** toolbar; you will be prompted to specify the center of the ellipse.
2. Click at the desired location in the drawing area to specify the center point; you will be prompted to select the endpoint of the major axis of the ellipse. Click in the drawing area to specify the point; a yellow rubber-band ellipse will appear with the cursor attached to the ellipse. Move the cursor in the drawing area to size the ellipse.
3. An ellipse is drawn when you click to specify the endpoint on the minor axis of the ellipse. The dimensions for the major radius and the minor radius will be displayed in gray color. The gray color indicates that the dimensions are weak.

Drawing an Arc

To draw an arc there are five buttons in the **Sketcher Tools** toolbar. To view them, choose the black arrow on the right of the **3-Point / Tangent End** button; the flyout appears with five buttons. The procedures to draw arcs using various buttons in the flyout are discussed next.

Drawing an Arc Using the 3-Point / Tangent End Button



The **3-Point / Tangent End** button is used to draw arcs that are tangent from the endpoint of an existing entity, or by defining three points in the drawing area.

When you choose this button to draw an arc from an endpoint, the **Target** symbol will be displayed as soon as you select an endpoint. This **Target** symbol is a green colored circle that is divided into four quadrants. The following steps explain the procedure to draw an arc from the endpoint of an existing entity by using this tool:

1. Choose the **3-Point / Tangent End** button from the **Sketcher Tools** toolbar; you will be prompted to select the start point of the arc.
2. Specify three points in the drawing area to draw an arc. If you want to draw an arc from the endpoint of an existing entity, select the endpoint of that entity. As soon as you select the endpoint, the **Target** symbol appears at the endpoint of the entity. Move the cursor along the tangent direction through a small distance, a yellow rubber-band arc appears with one end attached to the endpoint of the entity and the other end attached to the cursor. Note that when you move the cursor out of the **Target** symbol perpendicular to

the endpoint, an arc is drawn by specifying three points. In this case, the rubber-band arc does not appear, as shown in Figure 2-5.

On the other hand, if you move the cursor out horizontally from one of the quadrants of the **Target** symbol, an arc is drawn tangent to the endpoint, as shown in Figure 2-6.

3. Move the cursor to the desired position in the drawing area to size the arc. Use the left mouse button to complete the arc.

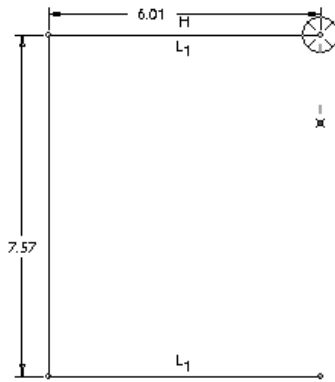


Figure 2-5 Cursor moved out of the **Target** symbol perpendicular to the endpoint

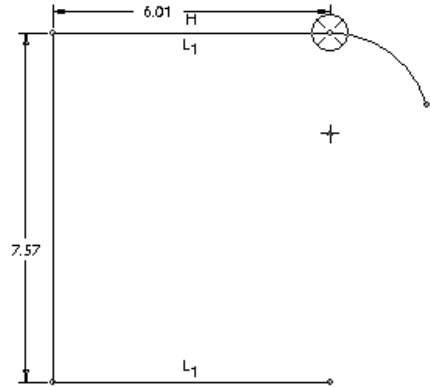


Figure 2-6 Cursor moved out of the **Target** symbol along the tangent direction



Tip: If you do not want to draw a tangent arc, move the cursor out of the **Target** symbol perpendicular to the endpoint.

Drawing an Arc Using the Concentric Button



The **Concentric** button is used to draw an arc concentric to an existing arc. You will have to select an entity to which the arc will be concentric. The entity selected must be an arc or a circle. The following steps explain the procedure to draw an arc using this button:

1. Choose the black arrow on the right of the **3-Point / Tangent End** button, the flyout appear with five buttons. Choose the **Concentric** button from the flyout; you will be prompted to select an arc to determine the center of the arc to be created.
2. As you select an entity, a dotted circle will appear on the screen and you will be prompted to select the start point of the arc. Click to specify the startpoint; a yellow rubber-band arc will appear with one end attached to the start point. As you move the cursor, the length of the arc will change and you will be prompted to select the endpoint of the arc.
3. Click to specify the endpoint; the arc will be created.

You can continue drawing another arc or end the arc creation by pressing the middle mouse button.

Drawing an Arc Using the Center and Ends Button



The following steps explain the procedure to draw an arc using the **Center and Ends** button:

1. Choose the **Center and Ends** button from the flyout in the **Sketcher Tools** toolbar; you will be prompted to select the center of the arc.
2. Click to specify a center point for the arc in the drawing area; a yellow colored center mark appears at that point. Now, you will be prompted to select the start point of the arc. As you move the cursor, a dotted circle appears and is attached to the cursor.
3. Specify the start point of the arc on the circumference of the dotted circle; a yellow rubber-band arc will appear from the start point. The length of this arc will change dynamically as you move the cursor and you will be prompted to select the endpoint of the arc.
4. Move the cursor to size the arc and then click to select the endpoint of the arc; an arc will be drawn between the two specified points.



Note

You can draw only one arc with one center. If you want to draw another arc, you will have to select the center again.

Drawing an Arc Using the 3 Tangent Button



The **3 Tangent** button is used to draw an arc that is tangent to three selected entities. The following steps explain the procedure to draw an arc using this button:

1. Choose the black arrow on the right of the **3-Point / Tangent End** button and then choose the **3 Tangent** button from the flyout in the **Sketcher Tools** toolbar; you will be prompted to select the start location on an arc, circle, or line.
2. As soon as you select the first entity, the color of the entity changes to red and you will be prompted to select the end location on an arc, circle, or line.
3. After doing so, you will be prompted to select a third location on an arc, circle, or line. Select the third entity; an arc is drawn tangent to the three selected entities.

You can continue drawing arcs or press the middle mouse button to abort arc creation.

Drawing an Arc Using the Conic Button



The **Conic** button is used to draw a conic arc. The following steps explain the procedure to draw a conic arc using this button:

1. Choose the **Conic** button from the flyout in the **Sketcher Tools** toolbar; you will be prompted to specify the first endpoint of the conic entity.
2. Click to specify the first point in the drawing area; you will be prompted to specify the second endpoint of the conic entity.

- Click to specify the second endpoint; a centerline is drawn between the two points and you will be prompted to specify the shoulder point of the conic. Specify a point on the screen; the conic arc is drawn.

**Note**

If you delete the centerline of the conic arc, the arc will not be deleted.

Note that if the conic arc is the only entity in the drawing area, then you cannot delete its centerline.

DIMENSIONING THE SKETCH

After you draw a sketch, the next step involves the dimensioning of the sketch. The basic purpose of dimensioning in Pro/ENGINEER is to control the size of the sketch and to locate it with some reference. In Pro/ENGINEER, a sketch cannot be regenerated unless it is fully dimensioned and constrained. The phrase “the sketch cannot be regenerated” means that the sketch is not accepted by Pro/ENGINEER.

By default, sketched entities are dimensioned and constrained automatically while sketching. However, sometimes you need to add additional dimensions to the sketch. The **Normal** button in the **Sketcher Tools** toolbar is used to manually dimension the entities. You can also choose **Sketch > Dimension** from the menu bar to display a cascading menu, as shown in Figure 2-7. This menu contains different dimensioning options.

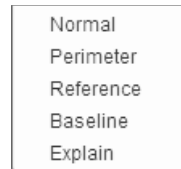


Figure 2-7 Dimensioning options

**Note**

*When the intent manager is off, the dimensions and constraints are not automatically applied. You need to manually add the dimensions by choosing the **Dimension** option from the **Sketch** menu.*

Converting a Weak Dimension into a Strong Dimension

As discussed earlier, when you draw a sketch, some weak dimensions are automatically applied to the sketch. As you proceed to complete the sketch, these dimensions are automatically deleted from the sketch without any confirmation.

Select a weak dimension from the drawing area; the selected dimension will be highlighted in red. Press and hold the right mouse button to invoke the shortcut menu, as shown in Figure 2-8. Choose the **Strong** option from the shortcut menu and then click outside using the middle mouse button. Alternatively, press CTRL+T to convert the selected dimension to a strong dimension.

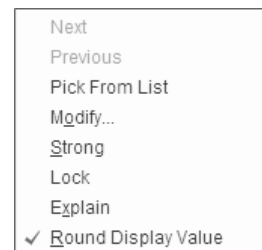


Figure 2-8 Shortcut menu to convert the weak dimensions to strong

You can also choose **Edit > Convert To > Strong** from the menu bar; the color of the selected dimension is changed from gray to orange, indicating that the selected dimension is made permanent.

