

# Chapter 10

## The Bracket Problem

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In this chapter, you will learn the following to World Class standards:

- **Creating a Drawing using Metric Measurements**
- **Creating a Top Orthographic View Starting with the Circle Command**
- **Using the Copy Option of the Move Command using Relative Coordinates**
- **Placing an Arc Between Circles using the Fillet Command**
- **Using the Trim Tool to turn Circles into Arcs**
- **Using the Mirror Tool to Copy Entities across the Centerline**
- **Creating a Front Orthographic View with Construction Lines**
- **Using the Offset Tool on the Front Orthographic View**
- **Creating a Front Orthographic View with Circles**
- **Finishing the Top View by Projecting Off the New Front View**
- **Creating an Arc from a Line to a Circle**
- **Using the Extend to Next Tool**
- **Using the Trim Tool**
- **Moving Entities from One Layer to Another**

The bracket problem is the fourth and last problem in your basic CAD training and it is just as important to achieve the drawing standards as it was in the first three problems: the rectangular, circular and border problems. Where the rectangular and circular problems are an instruction of basic concepts in straight and curved components, the bracket problem addresses the unique challenges of multi-view layouts. The bracket problem allows you to learn more skills such as orthographic view alignment but also reinforces many concepts from your first lessons. This repetition allows you to attain the World Class standard.

## Creating a Drawing Using Metric Measurements

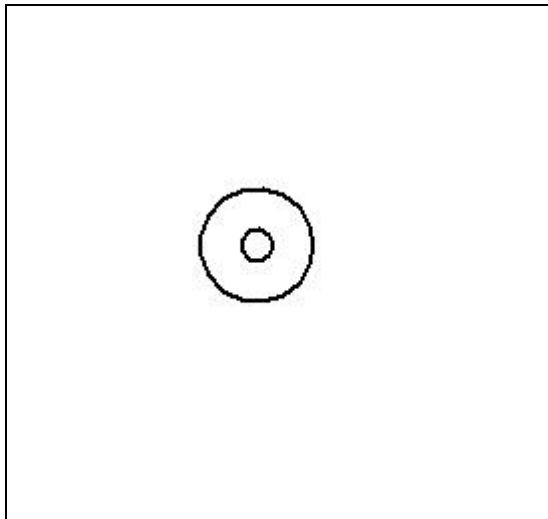
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When you draw the bracket problem, you will use dimensions that represent distances in Metric units of length, so one drawing unit will equal a millimeter and not an inch. Organizations that adopt the Metric system have a much easier time communicating with the majority of the inhabitants on the Earth, since the United States of America is the only major country still using the English system of measurement. To insert the completed bracket drawing into a CAD file made in inches, you will need to reduce the size of the views by 1:25.4 or by a factor of 0.03937. Other than having a different size or scale, making a Metric drawing is similar to making orthographic views with the English system.

## Using the Copy Option of the Move Tool Using Relative Coordinates

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To begin the bracket problem, draw a 25 mm radius circle in the upper left of the display screen. Next, draw a 14 mm diameter circle in the center of the first circle as shown in Figure 10.2.



Now, you need to copy both circles together 60 mm to the right and 20 mm up. You can do this by selecting the **Move** tool on the **Draw** panel. On the Move Window, there is the option to copy the objects that you are moving. Select the **Copy** tool on the window and then type in 60 mm for the **X** displacement and 20 mm for the **Y** displacement (Figure 10.3). Now, pick the center of the 14 mm diameter circle as the point from which you want to move and copy the circles and then place the new circles up and to the right of the original circles as shown in Figure 10.4. This is a very powerful movement technique since in one command you can both move and copy entities simultaneously when using the **Move** command.

**Figure 10.2 – Drawing First Two Circles**

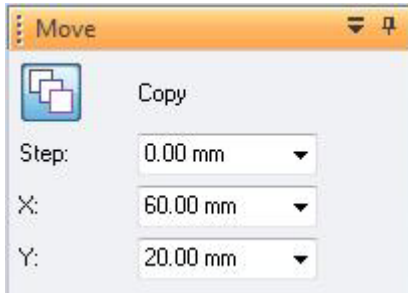


Figure 10.3 – Move Window

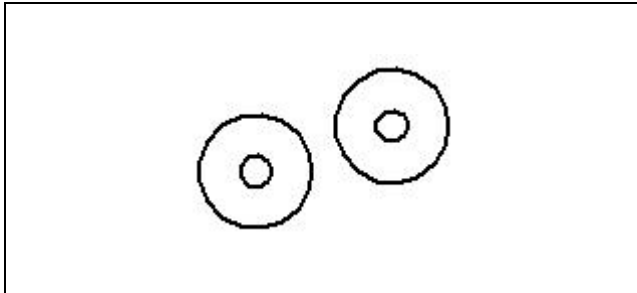


Figure 10.4 – Copied Circles

## Placing an Arc Between Circles Using the Fillet Command

Previously, you have used the **Fillet** command to create radius entities between two straight lines, but now you will learn that an arc can be formed when selecting between a circle and a straight line, between two circles or between an arc and a line. In earlier versions of Computer Aided Design software, drawing arcs on the computer graphical screen was as difficult as those drawn in pencil on a drafting board because construction techniques using a starting point, endpoint and radius involved mathematical calculations. When using the **Fillet** command, many of the tedious precision calculations are eliminated.



You can create the between the two 25 mm circles using the **Fillet** tool on the **Draw** panel. Select the **Fillet** command and the Fillet Window will appear to the left of the screen. At the bottom of the window type in “30” for the radius (Figure 10.5). Next select the original 25 mm radius circle and then select the copied 25 mm circle. Place the arc above the two circles and left click with your mouse. A 30 mm arc will appear between the two circles as in Figure 10.6.

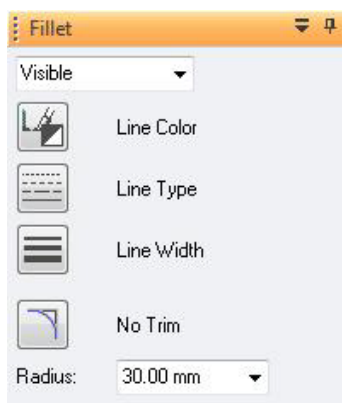


Figure 10.5 – Fillet Window

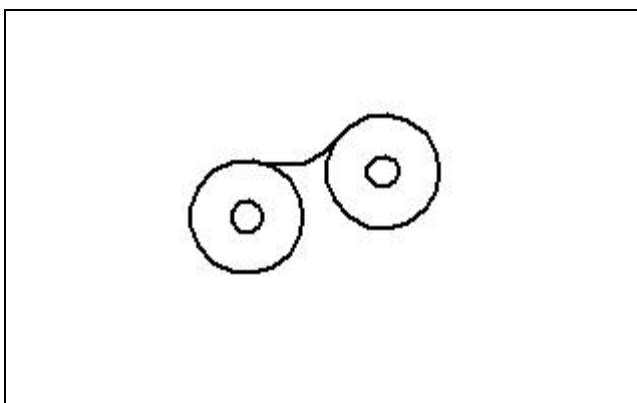
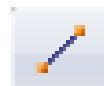
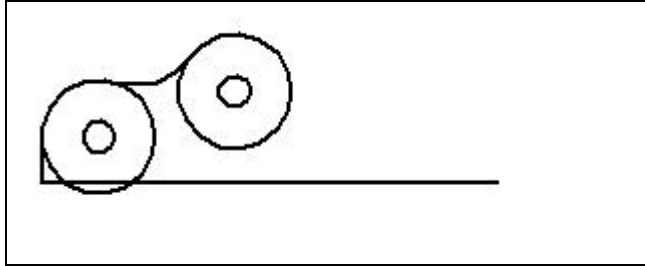


