

# Chapter 10

## The Bracket Problem

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

1. **Create a Drawing Using a Template (CAD)**
2. **Create a Top Orthographic View Starting with the Circle Command**
3. **Use the Copy Command Using Relative Coordinates**
4. **Placing an Arc between Circles Using the Fillet Command**
5. **Using the Trim Tool to Turn Circles into Arcs**
6. **Using the Mirror Tool to Copy Entities across the Centerline**
7. **Creating a Front Orthographic View with Construction Lines**
8. **Using the Offset Tool on the Front Orthographic View**
9. **Creating a Front Orthographic View with Circles**
10. **Finishing the Top View by Projecting Off the New Front View**
11. **Creating an Arc from a Line to a Circle**
12. **Using the Extend Tool**
13. **Using the Trim Tool**
14. **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 problem, and borders. 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. It is this repetition that allows you to attain the World-Class standard.

## Creating a Drawing Using a Template

In the Bracket problem, you will begin the drawing by selecting the template you created in the previous assignment. In Figure 10.1, the window “Select template” is loaded by selecting the New tool on the Standard Toolbar. Browse and find the template you just made in the last chapter, “Metric.dwt”. Click Open to open the template.

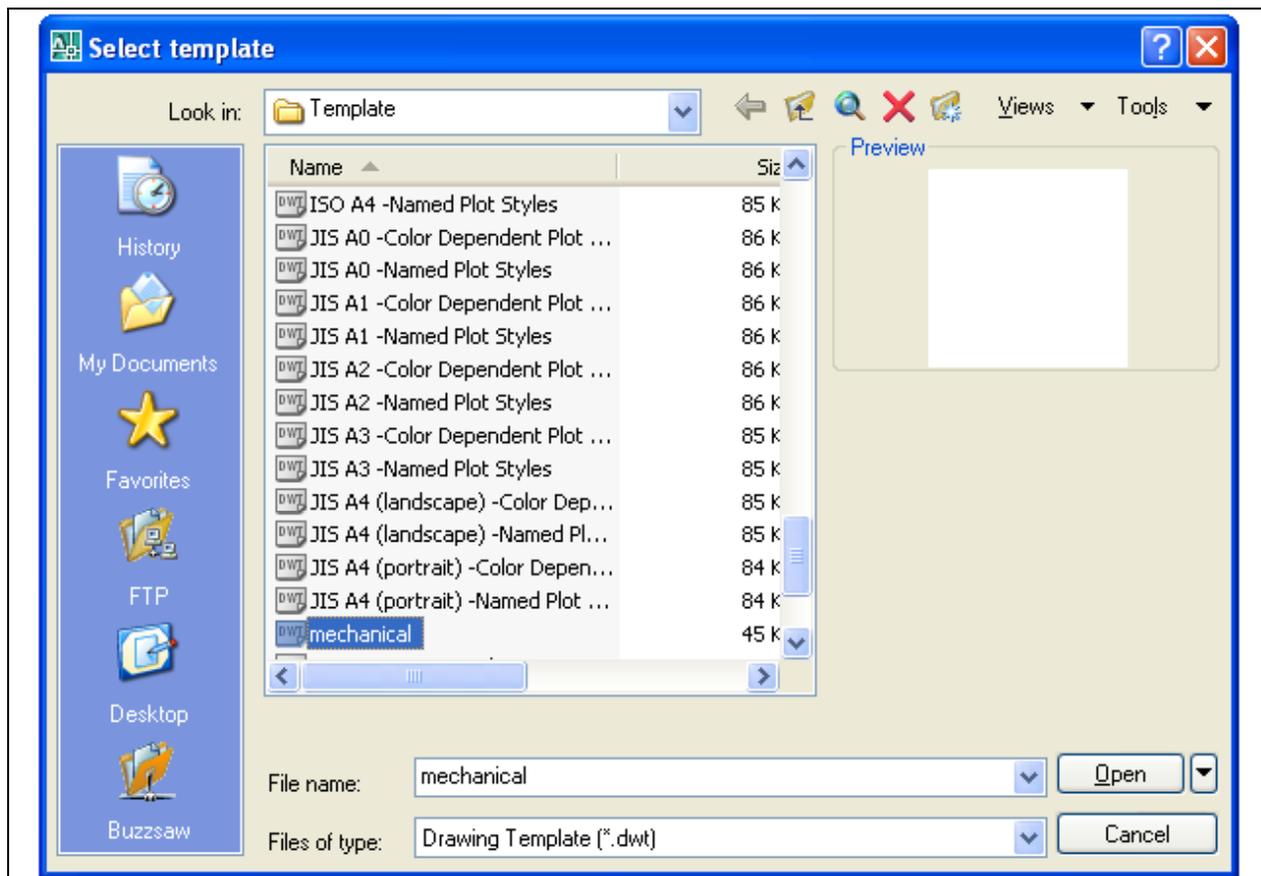


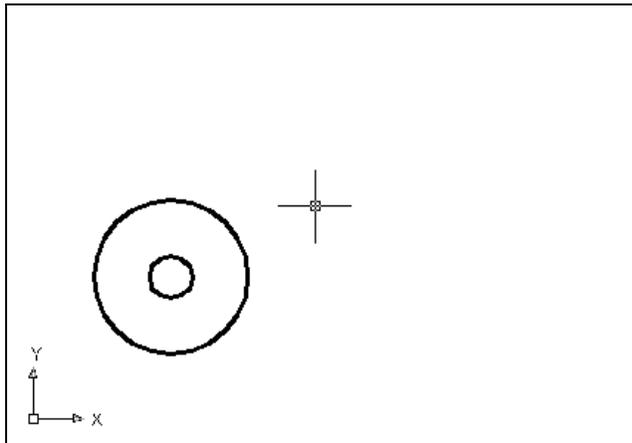
Figure 10.1 - Starting the Drawing Using the Metric Template

Remember, your drawing times will be greatly decreased since the drawing Layers, Dimension Styles, and Limits are already calibrated.

## Use the Copy Command using Relative Coordinates

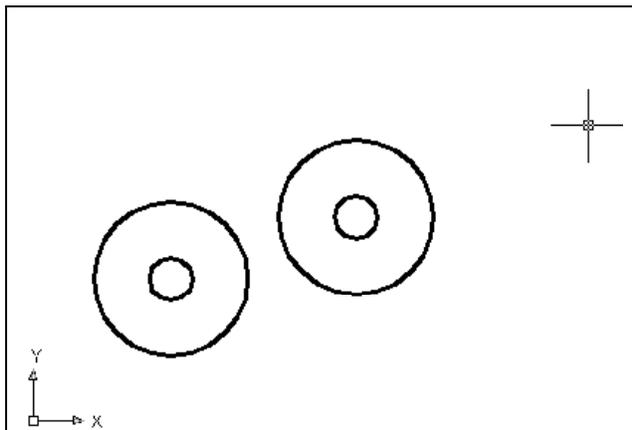
