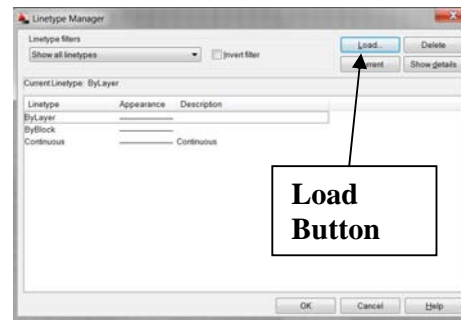## 2 – Orthographic Drawings

Orthographic drawings are a very common style of drawing and are easily created with AutoCAD. In this exercise, we will use AutoCAD to draw the front, top, and right side views of the object shown at the right. We will start with a third angle view then try some first angle views in the exercises. The dimensions of the object are shown at the right and we will make our AutoCAD drawing dimensionally correct. Unlike some of our previous drawings, we will use coordinates to draw the lines instead of simply clicking with the mouse.
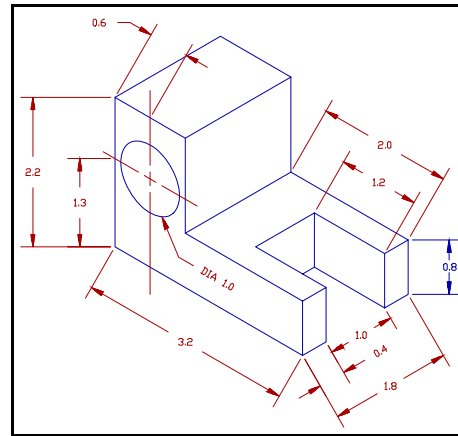
In the last assignment, you drew solid lines but sometimes you need dashed or dotted lines. AutoCAD has the ability to draw many different types of lines but the line type or style must be loaded before they can be used. The line types are loaded with the commands:

LINETYPE

Load
Button

This brings up the line type dialog box shown on the right. Click on the **LOAD** button to bring up a selection of line types that can be loaded. The dialog box is shown on the right.

Search through the file and click on the HIDDEN2 line type. We will use this line type to draw hidden lines in our orthographic or multi-view drawings.
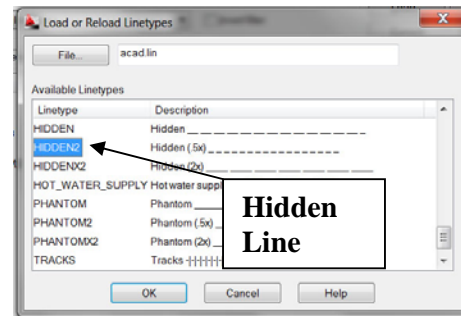
You can highlight several line types by holding down the CTRL key while you click on the names. Once you have selected the HIDDEN2 name, click on the OK button. We could load many other lines types but this is the only one we will need for this drawing.

Hidden
Line

Now click on the LAYER PROPERTIES button shown in the figure shown on the right.

This button creates the layers management dialog box shown at the top of the next page.

Manage
Layers
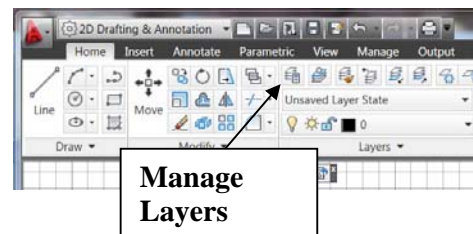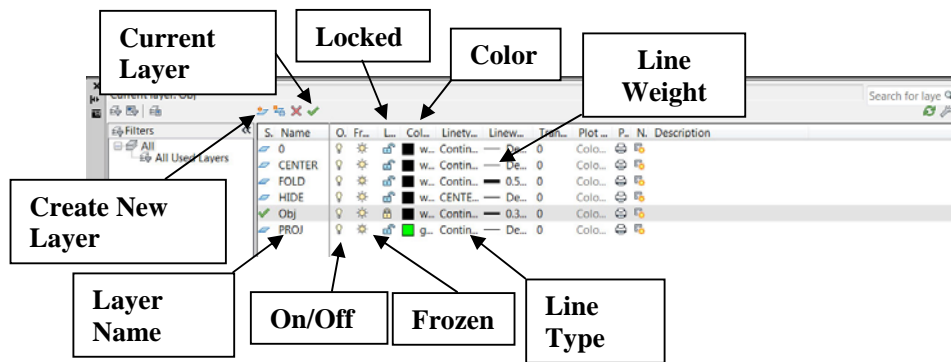
Lines, circles, and arcs belong to layers and each layer determines how the lines, circles, and arcs will be drawn. The layer controls the color, line type, line weight and several other attributes for the layer. These attributes are:

Layer Name	The name used for the layer. Each layer has a unique name.
On/Off	If on the lines can be seen and if off they cannot be seen if it is on it can be seen.
Frozen	This attribute is very similar to On/Off. If a layer is frozen, it cannot be seen.
Locked	The lines in the layer cannot be deleted or modified.
Color	Determines the color of the lines when they are displayed.
Line Type	Determines which line type is used to draw lines in this layer. They can be solid or dashed in many different ways.
Line Weight	This attribute controls how thick the line is when it is drawn on the screen and plotted. The varying thickness on the screen can be turned on and off using a button at the bottom of the main window.
Create New Layer	This button creates a new layer. After it is created you can change the attributes so that it meets your needs.
Current Layer	Click on one of the existing layers then click on the Current Layer check mark. All lines drawn from this point on will be in the layer marked as the Current Layer. This will remain in effect until the current layer is changed again.

This dialog box allows you to create new layers and define their attributes. Click on the Create New Layer button and create layers with the names: OBJ, PROJ,

HIDE, FOLD, and CENTER. Click on the color for the projection layer and change its color. This will make it easier to distinguish projection lines form object lines. You can choose a different color for each layer if you desire.

In this exercise, we will create several new layers. They are:

OBJ   This layer is used for line that make up the objects we are drawing.

HIDE   This layer is used for hidden lines.

CENTER   This layer is used for centerlines.

PROJ   This layer is used for lines that project from one view to the next. They aid in the placement and size of the views.

FOLD   Orthographic views are created by projecting views to the faces of a projection box. The lines in this layer represent the edges of that box.

For the HIDE layer, click on the Line Type and select hidden from the list of loaded line types. This is the line type we added when we loaded line types in a previous step. We did not have to load the line types during that step, we can load them now. Click on the line type for the CENTER layer and in the line type dialog box click on the LOAD button. Now search for CENTER2 in the line types, click on it then click on OK to load the line type also. You can now select it for the CENTER layer.

The lines drawn in each layer can have different weights. Click on the line weight for the OBJ layer and set the line weight to 0.3 mm. When you have finished that, click on the line weight for FOLD and set the line weight to 0.5 mm. We will use different line weights for the object lines and for the folding lines between views. All other layers will use the DEFAULT line weight which is the thinnest line the graphics device can produce.
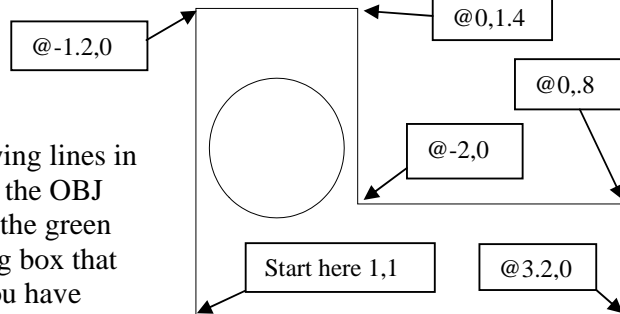
We are going to start drawing lines in the OBJ (object) layer so click on the OBJ name to highlight it then click on the green check mark at the top of the dialog box that selects the current layer. Once you have selected the OBJ layer, click on the X in the extreme upper left corner of the dialog box to dismiss the dialog box.