Figure 10.6 – 30 mm Arc

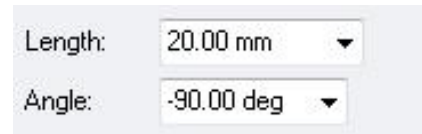
Next, draw a line off of the left quadrant of the left circle 20 mm downward and then draw another line of undetermined length to the right and perpendicular to the 20 mm line (Figure 10.7). Select the **Line** tool from the **Draw** panel and then click on the west quadrant of the left 25 mm radius circle. Type “20” in the Length textbox of the Line Window and hit **Enter**. The Angle textbox should read “-90.00” degrees. Left



click with your mouse to draw the line. Another line will be coming from the one you just drew. Take the second line and draw it to the right making sure it is perpendicular with the 20 mm line. It does not matter exactly how long the second line is but make sure it is at least 200 mm long.

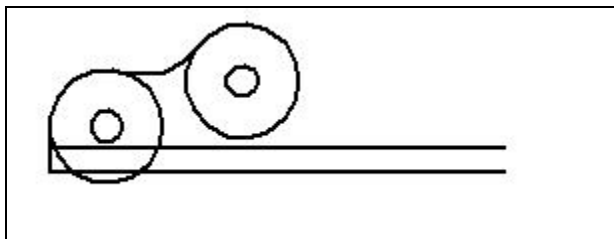


**Figure 10.7 – Drawing the 2 Lines**

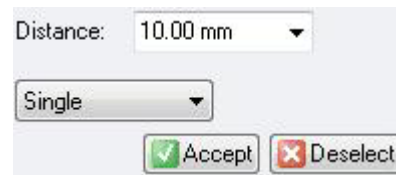


**Figure 10.8 – Line Window for 20 mm Line**

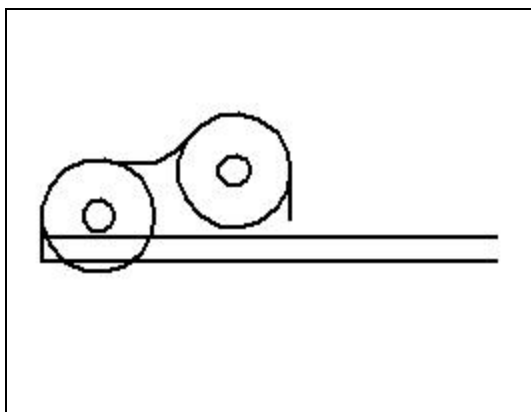
The first line is part of the bracket and the second line will become the centerline of the symmetrical part. The locking loop of the bracket can be formed beginning with the offsetting of the centerline 10 mm upward. Select the **Offset** tool on the **Draw** panel. In the Distance textbox type in “10” and press **Enter**. In the drop-down box below the Distance textbox, select the “**Single**” offset option (Figure 10.10). Next, left click on the centerline and then hit the Accept button on the Offset Window. Now move your cursor above the centerline and the offset line will appear above it. Left click with your mouse to draw the line and then right click to end the command. When you are finished, your drawing should appear as in Figure 10.9.



**Figure 10.9 – Offset Centerline**



**Figure 10.10 – Offset Window for Centerline**



Draw another line of undetermined length by selecting the **Line** tool on the **Draw** panel. Using the Quadrant IntelliSketch icon, pick the east quadrant of the right 25 mm radius circle. Now, draw the line downward and pick any point below the initial starting point. Make sure the line is perpendicular to the centerline. Left click with your mouse to draw the line and then right click to end the command. Did you notice that four lines were drawn in consecutive order to maximize efficiency of command repeatability? One line was created using the **Offset** tool which is very effective.

**Figure 10.11 – Drawing a Line of Undetermined Length Off of the Right Circle**

Draw a 10 mm arc with the **Fillet** command between the 10 mm offset line and the vertical line you just drew off of the right circle. Select the **Fillet** tool form the **Draw** panel and type “10” into the Radius textbox (Figure 10.13). Now select the vertical line coming off of the right circle. Then select the offset line. Place the arc by moving the cursor to the upper right of the screen. Left click to place the arc, making sure that it appears as in Figure 10.12. Placing the arc will trim the offset line and extend the vertical line to connect with the offset line through the arc. The top view of the bracket is coming into shape.

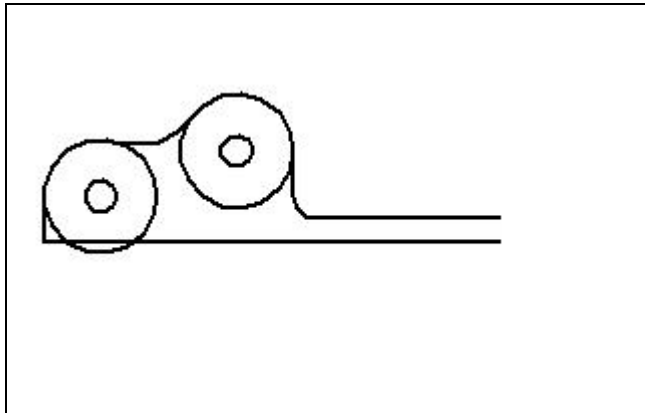


Figure 10.12 – Filleting Two Lines

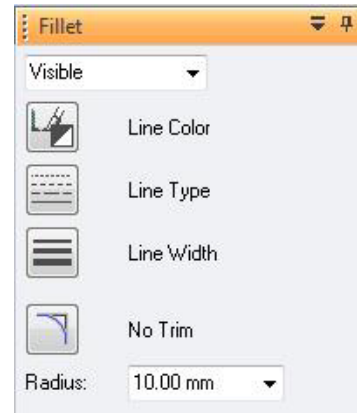


Figure 10.13 – Fillet Window for 10 mm Arc

## Using the Trim Tool to Turn Circles into Arcs

By precision selection of entities in a drawing, the **Trim** tool can be utilized to modify basic circles into arcs. By selecting precise lines as cutting surfaces, entities that are overlapping each other will be ignored and less cutting will be required. Select the **Trim** tool from the **Draw** panel and trim all of the parts of the 25 mm circles that are part of the perimeter of the bracket. Figure 10.14 shows all the lines that need to be trimmed. Figure 10.15 shows the bracket after it has been trimmed.