Dimensioning a Sketch Using the Normal Button or the Normal Option



The **Normal** button or the **Normal** option is used for normal dimensioning of the sketch. The following steps explain the procedure to dimension a sketch using this option:

1. Choose the **Normal** button from the **Sketcher Tools** toolbar. Click on the entity you want to dimension; the color of the entity changes from yellow to red.
2. Move the cursor and place the dimension at the desired place by pressing the middle mouse button. You can modify the dimension values using the modifying options that will be discussed later in this chapter.

The remaining options in the cascading menu are not used while sketching and they are discussed in Chapter 3.

DIMENSIONING THE BASIC SKETCHED ENTITIES

Choose the **Normal** button and follow the procedures given below to dimension the sketched entities.

Linear Dimensioning of a Line

You can dimension a line by selecting its endpoints or by selecting the line. After selecting the two endpoints or the line, press the middle mouse button to place the dimension. If the line is inclined and you select the two endpoints to dimension, then the location where you press the middle mouse button is important, because it defines the orientation of the dimension that will be displayed on the screen.

Figure 2-9 shows the three possible orientations of dimension that can be displayed when you dimension a line.



Note

It is not possible to dimension a line in three orientations simultaneously in the sketcher environment. The dimensions in Figure 2-9 are shown for explanation purpose only.

Angular Dimensioning of an Arc

To add angular dimension to an arc, select both ends of the arc by pressing the left mouse button and then select a point on the arc. Next, place the dimension at the desired point by pressing the middle mouse button. The dimension, as shown in Figure 2-10, is displayed. You can modify the dimension using tools that are discussed later.

Diameter Dimensioning

For diameter dimensioning, click on a circle twice. Then place the dimension at the desired location by pressing the middle mouse button. The diameter dimension will be displayed, as shown in Figure 2-11. The same diameter dimensioning technique can also be used for arcs.

x - Cursor location
MMB - Middle mouse button
AD - Aligned dimension
HD - Horizontal dimension
VD - Vertical dimension

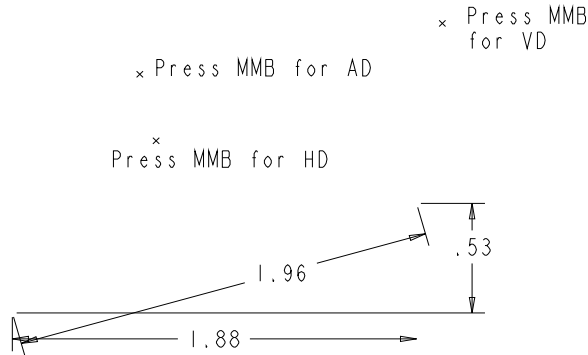


Figure 2-9 Approximate locations of the cursor to achieve different dimensions

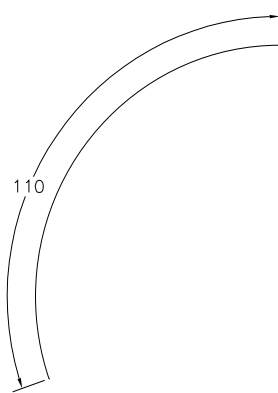


Figure 2-10 Angular dimensioning

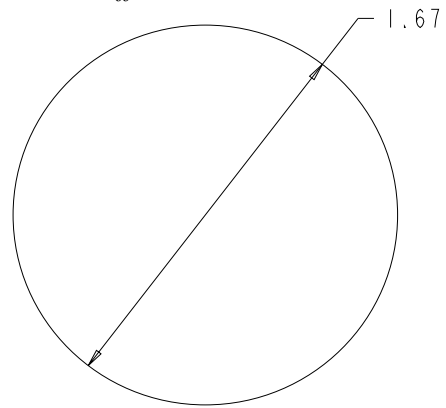


Figure 2-11 Diameter dimensioning

Radial Dimensioning

For radial dimensioning, click on the entity once. Then, place the dimension at the desired location by pressing the middle mouse button. The radial dimension will be displayed, as shown in Figure 2-12.

Dimensioning Revolved Sections

Revolved sections are used to create revolved features such as flanges, couplings, and so on. To dimension a revolved section, click on the entity to be dimensioned. Next, select the centerline about which you want the section to be revolved. Once again, select the original entity that you want to dimension. Now, place the dimension at the desired location by pressing the middle mouse button. The dimension will be displayed, as shown in Figure 2-13. This dimension represents the diameter of a revolved section.

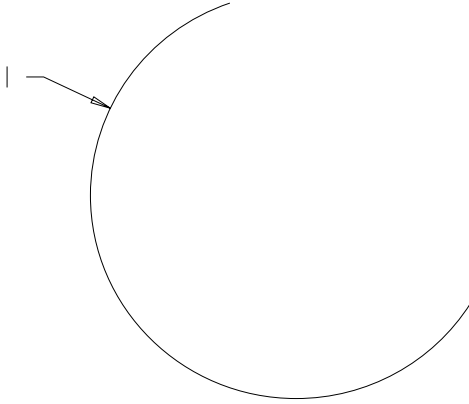


Figure 2-12 Radial dimensioning

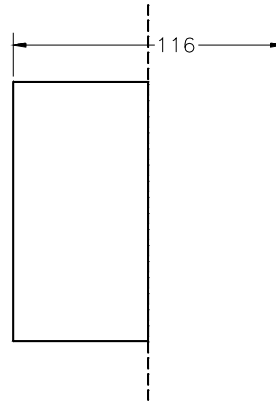


Figure 2-13 Dimensioning the revolved sections



Tip: To add dimension to a revolved section, you can also first select the centerline, next the entity to dimension, and then again the centerline.

WORKING WITH CONSTRAINTS

In Pro/ENGINEER, the entities in a sketch have to be fully specified in terms of size, shape, orientation, and location. This is achieved by setting constraints. Using constraints in a sketch reduces the number of dimensions in that sketch.

Constraints are the logical operations that are performed on the selected geometry to make it more accurate in defining its position with respect to the other geometry. For example, if a line is nearly parallel to another line, Pro/ENGINEER snaps the parallel line and displays the parallel constraint symbol. Now, if you confirm the line creation, the line is drawn parallel to the other line. You can also apply constraints manually.

Types of Constraints

There are two types of constraints in Pro/ENGINEER, **Geometry** constraints and **Assembly** constraints. Here, you will learn about the **Geometry** constraints and the **Assembly** constraints will be discussed in later chapters.

To apply constraints manually, choose the arrow on right of the **Vertical** button from the **Sketcher Tools** toolbar; a flyout will be displayed as shown in Figure 2-14.

This flyout is used to apply constraints manually. Although the constraints are applied automatically as you draw the sketch, you can use this flyout if you want to manually apply additional constraints to the sketch. The constraints in the flyout are discussed next.

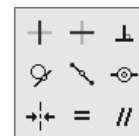


Figure 2-14 Flyout displayed on choosing the arrow on the right of the **Vertical** button

Vertical



This constraint forces the selected line segment to become a vertical line. This constraint also forces the two vertices to be placed along a vertical line.

Horizontal



This constraint forces the selected line segment or two vertices that are apart by some distance to become horizontal or to lie in a horizontal line.

Perpendicular



This constraint forces the selected entity to become normal to another selected entity.

Tangent



This constraint forces the two selected entities to become tangent to each other.

Mid-point



This constraint forces a selected point or vertex to lie on the middle of a line.

Coincident



This constraint performs three functions. This constraint can be used to force the two selected points to become coincident to constrain a point on the selected entity, and to make two selected entities collinear, so that they lie on the same line. This constraint aligns two vertices or entities.

Symmetric



This constraint makes a section symmetrical about the centerline. When you select this constraint, you will be prompted to select a centerline and two vertices to make them symmetrical.

Equal



This constraint forces any two selected entities to become equal in dimension. When you select this constraint, you will be prompted to select two lines to make their lengths equal, or you will be prompted to select two arcs, circles, or ellipses to make their radii equal.

Parallel



This constraint is used to force two lines to become parallel. When selected, this constraint prompts you to select two entities that you want to make parallel.

Disabling the Constraints

The need to disable a constraint arises when you are drawing an entity. For example, consider a case where you want to draw a circle at some distance apart from another circle. While drawing it, the system tends to apply the equal radius constraint when the sizes of the two circles become equal. At this moment, if you do not want to apply the equal radius constraint, right-click twice to disable the equal radius constraint; a red line / will appear across the symbol. However, if you right-click once, the constraint will get locked and a circle will appear as its symbol.

MODIFYING THE DIMENSIONS OF A SKETCH

There are four ways to modify the dimensions of a sketch. These methods are discussed next.

Using the Modify Button



You can select one or more dimensions from the sketch to modify them. When you select dimension(s) from a sketch, they are highlighted in red. If you want to select more than one dimension, hold the CTRL key and select the dimensions by clicking on them. You can also use the CTRL+ALT+A keys or define a window to select the dimensions in the sketch. Next, choose the **Modify** button from the **Sketcher Tools** toolbar to modify the dimensions; the **Modify Dimensions** dialog box will be displayed, as shown in Figure 2-15.