Now we can start drawing the object. We will start with the Front view. Either type LINE or click on the line button at the top left of the Now use the LINE command to first draw the front view of the object.

```
LINE
From point:      1,1                    {Start the drawing here for convenience}
To point:        @3.2,0
To point:        @0,.8
To point:        @-2,0
To point:        @0,1.4
To point:        @-1.2,0
```
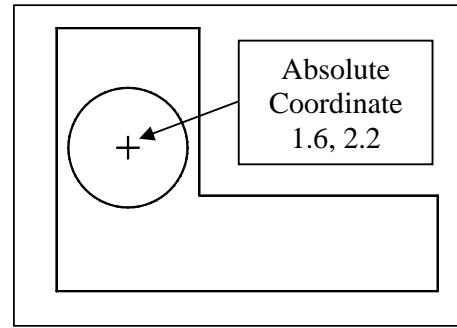
```
To point:          C
```
                    {Close the
                    outline of the object}

Next, draw the circle that represents the hole through the object. Note that you started the drawing at coordinates 1,1 so the center of the circle must be biased by these coordinates. That puts the center at 1.6, 2.2.

```
CIRCLE
3P/2P/TTR/<Center Point>:    1.6,2.2
Diameter/<Radius>:           D
Diameter:                    1
```

The finished drawing with the circle is shown above. This is the front view of the object.

We set the OBJ layer lines to a line weight of 0.3 mm but you will probably notice that they are not being drawn any heavier than any other line. We need to turn that feature on. At the bottom left of the screen, you will see a number of buttons which are shown in the figure below. These buttons help us control the drawing process.
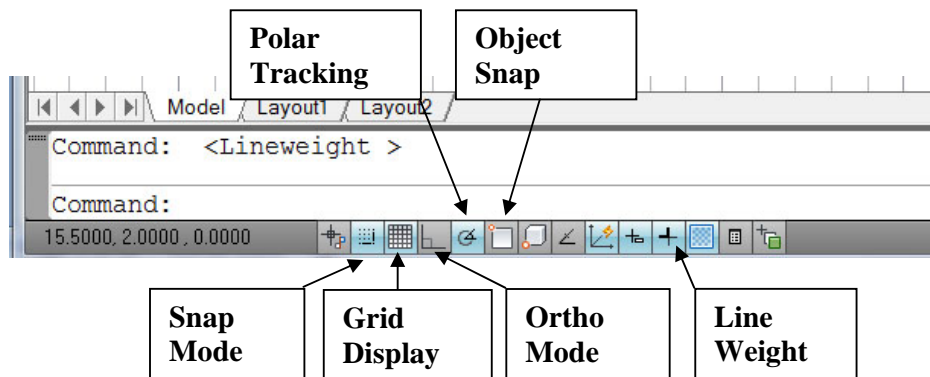
Click on the "Line Weight" button to turn on the display of heaver lines.

ORTHO Mode

Drawing perfectly horizontal and vertical lines with the mouse is very difficult, but AutoCAD can assist you. At the very bottom of the AutoCAD window is a small icon shown above called ORTHO. ORTHO is an AutoCAD setting. When ORTHO is on, you can only draw vertical and horizontal lines with the mouse and when ORTHO is off, you can draw lines in any direction. You turn ORTHO on and off by clicking on the ORTHO icon at the bottom of the window or by typing the **ORTHO** command. When you click on the icon, the background of the icon changes colors indicating the ORTHO setting is on. You can turn the setting on and off while you are in the LINE or other commands by just clicking on the icon.

The ORTHO setting does not affect lines drawn by entering coordinates.

We will start the additions by drawing the folding lines. Folding lines represent the corners of the projection box used to view orthographic drawings. Switch to the FOLD layer by clicking on the Layer Manage button or by typing LAYER then selecting FOLD as the current layer. These folding lines are horizontal and vertical and you can force AutoCAD to draw only horizontally or vertical lines by typing the **ORTHO** command as shown below or by clicking on the ORTHO MODE button at the bottom of the screen. You must do this before you draw the folding lines.

```
ORTHO
ON/OFF/<off>:      ON    {Turn the ORTHO setting on so we can only draw
                          horizontal and vertical lines}
```