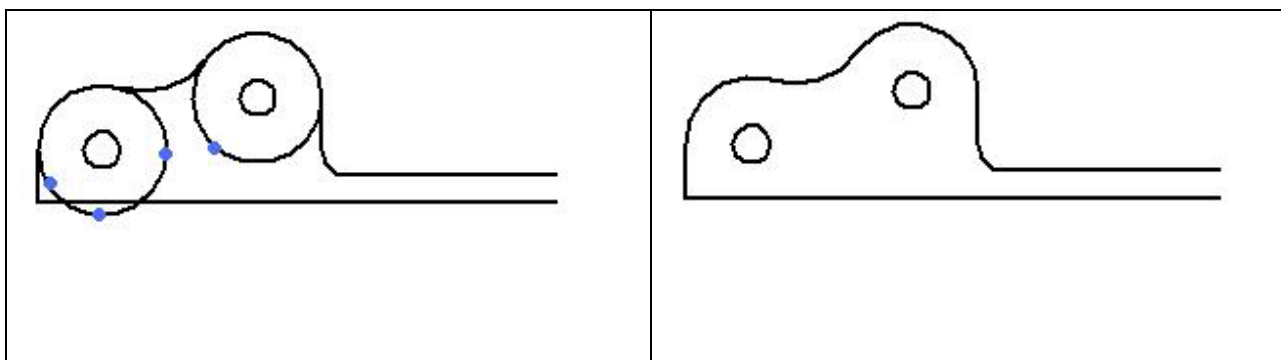


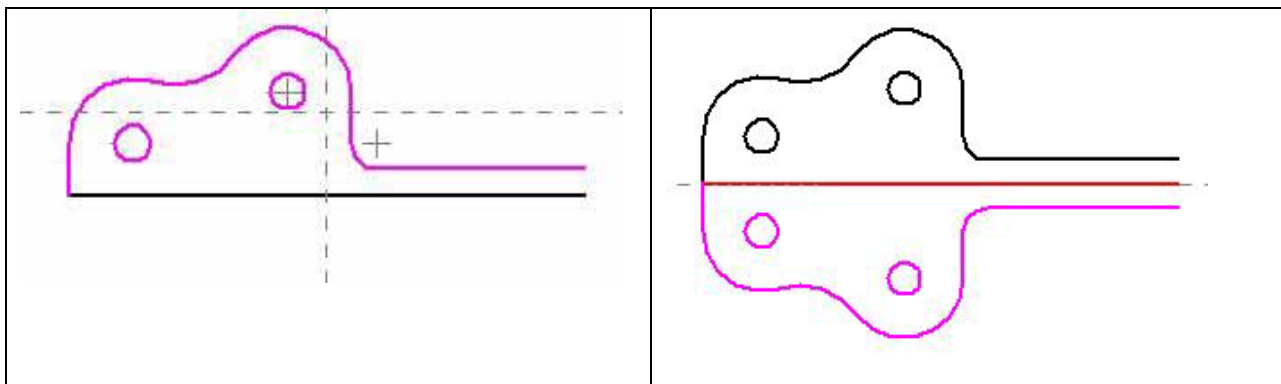
Figure 10.14 – Entities to be Trimmed

Figure 10.15 – Finished Trimming

\* World Class CAD Challenge 22-19 \* (See End of Chapter)

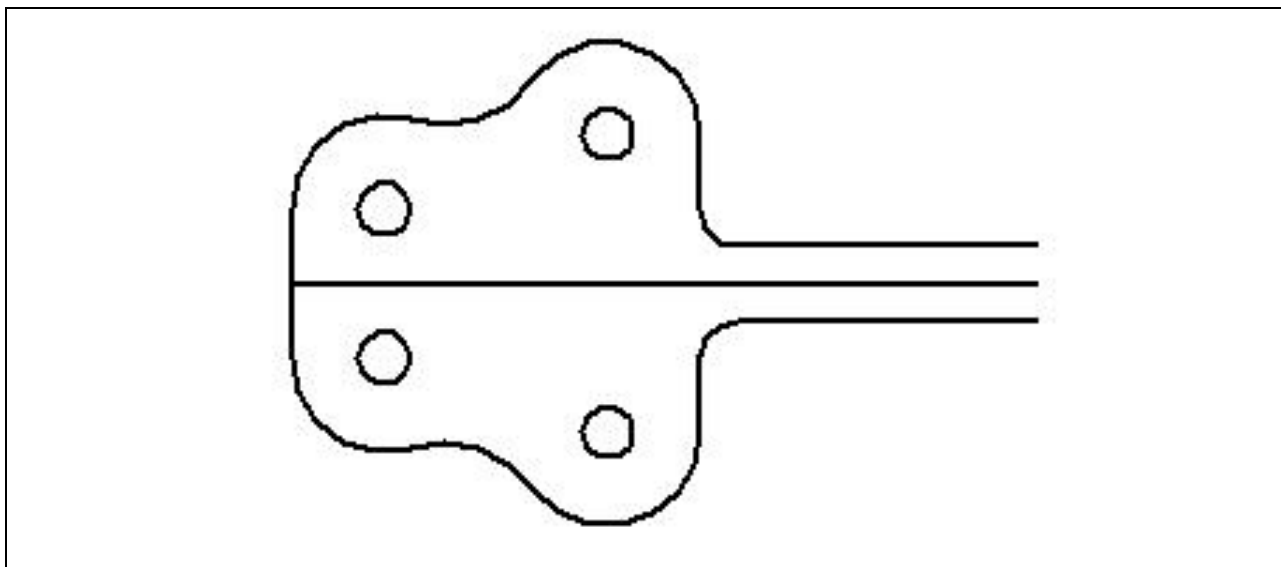
## Using the Mirror Tool to Copy Entities Across the Centerline

The strategy of the bracket problem is to draw the top half of the top view since the dimensions to construct the problem are present and do not require any mathematical calculations. In other words, this is a simple view to assemble. Now to double the entity count you will use the **Mirror** command located under the drop-down arrow next to the **Move** tool. Select the **Mirror** tool and then select all of the entities except for the centerline (Figure 10.16). Next, place the cursor on the centerline so that it will act as the axis for mirroring. A grey, dashed line should appear horizontally across the centerline and the drawing screen with the part reflected across the line (Figure 10.17). Left click with your mouse to draw the second half of the part and then right click to end the command. The bracket should now appear as in Figure 10.18.