To modify dimensions by using this dialog box, you can either enter a value in the edit box or use the thumbwheel available on the right of the edit box. The **Sensitivity** slider is used to set the sensitivity of the thumbwheel.

By default, the **Regenerate** check box is selected. As a result, any modifications in the dimensions are automatically updated in the sketch. If you want to modify the dimensions of the sketch without regenerating the sketch you need to clear this check box. If this check box is cleared, the dimensions will not be modified until you exit this dialog box. This means that Pro/ENGINEER allows you to make multiple modifications before updating the sketch.

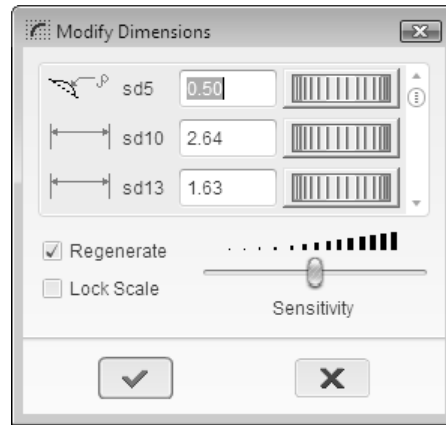


Figure 2-15 The **Modify Dimensions** dialog box



Note

*It is recommended that you clear the **Regenerate** check box and then modify the dimensions if you need to modify more than one dimension. Also, when the dimensions you specify vary drastically with the original ones.*

The **Lock Scale** check box is used to lock the scale of the selected dimensions. After locking the scale, if you modify any dimension, all other dimensions will also be modified by the same scale.

Using the Edit Menu

The **Modify** option in the **Edit** menu in the menu bar can be used to modify the dimensions. Choose the **Modify** option from the **Edit** menu; the **Select** dialog box will appear on the right of the screen. Now, you can select a dimension from the sketch to modify it. When you select a dimension, the **Modify Dimensions** dialog box will be displayed. By default, the **Regenerate** check box is selected. As a result, the sketch will be regenerated dynamically as you modify the dimension.

Modifying a Dimension by Double-Clicking on it

You can also modify a dimension by double-clicking on it. When you double-click on a dimension, the pop-up text field appears. Enter a new dimension value in this field and press ENTER or use the middle mouse button. Remember that you can select a dimension only when you choose **One-by-One** button from the **Sketch Tools** toolbar.

Modifying Dimensions Dynamically

In the sketcher environment, Pro/ENGINEER is always in the selection mode, unless you have invoked some other tool. When you bring the cursor to an entity, the color of the entity changes to cyan. Now, if you hold down the left mouse button, you can modify the entity by dragging the mouse. You will notice that as the entity is modified, the dimensions referenced to the selected entity are also modified.

RESOLVE SKETCH DIALOG BOX

While applying constraints or dimensions, sometimes the system may prompt you to delete one or more highlighted dimensions or constraints. This is because while adding dimensions or constraints, some strong dimensions or constraints conflict with the existing dimensions or constraints. As soon as, a conflict occurs, the **Resolve Sketch** dialog box is displayed, as shown in Figure 2-16 and the constraints or dimensions that conflict are displayed in red. When you select a dimension or a constraint from the **Resolve Sketch** dialog box, the corresponding dimension or constraint in the drawing area is enclosed in a blue box. The buttons in the **Resolve Sketch** dialog box are discussed next.

Undo

When you choose the **Undo** button, the section is brought back to the state that was just before the conflict occurred.

Delete

The **Delete** button is used to delete a selected dimension or constraint that is enclosed within the blue box. Select the dimension or the constraint to delete before you choose the **Delete** button from the **Resolve Sketch** dialog box.

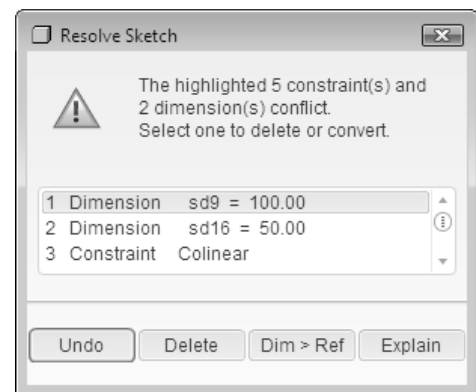


Figure 2-16 The **Resolve Sketch** dialog box

Dim > Ref

On choosing the **Dim > Ref** button, the selected dimension is converted to a reference dimension.



Note

The reference dimensions are used only for reference. They do not participate in the feature creation.

Explain

When you choose the **Explain** button, the system provides you with the information about the selected constraint or dimension. The information will be displayed in the message area.

DELETING THE SKETCHER ENTITIES

To delete a sketched entity, select it by defining a window. You can specify a window by picking two points so that the entity or entities are enclosed in the window. After specifying the window, the color of the selected entity changes to red. Hold down the right mouse button in the drawing area to invoke a shortcut menu. Now, choose the **Delete** option from this menu to delete the selected item.

You can also delete an item by selecting it and pressing the DELETE key.

To delete more than one item from the drawing area, press the CTRL key and click to select the entities to be deleted. Press the DELETE key to delete the selected entities. You can also specify a window to select the entities.



Note

*It is necessary to be in the selection mode while selecting the items. The term “items” used in this chapter refers to dimensions and entities. The **Geometry**, **Dimension**, and **Constraint** filters are available in the drop-down list located in the **Status Bar**. These filters allow you to select exactly the item that you need to select. This means, if you want to select all constraints in the sketch, choose the **Constraint** filter and specify a window to select. You will notice that only the constraints are selected.*



To restore the last deleted item, choose the **Undo Delete** button. This button is available in the **Edit** toolbar on the **Top Toolchest**.

TRIMMING THE SKETCHER ENTITIES

While creating a design, there are a number of places where you need to remove the unwanted and extended entities. You can do this by using the trimming tools that are available in the **Sketcher Tools** toolbar. You can trim entities using three buttons. These buttons are discussed next.

Delete Segment



This button is used to trim the entities that extend beyond the point of intersection. It is also used to delete the selected entities. After choosing the **Delete Segment** button, when you move the cursor over an entity, the entity will be highlighted in cyan color. Press the left mouse button to trim the entity.

Corner



The **Corner** button is used to trim two entities at their corners. Note that when you trim entities using this option, the portion from where you select the entities is retained and the other portion is trimmed. The following steps explain the procedure to trim entities using this button:

1. Choose the black arrow on the right of the **Delete Segment** button to display the flyout. From this flyout, choose the **Corner** button; you will be prompted to select two entities to be trimmed.
2. Click to select the two entities on the sides that you want to keep after the trimming action, see Figure 2-17. These two entities must be intersecting entities. The entities are trimmed from the point of intersection.

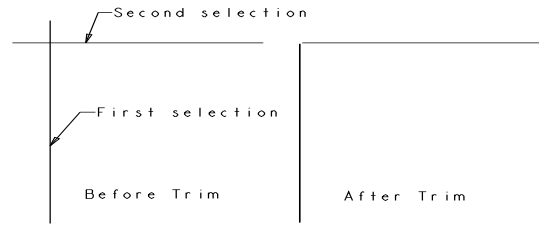


Figure 2-17 Trimming the lines

Divide



The **Divide** button is used to divide an entity into a number of parts or entities by specifying points on the entity.

When you choose the black arrow on the right of the **Delete Segment** button, a flyout is displayed. You can choose the **Divide** button from this flyout.

The following steps explain the procedure to divide an entity:

1. Choose the **Divide** button from the flyout; you will be prompted to specify a point on an entity.
2. Click to select the entity at the point where you want to divide it; the entity is divided into two different entities. They can now be treated as two separate entities.
3. Similarly, you can break other entities like circles or arcs into several small entities.

MIRRORING THE SKETCHER ENTITIES



The **Mirror** button is used to mirror sketched geometries about a centerline. This button helps to reduce the time used for creation of symmetrical geometries and dimensioning them.

The following steps explain the procedure to mirror the sketched geometry:

1. Sketch a geometry and then sketch a centerline about which you need to mirror the geometry.
2. Select the entities that you need to mirror. The selected entities turn red in color.
3. Choose the **Mirror** button from the **Sketcher Tools** toolbar; you will be prompted to select the centerline about which you need to mirror. Select the centerline; the selected entities will be mirrored about the centerline.



Tip: In case of symmetrical parts, you can save time involved in dimensioning a sketch by dimensioning half of the section and then mirroring it. Pro/ENGINEER will assume that the mirrored half has the same dimensions as the sketched half.