Draw the folding lines with the LINE command. Visually select a starting place for the folding lines. You could locate the lines with coordinates but that is not really necessary.

```
LINE
From point:        {Click on an appropriate
                   point to draw the
                   horizontal folding line}
To point:          {Move the mouse to the
                   right and extend the
                   folding line out as far as
                   you think will be
                   necessary. The Ortho
                   Mode is on so the line is
                   horizontal.}
```
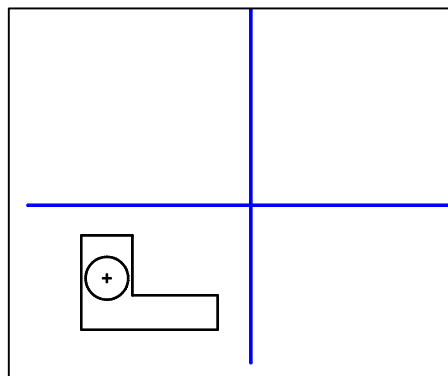
Repeat the process and draw the vertical folding line. After you have drawn this line you are ready to draw projection lines. These projection lines will help us position and control the size of the top and right side views. The projection lines are used in much the same way as they are when drafting orthographic drawings.

The projection lines are either horizontal or vertical so the ORTHO ON setting you are current using is appropriate. The projection lines must start at the corners of the front view. You could use coordinates to place the lines in this position, but that would be difficult to do. AutoCAD provides a simpler method called OSNAP tools.

AutoCAD OSNAP tools allow you to use the coordinates of specific points in the drawing as the coordinates of lines, circles, etc. that you are creating. To use the OSNAP tools, type:

OSNAP

This creates the dialog box shown on the right. It is used to determine which things the program will snap points to. For example, if the intersection on the left side of the dialog box is marked, the program will look for intersecting lines. If the mouse passes over one of these intersections, the pointer will hesitate and the program will draw a small box indicating it has found an intersection. If you click with the mouse to start a line,
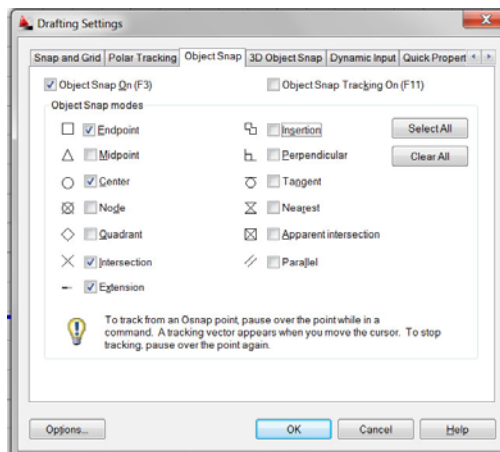
arc, circle or any other entity, it will start at the intersection. The dialog box on the right is used to select the things the program will snap to. Mark *Endpoint, Center, Intersection,* and *Extension* then click on OK at the bottom of the dialog box.

Switch to the **PROJ** layer by typing:

`LAYER`
{Make projection lines the current layer}

Next use the **LINE** command to draw projection lines from the front view into both the top and right side view (remember, you are drawing a third angle projection.) You repeat this sequence of commands and draw both vertical and horizontal projection lines. These lines are easy to draw because AutoCAD automatically finds the corners of the object and with ORTHO on you only have to draw with the mouse. When you have finished drawing these lines you can draw both horizontal and vertical projection lines from the center of the circle.

You have not finished with the projection lines. You need to draw projection lines from the extreme edges of the circle into both the top and right views of the object. You can do this by first extending the projection lines starting at the center of the circle through the other side of the circle then projecting the intersection points of these lines and the circle to the other two views. Start with the EXTEND command.
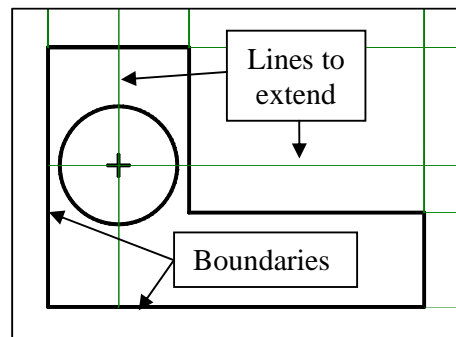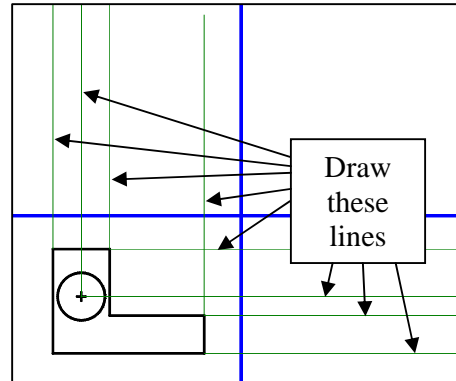
`EXTEND`