**Figure 10.16 – Selecting the Entities for Mirroring**

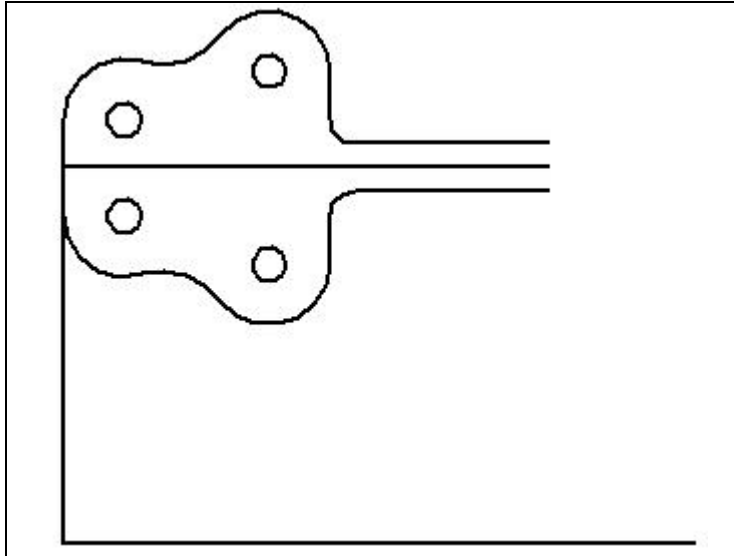
**Figure 10.17 – Selecting Centerline as Mirroring Axis**



**Figure 10.18 – Finished Mirroring Process on Bracket**

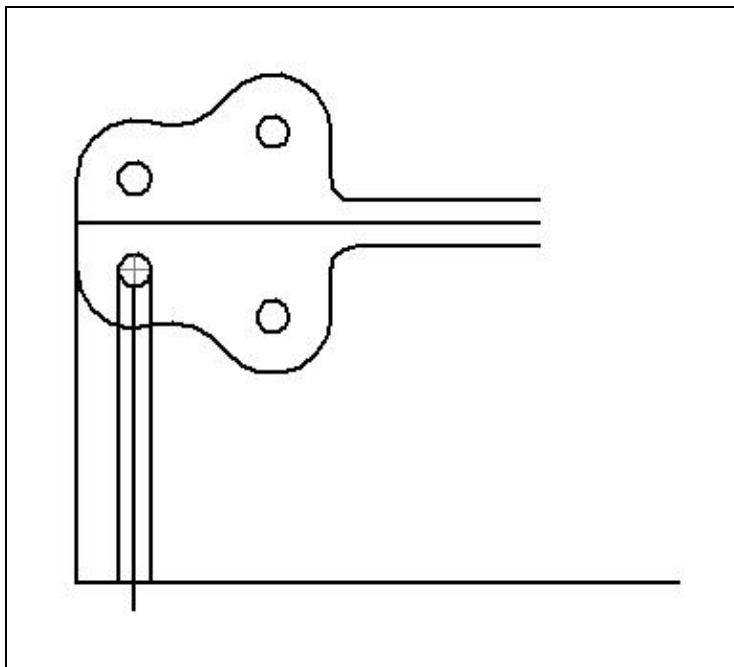
## Creating a Front Orthographic View Using Construction Lines

Once in a while you will be required to draw free hand in Solid Edge, where in the past the majority of the lines or other entities were created with exact precision. When free-handing the boundaries for the next view, you may underestimate the height of the front view and need to use the **Move** tool to adjust for your oversight. Make your best guess and continue to draw.



Now you will add construction lines to create the front orthographic view. Go to the Line tool on the Draw panel, select the command and go to the bottom of the left line of the top view. Select the Endpoint IntelliSketch icon and pull the line down to almost the bottom of the graphical display. Draw a baseline over to the right and then left click to finish placing the second line and then right click to stop from drawing another line.

**Figure 10.19 – Drawing the Left Boundary and Bottom Lines of the Front View**



You are still in the Line command, so draw another construction line by selecting the west quadrant of the bottom circle and draw it down, perpendicular to the baseline. Left click to draw the line and then right click to draw a new one. Draw the next line, which will later become a centerline, from the south quadrant of the circle and drawing downward and a little bit past the baseline. Left click to draw the line and then right click to draw a new line. Draw another construction line from the east quadrant of the circle, drawing downward and perpendicular to the baseline. Left click to draw the line and then right click to end drawing the line.

**Figure 10.20 – Lines from Left Circle**

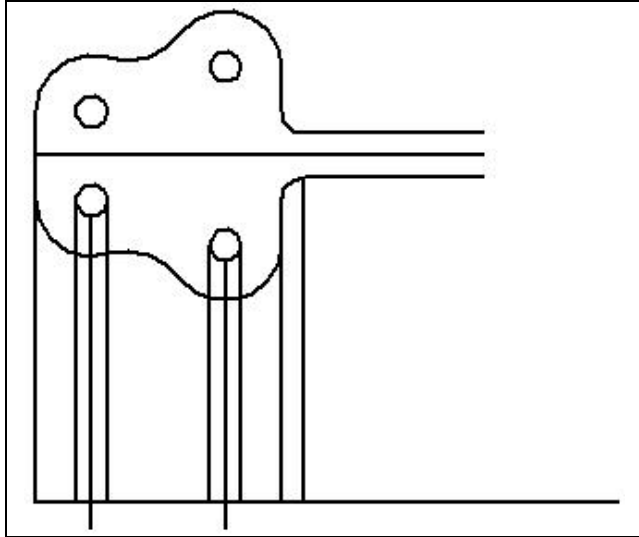


Figure 10.21 – More Projection Lines

Continue to draw the construction lines projecting off the west, south and east quadrants of the second small circle. The next projection line in this set is at the right side of the 20 mm radius arc, which will be drawn from the endpoint of the arc to the perpendicular point on the baseline. Finally, draw the line from the right side of the 10 mm radius fillet to the perpendicular point on the baseline (Figure 10.21).

## Using the Offset Tool on the Front Orthographic View

Select the **Offset** tool on the **Draw** panel. Type “15” into the Distance textbox in the Offset Window and choose the “**Single**” offset option (Figure 10.22). Select the baseline of the front orthographic view and then hit the Accept button the Offset Window. Place the offset line above the base line by left clicking with your mouse and then right clicking to end the command (Figure 10.23). We will offset another line to make the centerline for the bracket’s loop so stay in the **Offset** command. In the distance textbox, type “150.” Select the “**Single**” offset option and then select the line coming off of the south quadrant of the left hole (Figure 10.24). Hit the Accept button on the window and then place the offset line to the right. Left click to place the line and then right click to end the command (Figure 10.25).