INSERTING STANDARD/USER-DEFINED SKETCHES



This button helps you insert certain standard or user defined features such as polygons, profiles, shapes, stars, and other previously created sketches in the **Sketch** mode, thus minimizing the time for repetitive sketching.

The steps that explain the procedure to insert a foreign entity in the **Sketch** mode are given next.

1. Choose the **Palette** button from the **Sketcher Tools** toolbar; the **Sketcher Palette** dialog box will be displayed. The options in this dialog box are used to insert a previously created sketch.



Note

If you have selected a working directory which contains only .sec files, a tab with the name of the working directory will be available in the **Sketcher Palette** dialog box, as shown in Figure 2-18. Also, this tab is chosen by default. On the other hand, if you have selected a working directory which contains other types of files, the same tab will be displayed in the end. In such cases, the **Polygon** tab will be chosen by default.

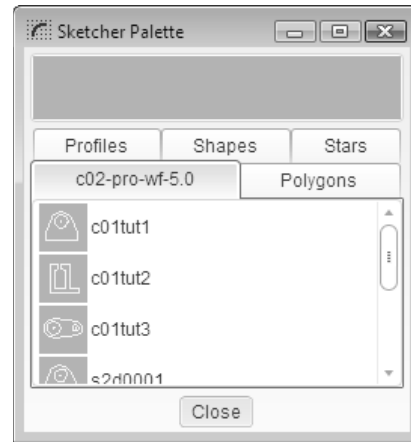


Figure 2-18 The Sketcher Palette dialog box

2. For inserting a sketch from the working directory tab into the sketch, double-click on the required sketch from the list in the dialog box; a + sign will be attached to the cursor. Click anywhere in the drawing area; the **Move & Resize** dialog box will be displayed, as shown in Figure 2-19. Also, the move, rotate, and scale handles will be displayed on the imported sketch automatically.
3. Enter the scale value in the **Scale** edit box and the rotational angle value in the **Rotate** edit box of the **Move & Resize** dialog box. Alternatively, left-click on the required handle on the sketch and drag; the corresponding

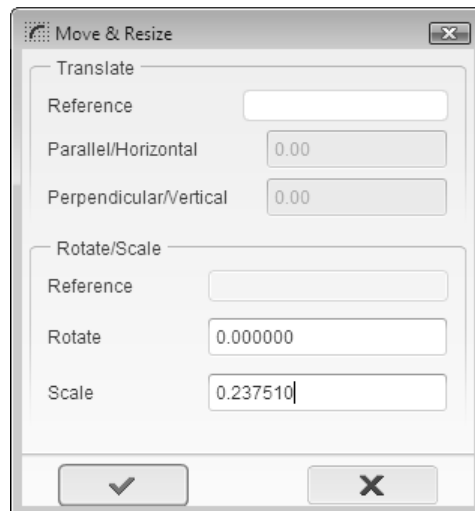


Figure 2-19 The Move & Resize dialog box

action will take place dynamically. The move handle also acts as the pivot point for rotation and scale. However, you can relocate the pivot point. To move the pivot point, right-click on the pivot point and drag it to the required location and then release the right-click; the pivot point will be relocated.

4. Next, choose the **Accept the changes and close the dialog** button to exit the **Move & Resize** dialog box.
5. Choose the **Close** button from the **Sketcher Palette** dialog box to accept the sketch inserted. Else, repeat the steps 2-4 to continue inserting more sketches in the drawing area.

Similarly, you can add the sketches from the **Polygon, Profiles, Shapes, and Stars** tab.

DRAWING DISPLAY OPTIONS

While working with complex sketches, sometimes you need to increase the display of a particular portion of a sketch so that you can work on the minute details of the sketch. For example, you are drawing a sketch of a piston and you have to work on the minute details of the grooves for the piston rings. To work on these minute details, you have to enlarge the display of these grooves. You can enlarge or reduce the drawing display using various drawing display tools provided in Pro/ENGINEER. These tools are available in the **View** toolbar. Some of these drawing display options are discussed next. The remaining drawing display options will be discussed in the later chapters.

Zoom In



This button enlarges the view of the drawing on the screen. After choosing the **Zoom In** button, you will be prompted to define a box. The area that you will enclose inside the box will be enlarged and displayed in the drawing area. Note that when you enlarge the view of the drawing, the original size of the entities is not changed. To exit the **Zoom** tool, right-click in the drawing area.

Zoom Out



This button reduces the view of the drawing on the screen, thus increasing the drawing display area. Each time you choose this button, the display of the sketch in the drawing area is reduced.

Refit



This option reduces or enlarges the display such that all entities that comprise the sketch are fitted inside the current display. Note that the dimensions may not necessarily be included in the current display.

Repaint



While working with complex sketches, some unwanted temporary information is retained on the screen. The unwanted information may include the shadows of the deleted sketched entities, dimensions, and so on. This unwanted information can be removed from the drawing area using the **Repaint** button. This option is extensively used while designing in Pro/ENGINEER.

**Note**

To remove the temporary information, you can also choose **View > Repaint** from the menu bar or **CTRL+R** to repaint the screen.

If you have a mouse that has a middle mouse button wheel, then scrolling the wheel will zoom in and out. One more way to zoom in and out is to use the middle mouse button and the **CTRL** key. When you use **CTRL+middle mouse button** and drag the mouse upward, the sketch is zoomed out and when you drag the mouse downward, the sketch is zoomed in.

In the **Sketch** mode, you can pan the sketch using the middle mouse button but in the **Part** mode, use **SHIFT+middle mouse button** to pan the model.

TUTORIALS

Tutorial 1

In this tutorial, you will draw the sketch of the model shown in Figure 2-20. The sketch is shown in Figure 2-21. **(Expected time: 30 min)**



Figure 2-20 Model for Tutorial 1

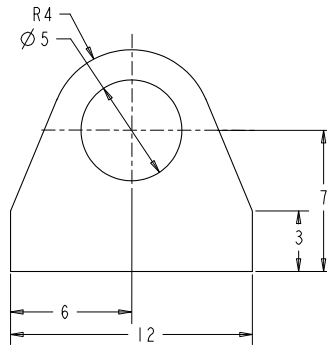


Figure 2-21 Sketch of the model

The following steps are required to complete this tutorial:

- Start Pro/ENGINEER Wildfire 5.0 session.
- Set the working directory and create a new sketch file.
- Draw lines by using the **Line** tool, refer to Figures 2-23 and 2-24.
- Draw an arc and a circle, refer to Figures 2-25 and 2-26.
- Dimension the sketch and then modify the dimensions of the sketch, refer to Figure 2-27
- Save the sketch and close the file.

Starting Pro/ENGINEER

- Start Pro/ENGINEER Wildfire 5.0 by double-clicking on the Pro/ENGINEER icon on the desktop of your computer. Alternatively, choose **Start > Programs > PTC > Pro ENGINEER > Pro ENGINEER** from the taskbar.

Setting the Working Directory

After the Pro/ENGINEER session is started, the first task is to set the working directory. A working directory is a directory on your system where you can save the work done in the current session of Pro/ENGINEER. You can set any existing directory on your system as the working directory. Since it is the first tutorial of this chapter, you need to create a folder with the name *c02*, if it does not exist.

1. Choose the **Set Working Directory** option from the **File** menu; the **Select Working Directory** dialog box is displayed.
2. In this dialog box, browse to *C:\ProE-WF-5.0* folder. If this folder does not exist, create this folder before setting the working directory.

For selecting *C:\ProE-WF-5.0*, click on the arrow at the right of the **C:** option in the top address box of the **Select Working Directory** dialog box; the contents of the **C** drive folder are displayed. Now, select *ProE-WF-5.0* from the flyout, as shown in Figure 2-22.

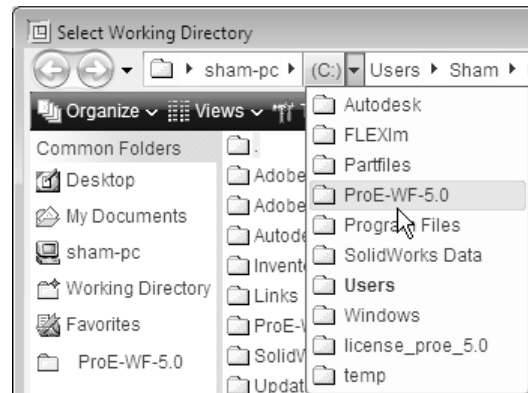


Figure 2-22 The flyout displayed by clicking on the arrow

3. Choose the **Organize** button from the **Select Working Directory** dialog box to display the flyout. From the flyout, choose the **New Folder** option; the **New Folder** dialog box is displayed.
4. Enter *c02* in the **New Directory** edit box and choose **OK** from the **New Folder** dialog box; a new folder named *c02* is created in *C:\ProE-WF-5.0* location.
5. Choose **OK** from the **Select Working Directory** dialog box to set the working directory to *C:\ProE-WF-5.0\c02*; the message **Successfully changed to C:\ProE-WF-5.0\c02 directory** is displayed in the message area.