|	
`Select boundary edge(s)...`	*{Click on the left side and bottom of the object. Press Return after you have selected the two edges}*
`Select objects to extend:`	*{Click on the two lines starting at the center of the circle. After extending these two lines press Return}*

Now that you have extended these two lines, project the lines from their intersection with the circle to the other two views. Repeat this operation to extend the projection lines into both the top and right views.

Once you have finished with these lines, draw a 45 degree line extending from the intersection of the two folding lines. AutoCAD can draw using X-Y (Cartesian coordinates) or polar coordinates. We will use polar coordinates to create this line. Polar coordinates consist of a length and an angle. The length is entered first followed by a < symbol then an angle. The < symbol separates the length from the angle and tells AutoCAD that you are entering a
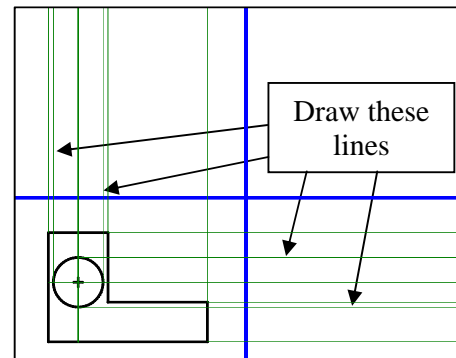
polar coordinate. The angle is specified in degrees measured from the horizontal axis. A positive number is an anticlockwise (counterclockwise) rotation and a negative number is a clockwise rotation. If you precede the length with a @ sign, the last point will be used for the origin of the polar coordinate.
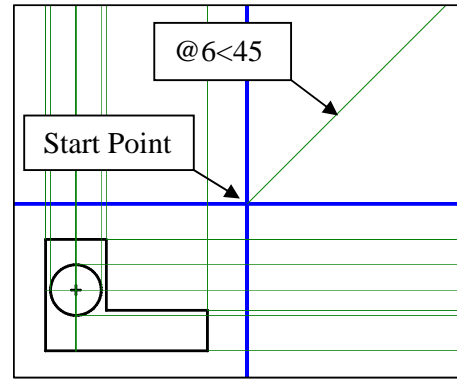
Enter:

```
Line
Specify first point:            {click at the intersection of the folding lines}
Specify next point: @6<45       {Create a line that is 6 long at an angle of 45 degrees from
                                 horizontal}
Specify next point:             {End line command}
```

   You are now ready to draw the top view. Use the LAYER command to change the current drawing layer back to OBJ and then draw a horizontal line with the mouse. This line represents the front of the object in the top view. This line should extend beyond both the left most and right most vertical projection lines. ORTHO is set to on so it should be rather simple to draw this line with the mouse. The vertical placement of the line is not important but the line should be as far from the top-front folding line as the front view is.
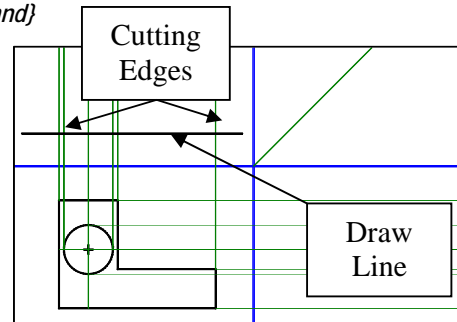
   You can use the TRIM command to trim the line you have just drawn so that it has the proper length.

```
TRIM
Select cutting edge(s) ...   {Click on the left and right projection lines. We
                              will trim the object line to these two lines. Press
                              Return after clicking on the two lines.}
Select objects to trim:      {Click on the left and right ends of the line we
                              want to trim. It will be trimmed to the proper
                              length.}
```