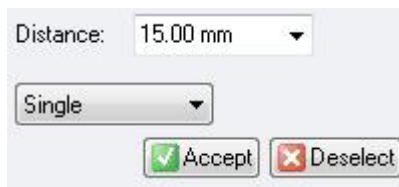


Figure 10.22 – Offset Window

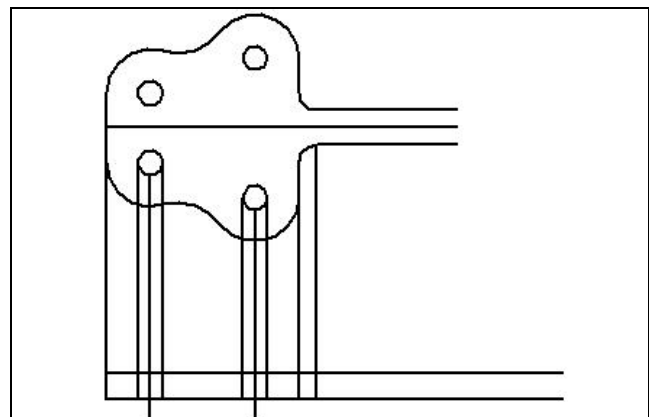


Figure 10.23 – 15 mm Offset Baseline



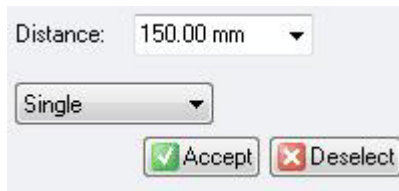


Figure 10.24 – Offset Window

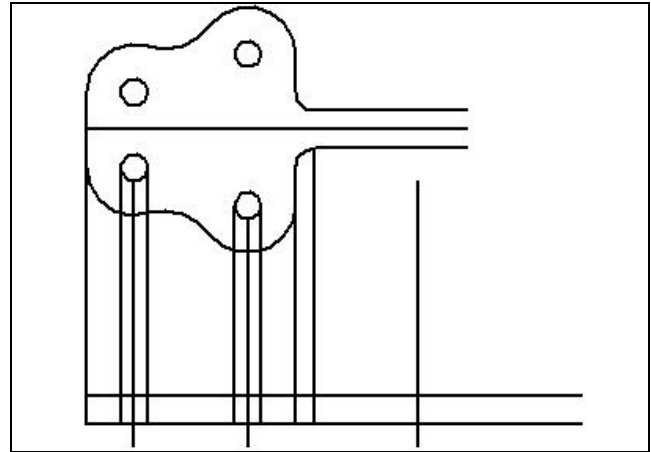


Figure 10.25 – 150 mm Offset Line

\* World Class CAD Challenge 22-20 \* (See End of Chapter)

## Creating a Front Orthographic View Using Circles

Periodically, a designer will draw entities in one location and move the group to another position in the drawing by using the drawing IntelliSketch icons or a relative coordinate using the **Move** command.

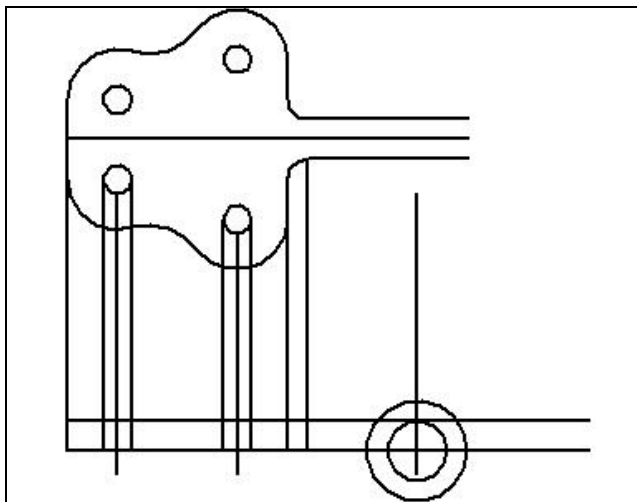
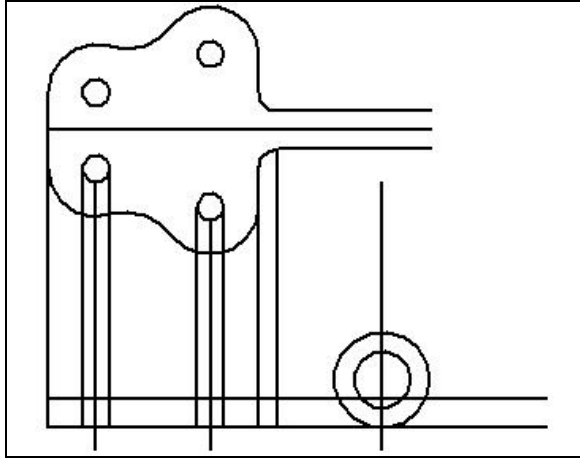


Figure 10.26 – Adding Two Circles

Select the **Circle** tool on the **Draw** panel. Bring your mouse over to the right line and pick the intersection of the construction line you just placed and the baseline. Select the intersection and type “**25**” into the Radius textbox on the Circle Window, hit **Enter** and then right click. Draw another circle using the center of the circle you just drew as the center of the next circle. Type “**15**” into the Radius textbox, hit **Enter** and right click to place the circle (Figure 10.26).

Now move both of the circles by choosing the **Move** command on the **Draw** panel. After selecting the two circles, specify the south quadrant of the 25 mm radius circle as the point from which you want to move them.

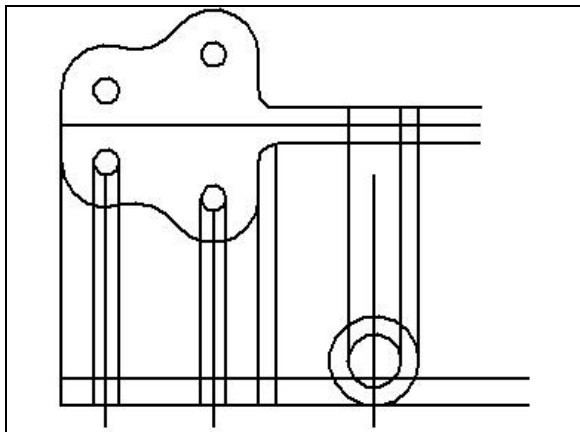




You want to move the circles to the perpendicular point on the baseline, which is also the original center of the circles. As you can see in Figure 10.27, the larger circle is now tangent with the baseline of the front view of the bracket. In previous problems, the use of **Move** and **Copy** were dependent on you typing in numeric distances but in this exercise you can see the power of the IntelliSketch icons in moving entities along their geometric interfaces.

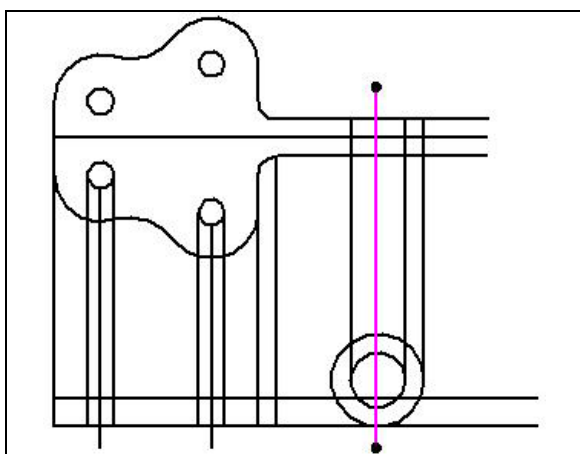
**Figure 10.27 – Moving the Circles to the Baseline**

### **Finishing the Top View by Projecting Lines Off the New Front View**



With the **Line** command, draw a construction line by selecting the east quadrant of the outer circle and drawing up to the perpendicular point on the upper line in the top view. Left click to place the line and right click to end it. Draw the next line off the east quadrant of the inner circle to the perpendicular point of the upper line. Draw a third line from the west quadrant of the inner circle as in Figure 10.28. These lines will assist in finishing the work on the top view.

**Figure 10.28 – Projecting Lines to Top View**



You will need to show a centerline on the top view so borrow the centerline of the two circles that make the loop of the bracket. Using the **Select** tool, click on the centerline and it will turn pink. Click and hold with your left mouse button on the top endpoint (black ball). Dragging with your mouse, move the line straight up through the object line in the top view. In the window on the left of the screen, you may need to modify the angle at which the line is projected. Make sure the line is at “-90.00” degrees.