Starting a New Object File

Any sketch drawn in the **Sketch** mode is saved with the *.sec* file extension. This file format is one of the file formats available in Pro/ENGINEER.

1. Choose the **New** button from the **File** toolbar or press CTRL+N; the **New** dialog box is displayed. In this dialog box, select the **Sketch** radio button from the **Type** area; the default name of the sketch appears in the **Name** edit box.
2. Enter *c02tut01* in the **Name** edit box and choose the **OK** button.



You are in the sketcher environment of the **Sketch** mode. When the **Sketch** mode is invoked, the Navigator is displayed on the left in the drawing area.

- Slide the Navigator to the left by clicking on the sash present on its right edge; the drawing area is increased.

Drawing the Lines of the Sketch

You need to start drawing the sketch with the right vertical line.

- Choose the **Line** button from the **Sketcher Tools** toolbar.
- Specify the start point by clicking on the right in the drawing area. One end of the line is attached to the cursor. Move the cursor down to get an approximate size of the line.



Notice that when the cursor moves vertically downward, a blue colored constraint **V** appears in the drawing area next to the line. Now, if you draw a line, the vertical constraint will be applied to it.

- Click to specify the endpoint of the line. The vertical constraint **V** is applied to the line, but it is not visible in the drawing area until the line creation is active.

Also, another rubber-band line is attached to the cursor with its start point at the endpoint of the last line.

- Move the cursor horizontally toward the left; a horizontal rubber-band line extends to the left as you move the mouse.

Notice that when the cursor is moves horizontally toward the left, a blue-colored constraint, **H** appears in the drawing area next to the line. Now, if you draw a line, a horizontal constraint will be applied to it.

- After getting the desired size of the creation of the line, click to end the line. The horizontal constraint **H** is applied to the line, but it is not visible in the drawing area until the line creation is active.
- Move the cursor upward in the drawing area; a vertical rubber-band line extends as you move the mouse. As you move the cursor upward, notice that at a particular point where the length of the left vertical line is equal to the length of the right vertical line, an **L₁** symbol is displayed on both the vertical lines. This symbol suggests that the equal length constraint is applied to two vertical lines.
- When the **L₁** constraint appears on the vertical line, click to specify the endpoint of the vertical line. The rubber-band line is still attached to the cursor.

You can also apply constraints later. However, to save an extra step of adding the constraints, you will use the constraints that are applied automatically while drawing.

- Move the cursor to size the line and specify the endpoint of the left inclined line, as shown in Figure 2-23.
- Press the middle mouse button to end the line creation.

10. The line option is still active. Move the cursor close to the top end of the right vertical line; the cursor snaps to the point that is at equal length of the right vertical line. Select the point by clicking.
11. Size the inclined line and specify the endpoint of the right inclined line. Press the middle mouse button twice to end the line creation.

Figure 2-24 shows the lines that you have drawn. Notice that when you end the line creation by pressing the middle mouse button twice, all the constraints that you have drawn become visible, refer to Figure 2-24. Now, you need to draw the arc and the circle.



Note

The labels such as L_2 or L_3 vary from sketch to sketch.

The horizontal constraint **H** and the vertical constraint **V** appear in orange color. The orange color of the constraint indicates that the constraint is strong. This means you cannot change the orientation of the line until you delete the constraint applied to the line. The constraints displayed in grey color indicates that they are weak constraints, refer to Figure 2-24.

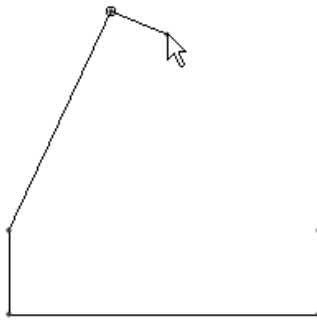


Figure 2-23 Partial sketch with left inclined line

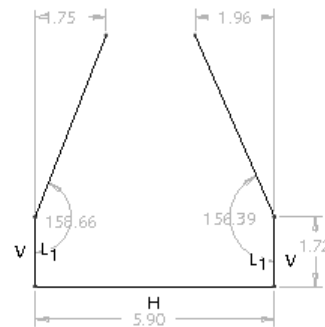


Figure 2-24 Partial sketch with weak dimensions

Drawing the Arc

1. Choose the **3-Point / Tangent End** button from the **Sketcher Tools** toolbar; you are prompted to select the start point of the arc.
2. Select the endpoint of the left inclined line; the **Target** symbol appears in green color.
3. Move the cursor along the tangent direction through a small distance. A rubber-band arc that is tangent to the inclined line appears. As you move the cursor to the endpoint of the right inclined line, at a particular point, the tangent constraint is applied to both ends of the arc. This is indicated by the symbol **T**, which appears at the endpoints of the inclined lines.

- As the tangent constraint appears, click to end the arc creation. You will notice that the tangent constraint with the symbol **T** appears at the endpoints of the arc, as shown in Figure 2-25. Press the middle mouse button to end the arc creation.

The tangent constraint **T** appears in orange, which indicates that it is a strong constraint and the tangency of the inclined line with the arc cannot be modified until you delete the tangent constraint.

Note that in Figure 2-24, there are some weak dimensions that are not displayed in Figure 2-25. This is because weak dimensions get deleted without confirming their deletion. Hence, after drawing the arc, some weak dimensions get deleted automatically.



Note

If the tangent constraint symbol is not displayed on any of the inclined lines, apply the constraint manually by using the flyout that is displayed when you choose the **Vertical** button from the **Sketcher Tools** toolbar (see page 2-16 for more information).

Dimensioning the Sketch

The right vertical line, the bottom horizontal line, the arc, and the circle are dimensioned automatically and the weak dimensions are applied to them. You will use these dimensions. Hence, there is no need to dimension these entities again.

- Choose the **Normal** button from the **Sketcher Tools** toolbar.
- Select the center of the arc and then the bottom horizontal line; both the center and the line turn red in color.
- Place the dimension on the right of the sketch by pressing the middle mouse button.
- Select the center of the arc and then the left vertical line; both the center and the vertical line turn red in color.
- Press the middle mouse button to place the dimension below the sketch, refer to Figure 2-26.

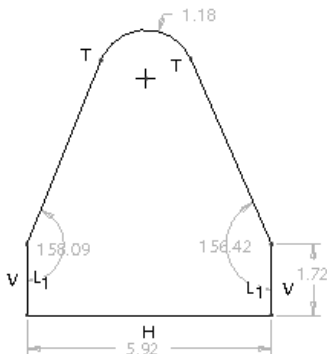


Figure 2-25 Sketch with arc

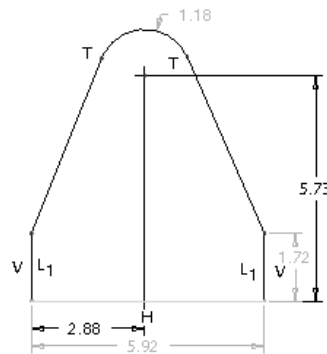


Figure 2-26 Sketch with all entities, weak dimensions, and weak constraints

Drawing the Circle

1. Choose the black arrow on the right of the **Center and Point** button to display the flyout. In this flyout, choose the **Concentric** button; you are prompted to select an arc.
2. Select the arc by clicking on it. Move the mouse; a circle appears.
3. To draw the circle, click to select a point inside the sketch.
4. Press the middle mouse button to end the circle creation. The sketch is complete.



Modifying the Dimensions

The sketch is dimensioned with default values. You need to modify these values to the given values.

1. Choose the **One-by-One** button from the Right Toolchest.
2. Select all dimensions by specifying a window around them.



Note

You can also use CTRL+ALT+A to select the entire sketch with dimensions.

3. When all dimensions turn red in color, choose the **Modify** button; the **Modify Dimensions** dialog box is displayed.



All dimensions in the sketch are displayed in this dialog box. Each dimension has a separate thumbwheel and an edit box. You can use the thumbwheel or the edit box to modify the dimensions. It is recommended that you use the edit boxes to modify the dimensions, if the change in the dimension value is large.

4. Clear the **Regenerate** check box and then modify the values of the dimensions.

Once you clear this check box, any modification in a dimension value does not update the sketch. It is recommended that you clear the **Regenerate** check box when more than one dimension has to be modified.

Notice that the dimension that you select in the **Modify Dimensions** dialog box gets enclosed in a blue box in the drawing area.

5. Modify all dimensions according to the dimensions shown in Figure 2-27. After modifying the dimensions, choose the **Regenerate the section and close the dialog** button from the **Modify Dimensions** dialog box; a message **Dimension modifications successfully completed** is displayed in the message area.

The sketch is completed and is shown in Figure 2-27.