Now draw the rest of the top view. Start at the right end of the line you just trimmed and draw around the top view, moving in a counter clockwise direction.

```
LINEFrom point:   {Click on the right end
                   of the line you just
                   trimmed}
To point:         @0,.4
To point:         @-1.2,0
To point:         @0,1
To point:         @1.2,0
To point:         @0,.4
```
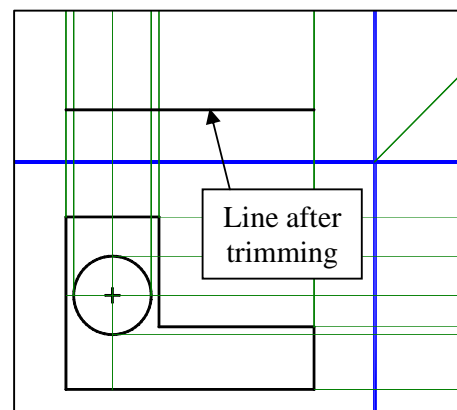
```
To point:        @-3.2,0
To point:        {Click on the left end of the
                 first line drawn to complete
                 the outline of the object.
                 Press return to end the
                 command.}
```
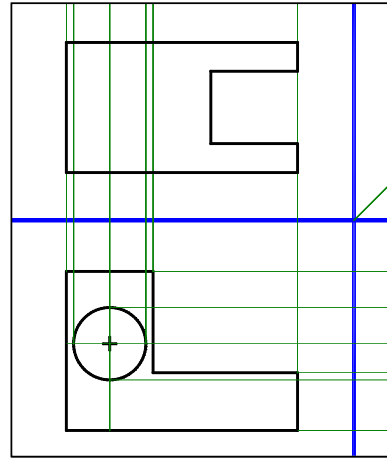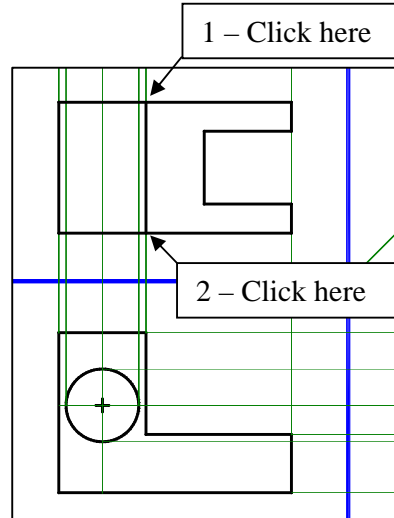

Next, add the vertical line defining the right edge of the rectangle containing the hole.

```
LINE
From point:      {1 - Click on the
                 intersection of the
                 projection line and
                 the front edge of the
                 object.}
To point:        {2 - Click on the
                 intersection of the
                 projection line and
                 the back edge of the
                 object.}
```


1 – Click here

2 – Click here

You should now have the drawing shown in the figure at the right.

The top view is not complete but we will leave it for now to project lines from the top to right side view and draw the right side view. Switch the layer to the PROJ layer and project horizontal lines from the top view to beyond the 45 degree line to the right. This is shown in the figure at the bottom of the page. The projection lines have no specific length so you can draw them with the mouse and ORTHO set to ON.

Create these lines
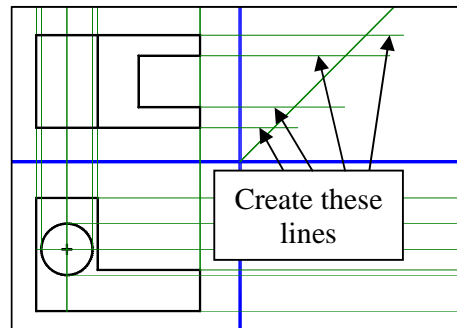
After drawing these projection lines, extend them down to the right side view by starting lines at the intersection of the 45 degree line and the horizontal projection lines from the top view. Here again, you can draw these projection lines with the mouse because their length is not important. The ORTHO ON setting forces the lines to be vertical.