**Figure 10.29 – Projecting the Centerline.**

## Creating an Arc from a Line to a Circle

There is a 200 mm radius arc that goes from the top of the bracket to a tangent point on the loop. Go to the **Fillet** tool on the **Draw** panel to create a new fillet. In the Radius textbox on the Fillet Window, you type “200” (Figure 10.30). Now pick the top line segment on the bottom view as your first object and the outer circle as the second object, placing the arc above the first line segment to create the 200 mm radius arc as shown in Figure 10.31.

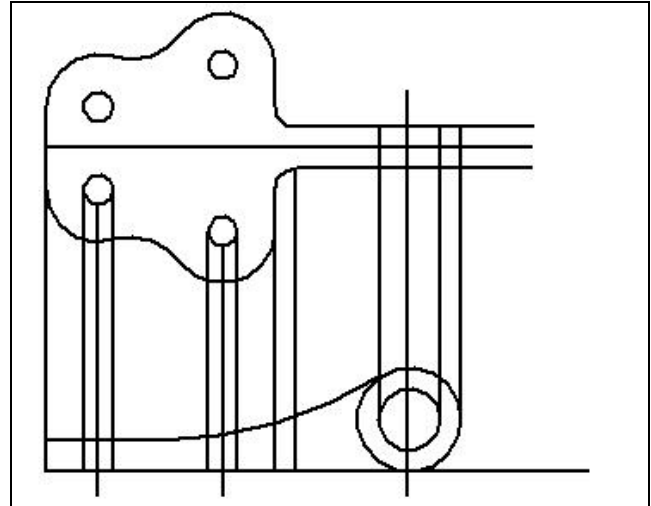
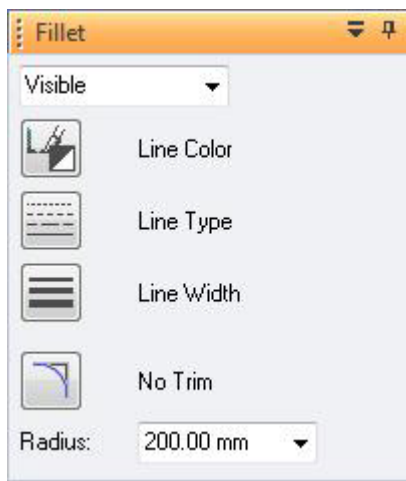
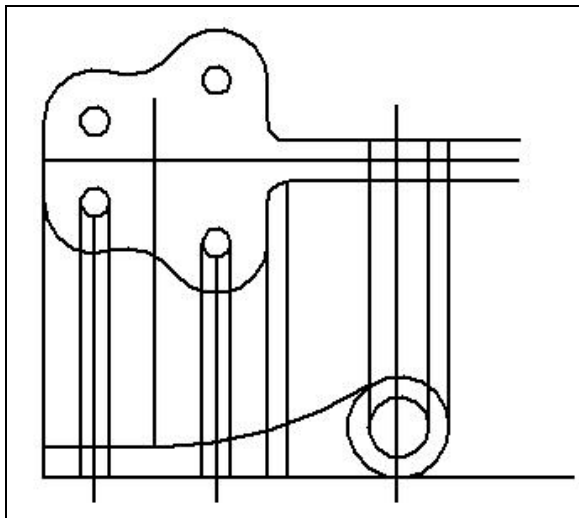


Figure 10.30 – Fillet Window for 200 mm Arc    Figure 10.31 – 200 mm Arc

## Using the Extend to Next Tool

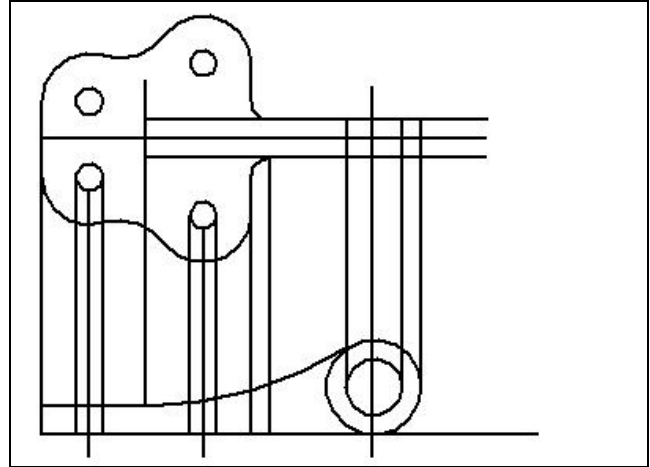


With the 200 mm arc drawn in the front view, you need to show the same detail in the top view. You will accomplish this by first selecting the **Line** tool to create a construction line. Select the left endpoint of the 200 mm arc and draw the construction line straight up in to the top view. Left click to place the line and right click to end the command. Make sure that the line goes past the upper line segment of the straight portion of the bracket as in Figure 10.32. This process makes a line that will allow you to extend two lines from the loop in the top view.

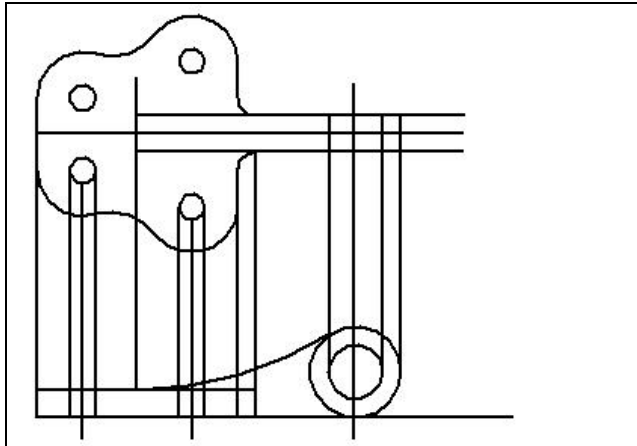


Figure 10.32 – Drawing an Extension Line

Use the **Extend to Next** tool on the **Draw** panel. The command will ask you to specify the objects you want to extend so pick the top line of the loop in the top view for your first line. As you can see, when you put your cursor over the line you want to extend, it will show you to where it will be extended. Now, pick the bottom line of the loop in the top view and left click on it with your mouse to extend it. Both lines will be extended to the construction line that you just drew as in Figure 10.33.

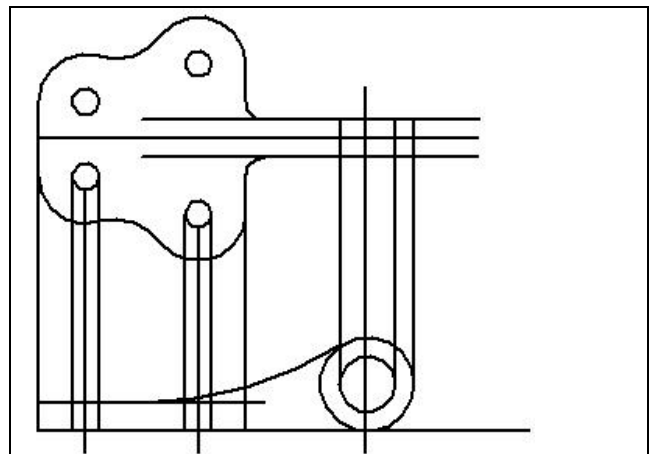


**Figure 10.33 – Extending Two Lines**



**Figure 10.34 – Extending One Line**

Now you need to remove the two construction lines that you used to draw and extend the lines of the bracket. You can do this using the **Select** tool and then deleting the lines. Pick both lines with the **Select** tool holding down the shift key to select both lines at the same time. With both lines picked, press the delete key on your keyboard to remove the lines (Figure 10.35).