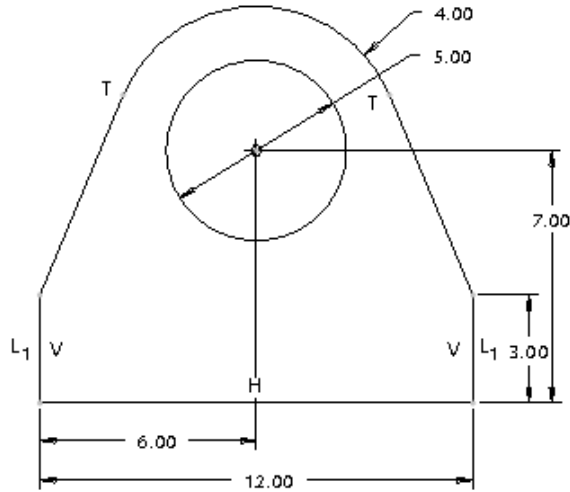



Figure 2-27 The complete sketch with dimensions and constraints



Tip: You can modify the location of the dimensions as they appear on the screen by selecting and dragging them to a new location.

Saving the Sketch

Now, the sketch needs to be saved because you may need the sketch later in the **Part** mode to create a 3D model.

1. Choose the **Save** button from the **File** toolbar; the **Save Object** dialog box is displayed with the name of the sketch that you had entered earlier. 
2. Choose the **OK** button; the sketch is saved.
3. After saving the sketch, choose **Window > Close** from the menu bar to close the window.

Tutorial 2

In this tutorial, you will draw the sketch for the model shown in Figure 2-28. The sketch is shown in Figure 2-29. For your reference, all entities in the sketch are labeled alphabetically. **(Expected time: 30 min)**

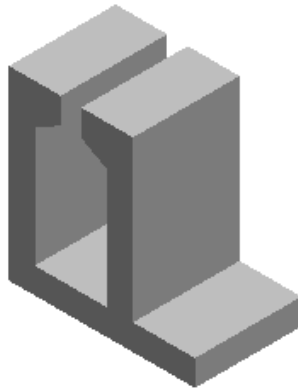


Figure 2-28 Model for Tutorial 2

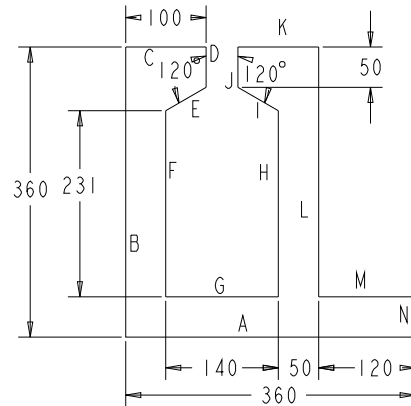


Figure 2-29 Sketch of the model

The following steps are required to complete this tutorial:

- Set the Working directory and create a new object file.
- Draw the sketch by using the line tool, refer to Figure 2-30.
- Dimension the required entities and then modify the dimensions of the sketch, refer to Figures 2-31 and 2-32.
- Save the sketch and close the file.

Setting the Working Directory

The working directory was selected in Tutorial 1, therefore you do not need to select the directory again. But, if a new session of Pro/Engineer is started, you need to set the working directory again by following the steps given below.

- Open the Navigator (if it is in collapsed state) by clicking on the sash button on the left of the Pro/ENGINEER main window; the Navigator slides out. At the bottom of the Navigator, the **Folder Tree** is displayed. Click on the black arrow on the right of the **Folder Tree**; the **Folder Tree** expands.
- Click on the plus sign adjacent to the *ProE-WF-5.0* folder in the Navigator; the contents of the *ProE-WF-5.0* folder are displayed.
- Now, right-click on the *c02* folder to display a shortcut menu. From the shortcut menu, choose the **Set Working Directory** option; the working directory is set to *c02*.
- Close the Navigator by clicking on the sash located at the right edge of the Navigator; the Navigator slides in.

Starting a New Object File


- Choose the **New** button from the **File** toolbar; the **New** dialog box is displayed. Select the **Sketch** radio button from the **Type** area of the **New** dialog box; the default name of the sketch appears in the **Name** edit box.



2. Enter *c02tut02* in the **Name** edit box and choose **OK**; you are in the sketcher environment of the **Sketch** mode.


Drawing the Sketch


The sketch in Figure 2-29 consists of only lines. For ease of understanding, all lines in the sketch are labeled alphabetically.

1. Choose the **Line** button from the **Sketcher Tools** toolbar. Select a point close to the lower right corner of the drawing area by clicking and start drawing the horizontal line A. You will notice that as you draw line A, the **H** symbol is displayed on the line. This indicates that the line is horizontally constrained. Move the cursor toward the left and specify the endpoint of the line. 
2. Move the cursor vertically upward so that the **V** constraint appears on the line. When you get the appropriate size of the line, click to specify the endpoint of line B; line B is completed.
3. Move the cursor to the right in the drawing area and click to specify the endpoint of line C.
4. Now, to draw line D, move the cursor down and click to specify the endpoint of line D.
5. Move the cursor to size the line and click to specify the endpoint of the inclined line E.
6. The next line you need to draw is line F. Move the cursor vertically downward and click to specify the endpoint of line F.
7. Now, to draw line G, move the cursor horizontally toward the right and click to specify the endpoint of line G.
8. Move the cursor vertically upward and click to specify the endpoint of line H.
9. Now, continue drawing the remaining lines that are shown in Figure 2-29. When the sketch is complete, end the line creation by pressing the middle mouse button. Notice that the sketched entities are dimensioned automatically as you draw them. These dimensions are weak dimensions and appear in gray color.

Applying Constraints to the Sketch

Constraints are applied to the sketch to maintain the design intent of the feature and this might sometimes result in less dimensions in the sketch.

1. Choose the black arrow on the right of the **Vertical** button in the **Sketcher Tools** toolbar; a flyout is displayed.
2. Choose the **Equal** button and select lines F and H. The equal length constraint **L₂** is applied to both the lines. The constraint labels such as **L₂** or **L₃** vary from sketch to sketch. 

3. Now, select lines J and N; the equal length constraint is applied to both the lines.
4. Select lines C and K; the equal length constraint is applied to both the lines.
5. Select lines A and B; the equal length constraint is applied to both the lines.
6. Choose the **Horizontal** button from the constraints flyout; you are prompted to select a line or two vertices. 
7. Select the vertex that is joining lines L and M and the vertex that is joining lines G and H. Both the vertices are aligned horizontally, as shown in Figure 2-30.
8. Select the vertex that is joining lines C and D and the vertex that is joining lines J and K. Both the vertices are aligned horizontally, as shown in Figure 2-31.

Dimensioning the Sketch

Weak dimensions have already been applied to the sketch while drawing. You need to dimension only the angle between lines D and E and lines J and I.


1. Choose the **Normal** button from the **Sketcher Tools** toolbar. 
2. Select lines D and E by using the left mouse button; the selected lines turn red in color. Now, press the middle mouse button to place the dimension close to the vertex where lines D and E join.
3. Similarly, dimension the angle between lines J and I.

Figure 2-31 shows the sketch after applying dimensions. If your sketch does not have all dimensions shown in this figure, apply them by using the **Normal** button.

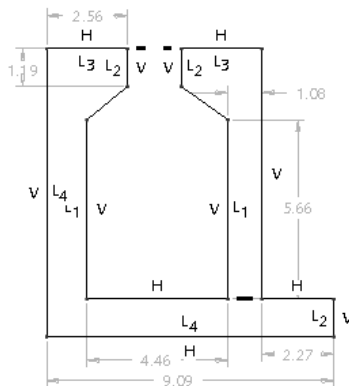


Figure 2-30 Sketch with weak dimensions and constraints

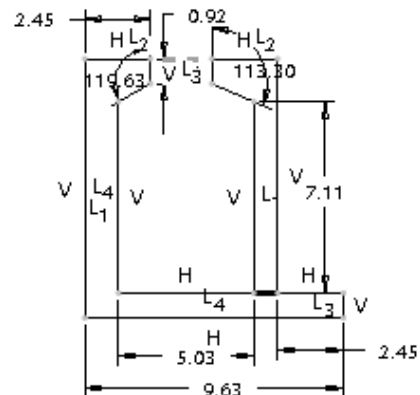




Figure 2-31 Sketch after dimensioning

Modifying the Dimensions

The dimensions that are applied to the sketch need modification in dimension values.

1. Choose the **One-by-One** button from the **Right Toolchest** and then select all dimensions by specifying a window around them. 
2. When dimensions turn red in color, choose the **Modify** button; the **Modify Dimensions** dialog box is displayed. 
3. Clear the **Regenerate** check box and then modify the values of the dimensions. On clearing this check box, the sketch is not regenerated while you modify the dimensions.