Draw these lines
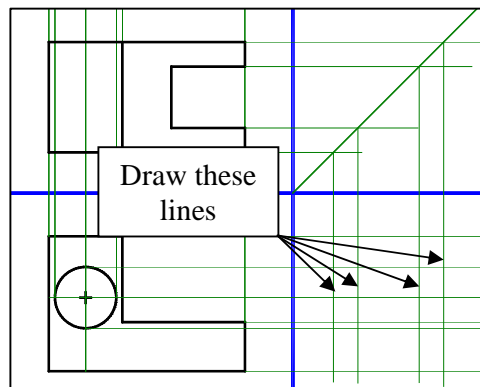
Your drawing should look like the one at the bottom of the previous page. It is getting cluttered with projection lines but these will aid you in drawing the right view and when you are finished, you can turn them off so that they do not show in our final plot.

The next step is to draw the right view. You could do this with coordinates but it is easier to use the projection lines and let AutoCAD compute the coordinates at the intersections of the projection lines. Just draw by clicking with the mouse at the intersection of the projection lines.

You are almost finished. The only things left to draw are a hidden line in the front view that shows the notch that is prominent on the right side of the top view and the center lines for the hole. We will draw the hidden line in the front view first.

Switch the layer back to PROJ and draw a projection line from the inside of the notch in the top view down to the front view.

Next switch to the HIDE layer and draw the hidden lines in the front view showing notch. The drawing should look like the one shown on the right.

After you have finished drawing the hidden lines in the front view, draw the hidden lines for the hole in both the top and right side views.

The only things missing are center lines for the hole. Change the layer to CENTER and draw the lines in the top and right side views using the following sequence of commands.
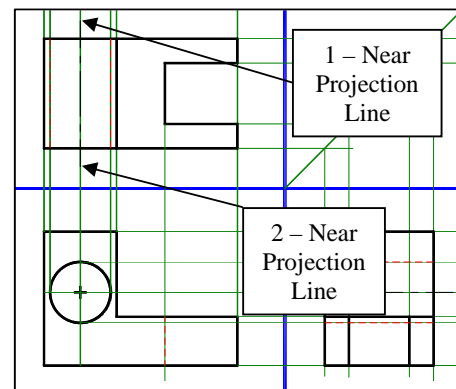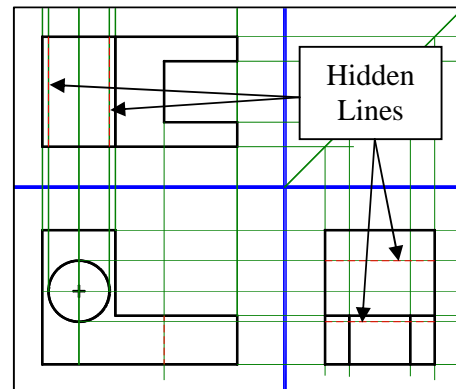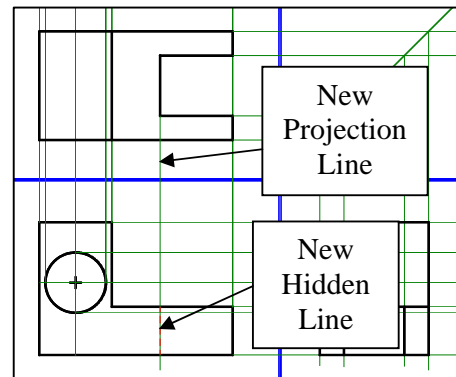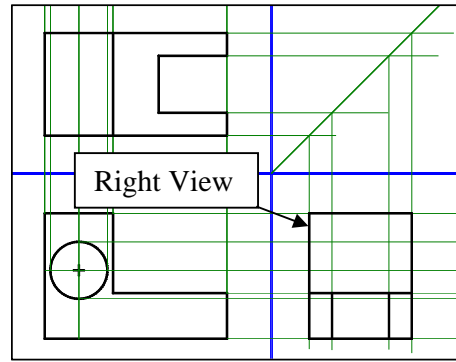
```
LINE
From point:        NEAR
Of:                               {1 - Click on the projection line extending through the
                                   center of the hole in the top view. Click where you
                                   want the centerline to start}
To point:          NEAR
```

Repeat the process for drawing the centerline in the right side view.