**Figure 10.35 – Removing Construction Lines**

## Using the Trim Tool

Select the **Trim** tool on the **Draw** panel. You need to trim the four lines that are being drawn from the two holes in the top view of the bracket. The lines are broken up into ten line segments you will need to trim ten different entities. The lines coming from the right hole have some parts that are very small that need to be trimmed so may need to zoom in to trim them. Make sure you do not erase the part of the line that is going through the front view of the bracket (Figure 10.36).



Staying in the **Trim** command, you now need to trim the lines coming from the circular loop and the remaining construction lines. There are eight line segments in total. Trim all the line segments, remembering not to remove the centerline (Figure 10.37). When you trim the far left, vertical line you will have to redraw the small line connecting the bottom of the front view to the line above it to close the part. The line is marked with a small blue dot in Figure 37.

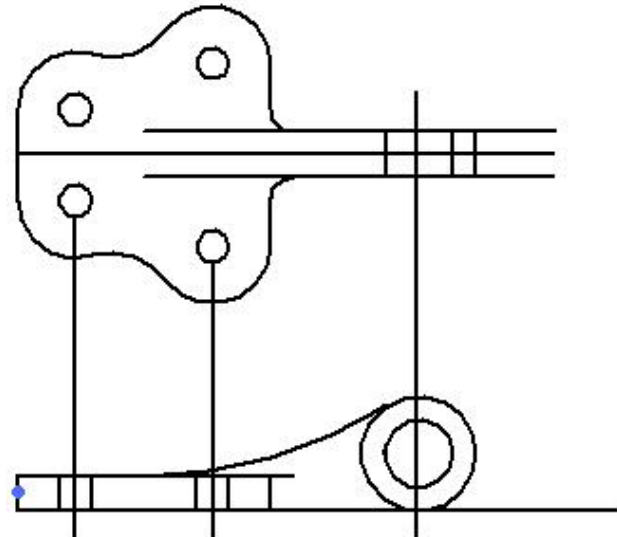
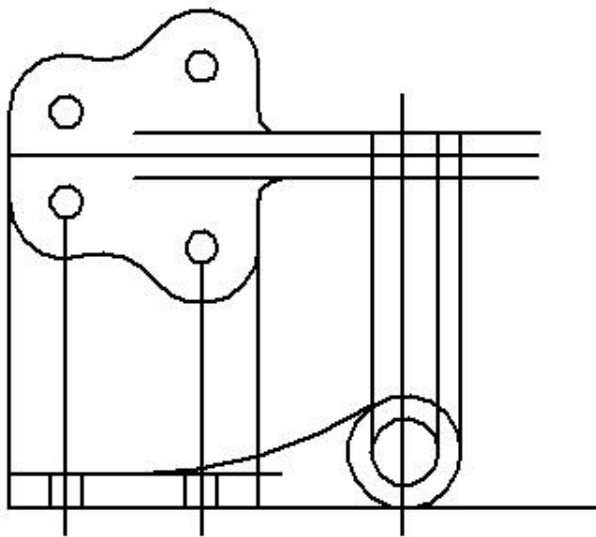


Figure 10.36 - Removing 10 Line Segments

Figure 10.37 - Removing 8 Line Segments

Now you need to cut away the very bottom line on the front view to the edge of the outer circle and remove a segment of the outer circle in the same view. Still using the **Trim** tool, pick the lines just described to be removed. Also trim the two lines extending from the loop in the top view as shown in Figure 10.38. Lastly, you can see in Figure 10.38 and on your graphic display that the centerlines need to be extended only a couple of millimeters past the outside perimeter of the part. Select each line and use the black endpoints to adjust the centerlines to be visually correct. You may need to change the angle of the lines when you extend them to make sure that they are straight.

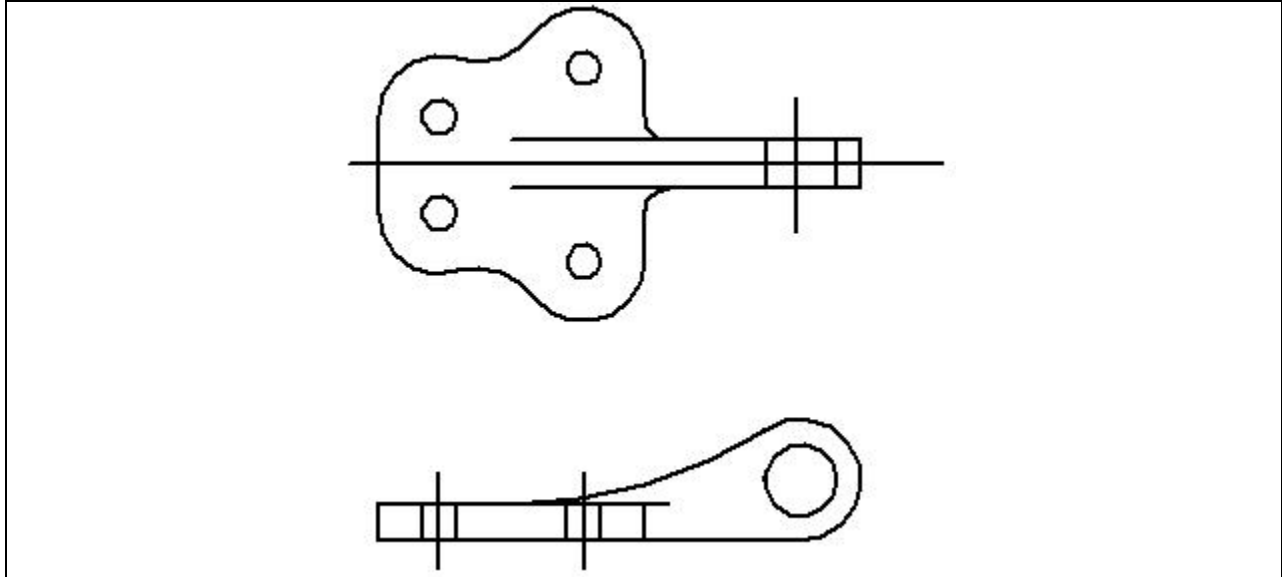


Figure 10.38 – Finished Bracket with Corrected Centerlines

## Moving Entities from One Layer to Another

Your last task is to move the lines representing the hidden entities and the lines representing holes and symmetry to their appropriate layers. Remember, all the layers you need are in the Metric template. To move an entity from one layer to another is as simple as selecting the line, going to the Layers Window, picking the **Move Elements** tool and then selecting the layer to which you want to move it. The line is removed from the present layer and placed in the newly selected layer.

So, with the default **Select** command active, select the four lines shown in Figure 10.39. After selecting the lines, go to the Layer Window and select the **Move Elements** tool at the top of the Window. The Move Elements Window will appear and you need to pick the Center layer and then hit the “OK” button. All four lines will be moved from the Default layer to the Center layer. Select a line color of green and change the line type to center (Figures 10.41 and 10.42).