Notice that the dimension that you select in the **Modify Dimensions** dialog box is enclosed in a blue box in the drawing area.

4. When all dimensions are modified, choose the **Regenerate the section and close the dialog** button from the **Modify Dimensions** dialog box; the message **Dimension modifications successfully completed** is displayed in the message area. The completed sketch is shown in Figure 2-32.

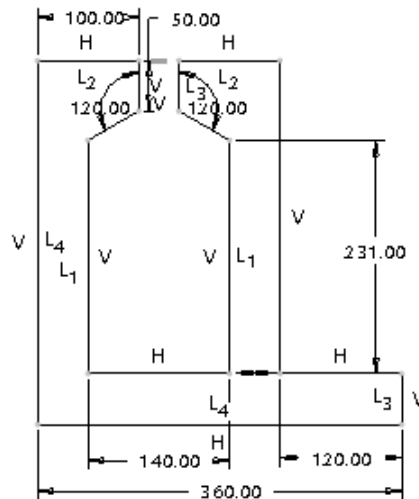


Figure 2-32 Complete sketch with dimensions and constraints

5. Save the sketch as discussed earlier. Next, choose **Window > Close** from the menu bar to exit the **Sketch** mode.



Note

You can also modify dimensions individually. However, individual modification of dimensions is recommended only when there is a minor change in the dimension value or when only one dimension is required to be modified.

Tutorial 3

In this tutorial, you will draw the sketch of the model shown in Figure 2-33. The sketch of the model is shown in Figure 2-34. For your reference, all entities in the sketch are labeled alphabetically. Also, you will print the sketch. **(Expected time: 30 min)**

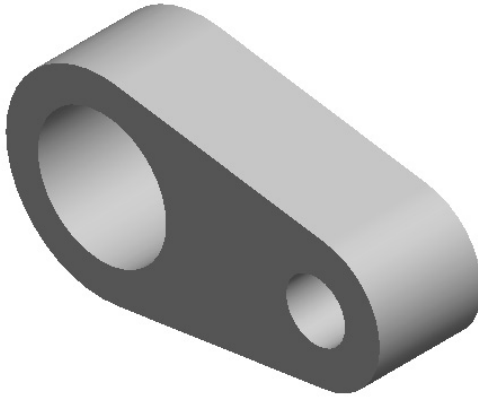


Figure 2-33 Model for Tutorial 3

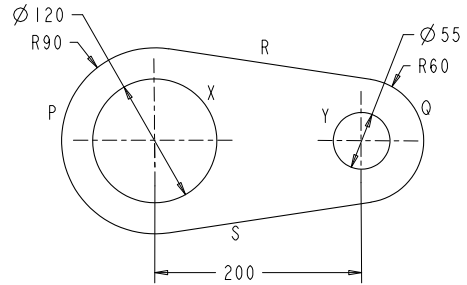


Figure 2-34 Sketch of the model

The following steps are required to complete this tutorial:

- Set the working directory and create a new object file.
- Draw the sketch by using the sketcher tools, refer to Figures 2-35 through 2-38.
- Dimension the sketch and then modify the dimensions of the sketch, refer to Figure 2-39.
- Save the sketch and print it.

Setting the Working Directory

The working directory was selected in Tutorial 1, therefore, you do not need to select the working directory again. But if a new session of Pro/Engineer is started, then you have to set the working directory again by following the steps given next.

- Open the Navigator by sliding it out. In the Navigator, the **Folder Tree** is displayed at the bottom. Click on the black arrow available on the right of the **Folder Tree**; the **Folder Tree** expands. Click on the plus sign adjacent to the *ProE-WF-5.0* folder in the Navigator; the contents of the *ProE-WF-5.0* folder are displayed.
- Now, right-click on the *c02* folder to display a shortcut menu. From the shortcut menu, choose the **Set Working Directory** option; the working directory is set to *c02*. Close the Navigator.

Starting New Object File

- Choose the **New** button from the **File** toolbar; the **New** dialog box is displayed. Select the **Sketch** radio button from the **Type** area of the **New** dialog box. The default name of the sketch appears in the **Name** edit box.



2. Enter *c02tut03* in the **Name** edit box. Choose the **OK** button to enter the sketcher environment of the **Sketch** mode.

Drawing the Circles

1. Choose the **Center and Point** button from the **Sketcher Tools** toolbar and specify the center of the circle.
2. Move the cursor to size the circle and then click to complete the circle.
3. Draw another circle whose center is collinear with the center of the previous circle.



Figure 2-35 shows the two collinear circles drawn by using the **Center and Point** button from the **Sketcher Tools** toolbar.

Drawing the Tangent Lines

1. Choose the **Line Tangent** button from the **Line** flyout in the **Sketcher Tools** toolbar; you are prompted to select the start location on the arc or the circle.
2. Select the left circle at the top. A rubber-band line appears whose one end is attached to the circle and the other end is attached to the cursor.
3. Click on the top of the right circle; a tangent connecting the two circles is drawn.
4. Similarly, draw a tangent by selecting the two circles at the bottom.



Figure 2-36 shows the sketch after drawing the tangent lines.

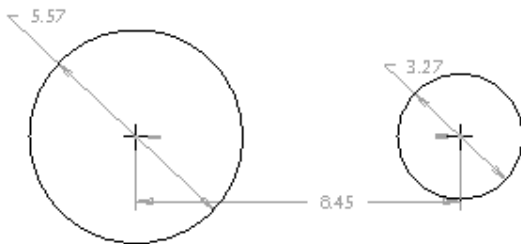


Figure 2-35 Two circles with weak dimensions and constraints

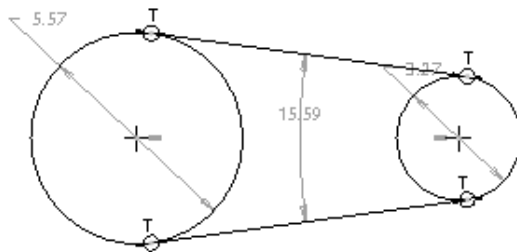


Figure 2-36 Circles joined by tangent lines

Trimming the Circles

As evident from Figure 2-36, the tangents that are drawn intersect the circles at the point where they meet the circle. Therefore, the part of the circle that is not required can be dynamically trimmed.

1. Choose the **Delete Segment** button from the **Sketcher Tools** toolbar.



2. Select the two circles individually to trim them at the locations shown in Figure 2-37.

Figure 2-38 shows the two circles after deleting the unwanted portions of the circle.

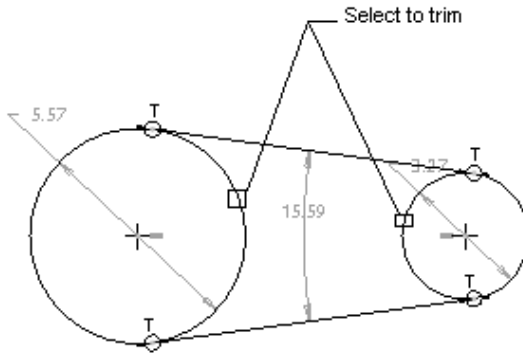



Figure 2-37 Locations to trim



Figure 2-38 Sketch after trimming


Drawing the Circles

1. Choose the black arrow on the right of the **Center and Point** button to display the flyout. Choose the **Concentric** button from the flyout; you are prompted to select an arc. 
2. Select arc P and create circle X concentric to the arc. Similarly, select arc Q to create a concentric circle Y.


Notice that the radius dimension is applied to the two arcs, whereas the diameter dimension is applied to the circles. This is because by default, the arcs are applied radius dimension and circles are applied diameter dimension.

Dimensioning the Sketch

In order to fully define a sketch, you need to dimension it.

1. Choose the **Normal** button. 
2. Select the centers of the two circles and place the dimension at the bottom of the sketch.


Modifying the Dimensions

1. Choose the **One-by-One** button. 
2. Select all dimensions by defining a window.



Note

You can also use **CTRL+ALT+A** from the keyboard to select all entities and items in the sketch.

3. When all dimensions turn red in color, choose the **Modify** button; the **Modify Dimensions** dialog box is displayed. 
4. Clear the **Regenerate** check box and then modify the values of the dimensions. You will notice that the dimension that you edit in the **Modify Dimensions** dialog box is enclosed by a blue box in the drawing area.
5. When all dimensions are modified, choose the **Regenerate the section and close the dialog** button from the **Modify Dimensions** dialog box; the message **Dimension modifications successfully completed** is displayed in the message area.

The sketch is completed and is shown in Figure 2-39.