Next, we will draw the center lines for the hole in the front view. It is difficult to draw the crossing type of center lines with two lines. The dashes usually do not line up correctly and the center lines will not look right. These types of center lines are best drawn using AutoCAD commands designed specifically to draw circle centers. Click on the Annotate tab at the top left of the AutoCAD window then on the Dimensions pull down under the dimension section of the ribbon. You should see a pull down menu like the one shown below.

Circle Center Button
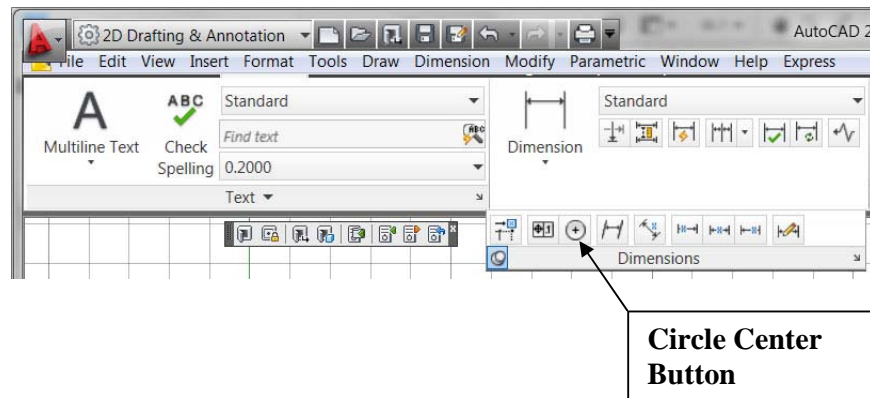
Click on the Circle Center Button then click on the circle in the front view. That will put a small cross in the center of the circle. If the cross is too small or too big, you can adjust its size with the **DIMCEN** command. **DIMCEN** sets the size of the plus that is drawn at the center of the circle. It should be large enough to see but not so large that it dominates the center of the circle. Later on, we will use this circle center for dimensioning our drawings.

```
dimcen
Enter new value for DIMCEN <0.0000>: .1
```

The **DIMCEN** command will not change the size of the plus after it is drawn. If you draw the plus and it is not the right size, delete it, change the **DIMCEN** size, and redraw it. Repeat this until it looks reasonable.

We are getting close to the end. We have drawn all three views and it is time to turn off the display of the projection and folding lines. They are no longer needed. Use the following method:

1.   Type LAYER to start the layer command
2.   Set the current layer to the OBJ layer.
3.   Click on the light bulb next the PROJ layer name.
4.   Click on the light bulb next to the FOLD layer name.
5.   Click on the X in the upper left of the layer dialog box to dismiss the layer box.

You will be left with drawing shown below.

If the dashes on the center lines and hidden lines do not seem appropriate, you can change their length with the LTSCALE command. This command sets a scale factor for the dashes used in non-continuous lines.

You can change the scale with the commands:
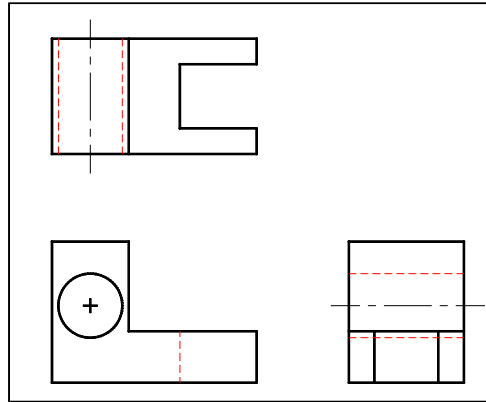
LTSCALE
New scale factor <1.0000>   **0.5**

{Changing the line type scale to 0.5 makes the dash length ½ its current size. A factor smaller than one reduces the size of the dashes and a factor greater than one increases the size. You can experiment with different sizes until the line types look correct.}

Through at last !!!!!!!