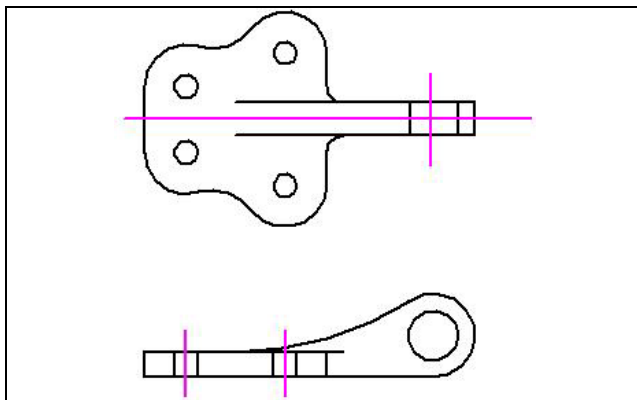


Figure 10.39 – Selecting Centerlines

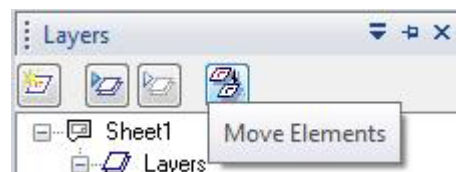
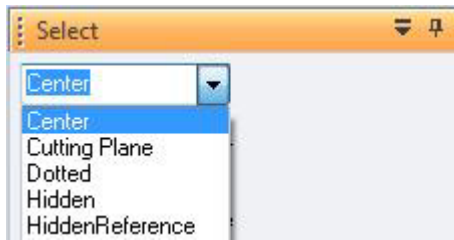


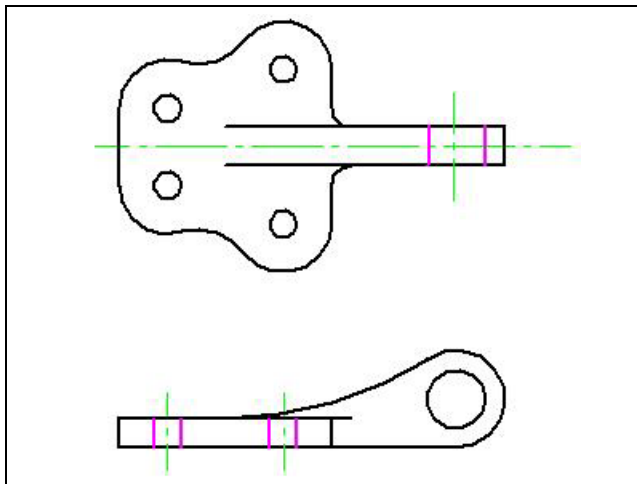
Figure 10.40 – Move Elements Tool



**Figure 10.41 – Selecting Center Line Type**

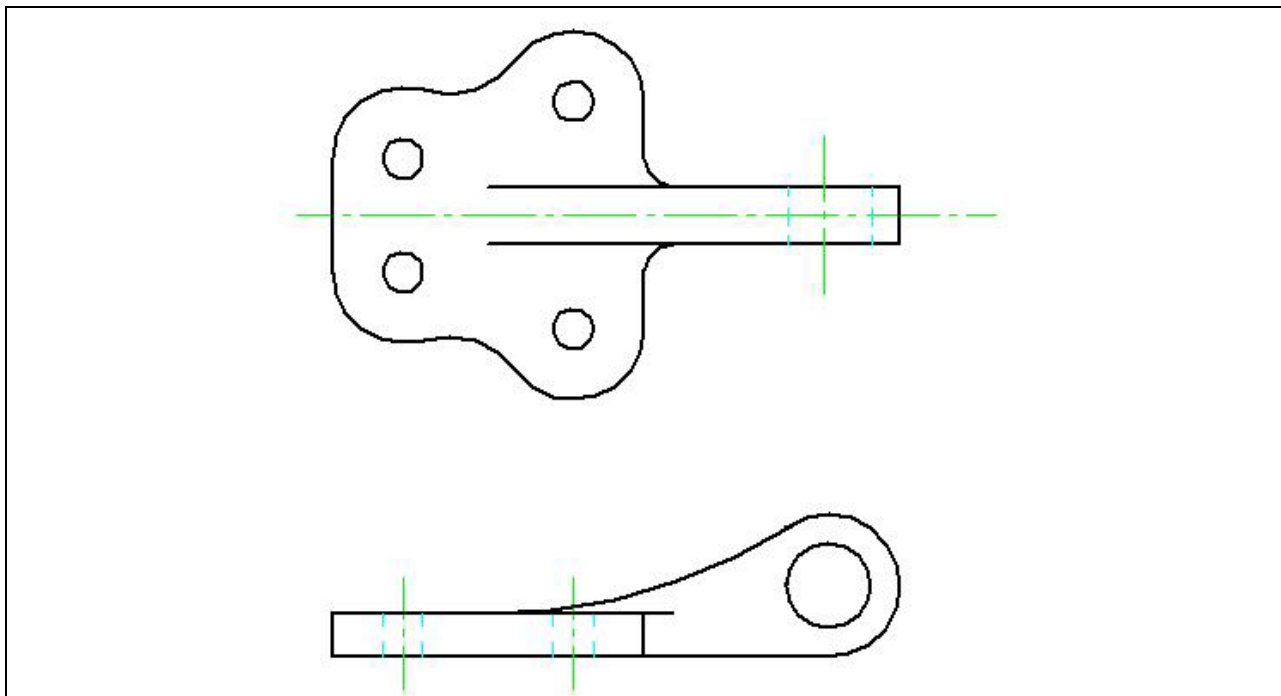


**Figure 10.42 – Selecting Green Line Color**



Now select the six pink lines shown in Figure 10.43. After selecting the lines, go to the Move Elements tool on the Layers Window and then select the Hidden layer on the Move Elements Window. All six lines will move from the Default layer and reside on the Hidden layer. Also, change the line type to Hidden and the line color to blue. Your first multi-view orthographic drawing is now complete, except for dimensions, drawing border and notes. Make sure you complete this first phase of the bracket problem to the time accuracy of the World Class CAD standards.

**Figure 10.43 – Changing to Hidden Layer**



**Figure 10.44 – The Bracket Problem**

**\* World Class CAD Challenge 22-21 \* (See End of Chapter)**

## **World Class CAD Challenges for Chapter 10**

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**\*(22-19)\* Create a New file using the Metric template and draw the ten entities shown in Figure 10.15 in 50 seconds. Continue this drill four times, each time completing the drawing in less than 50 seconds to maintain your World Class ranking.**

**\*(22-20)\* Create a New file using the Metric template and draw the 31 entities shown in Figure 10.25 in 2 minutes and 35 seconds. Continue this drill four times, each time completing the drawing in less than 2 minutes and 35 seconds to maintain your World Class ranking.**

**\*(22-21)\* Create a New file using the Metric template and draw the 39 entities shown in Figure 10.44 in 3 minutes and 15 seconds. Continue this drill four times, each time completing the drawing in less than 3 minutes and 15 seconds to maintain your World Class ranking.**