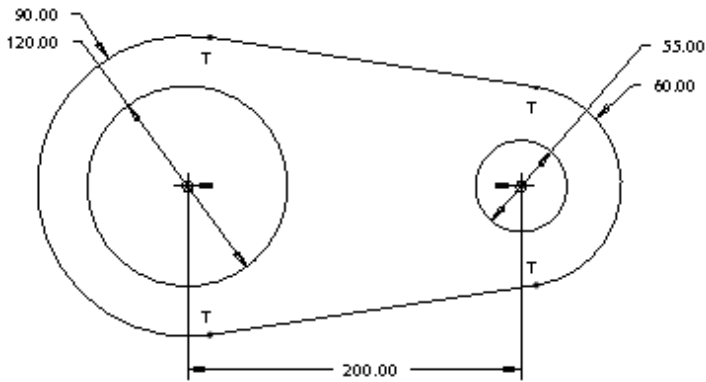


Figure 2-39 Complete sketch with dimensions and constraints

6. Save the sketch as discussed earlier. Next, you need to print the sketch.

Printing the Sketch Using the Plot Option



1. Choose the **Print** button from the **File** toolbar or press CTRL+P; the **Print** dialog box is displayed, as shown in Figure 2-40. 
2. Choose the **Commands and Settings** button from this dialog box; a shortcut menu is displayed, as shown in Figure 2-41. 
3. Choose the **Add Printer Type** option from the shortcut menu; the **Add Printer Type** dialog box is displayed.
4. From the printers listed in the **Add Printer Type** dialog box, select the printer that is installed on your system and choose the **OK** button.
5. From the **Print** dialog box, choose the **Configure** button; the **Shaded Image Configuration** dialog box is displayed. This dialog box allows you to set the paper size.



Figure 2-40 The **Print** dialog box

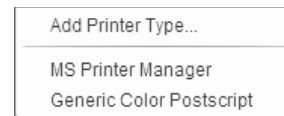


Figure 2-41 The **Commands and Settings** shortcut menu

6. Select the **A** option from the **Size** drop-down list, if not already selected; the dimensions of the sheet are set, by default. Also, select the image resolution and the image depth from the dialog box.
7. Choose the **OK** button from the **Shaded Image Configuration** dialog box.
8. Now, choose the **OK** button from the **Print** dialog box to complete the printing.

Self-Evaluation Test

Answer the following questions and then compare them to those given at the end of this chapter:

1. Dimensions and constraints are automatically applied to a sketch when you draw it. (T/F)
2. In Pro/ENGINEER, you can create lines that are tangent to two circles. (T/F)
3. If the **Intent Manager** is on and you draw a line, the cursor snaps to the endpoint of the previous line. (T/F)
4. You can convert a weak constraint into strong constraint by using the shortcut menu that is displayed when you right-click on the weak constraint. (T/F)
5. While drawing a circle, first you need to specify its diameter. (T/F)
6. The _____ menu in the menu bar has the **Modify** option.
7. A sketch can be modified by changing its _____.

8. The **Intent Manager** is _____ by default when you enter the **Sketch** mode. (on/off)
9. In the **Sketch** mode, the tangent constraint is represented by a _____ symbol.
10. The file created in the **Sketch** mode is saved with a _____ file extension.

Review Questions

Answer the following questions:

1. You can dynamically modify the geometry of a sketch. (T/F)
2. You can use the **Rectangle** button from the **Sketcher Tools** toolbar to draw a square. (T/F)
3. The _____ button is used to apply constraints manually.
4. You cannot undo a previous operation in the sketcher environment. (T/F)
5. You can also use the options in the menu bar to draw a sketch from the **Sketch** menu. (T/F)
6. What is the need of the **Sketch** mode in Pro/ENGINEER?
7. What are the four basic steps required to create a sketch?
8. How many types of lines can be sketched by using the buttons available in the **Sketcher Tools** toolbar?
9. Why the selection of working directory is important before creating a new file?
10. Write all steps involved in creating a sketch that is accepted by Pro/ENGINEER.

Exercises

Exercise 1

In this exercise, you will draw the sketch of the model shown in Figure 2-42. The sketch is shown in Figure 2-43.
(Expected time: 30 min)

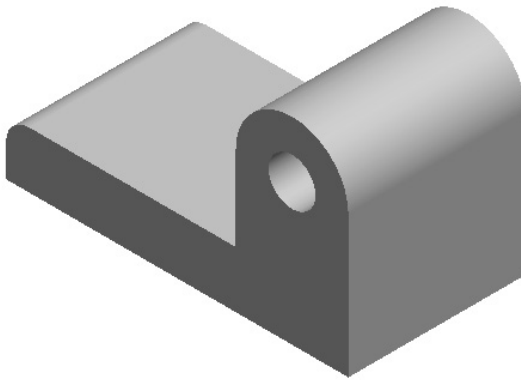


Figure 2-42 Solid model for Exercise 1

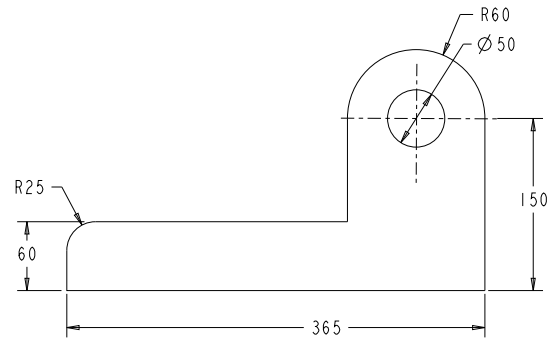


Figure 2-43 Sketch of the model

Exercise 2

In this exercise, you will draw the sketch of the model shown in Figure 2-44. The sketch is shown in Figure 2-45. **(Expected time: 30 min)**

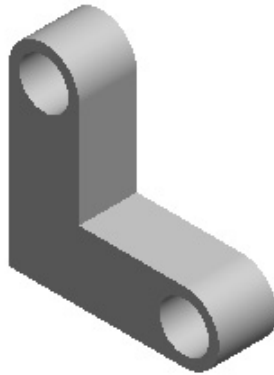


Figure 2-44 Solid model for Exercise 2

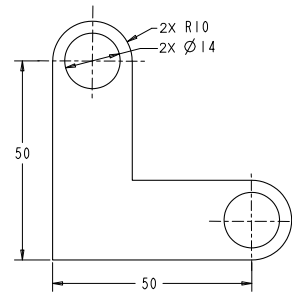


Figure 2-45 Sketch of the model

Exercise 3

In this exercise, you will draw the sketch of the model shown in Figure 2-46. The sketch is shown in Figure 2-47. **(Expected time: 30 min)**

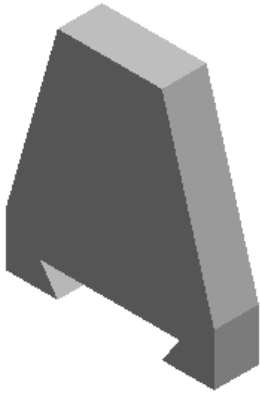


Figure 2-46 Solid model for Exercise 3

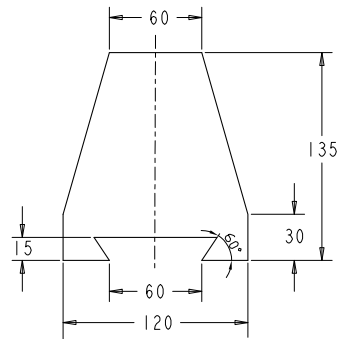


Figure 2-47 Sketch of the model

Exercise 4

In this exercise, you will draw the sketch for the model shown in Figure 2-48. The sketch is shown in Figure 2-49.

(Expected time: 30 min)

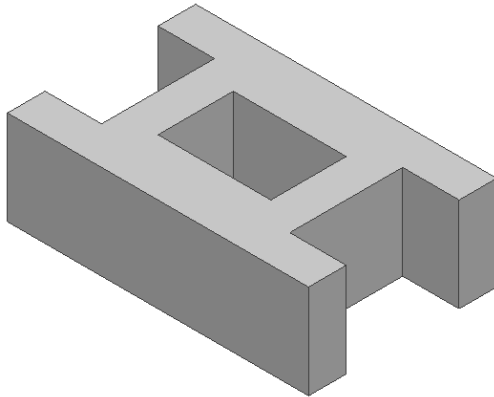


Figure 2-48 Solid model for Tutorial 2

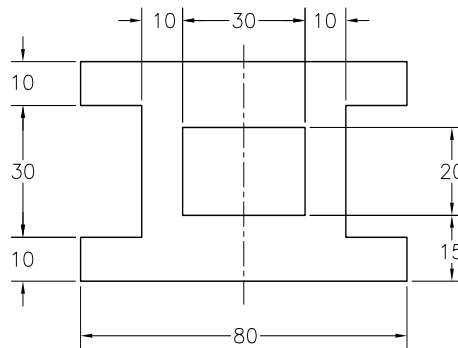


Figure 2-49 Sketch of the model

Answers to Self-Evaluation Test

1. T, 2. T, 3. T, 4. T, 5. F, 6. Edit, 7. dimensions, 8. on, 9. T, 10. .sec