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To begin drawing the Bracket problem, draw a 25 mm radius circle in the lower left hand corner of the display screen. Next, draw a 14 mm diameter circle in the center of the first circle as shown in Figure 10.2.



**Figure 10.2 - Draw First Two Circles**

Now, you need to copy both circles together 60 mm to the right and 20 mm up. You can do this by selecting the Copy tool on the Modify toolbar. Pick both circles and press Enter to advance to the second half of the Copy command. At the prompt, “specify base point or displacement”, select anywhere on the display screen. This is the first time you will use a relative Copy command when drawing an entity, so at the “second point of displacement”, type “@60,20” and press Enter.



**Figure 10.3 – Copy First Two Circles**

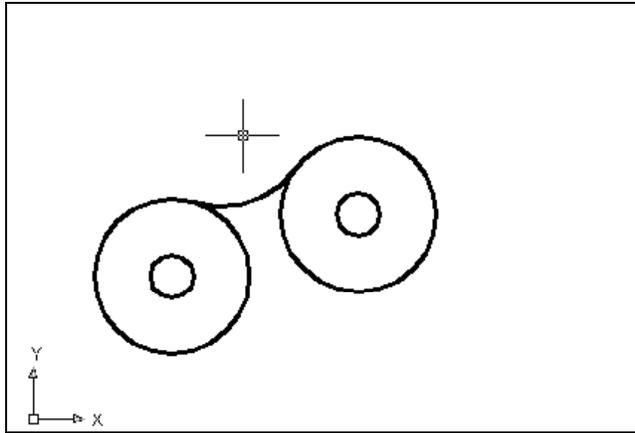
An identical set of circles exactly the same as the first, will appear 60 mm to the right and 20 mm up relative to the first set. This is a very powerful type of movement technique, since in one command sequence, you can both move and copy entity simultaneously when using the Copy command.

## Placing an Arc between Circles using the Fillet Command

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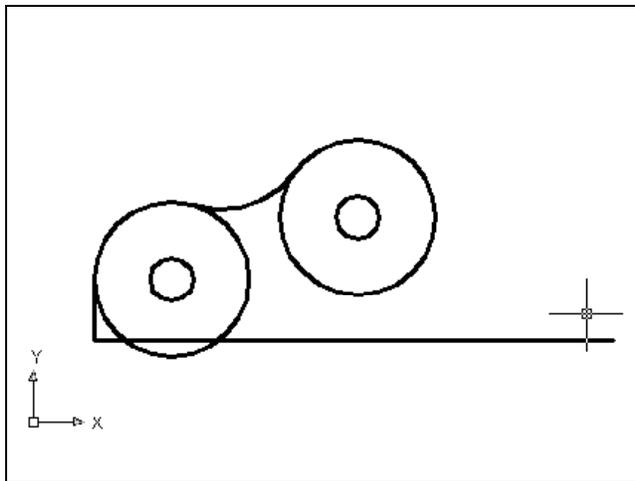
Previously, you have used the Fillet command to create radius entities between two straight lines, but now you will learn that an arc can be formed when selecting between a circle and a straight line, between two circles or between an arc and a line. In earlier versions of Computer Aided Design software,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





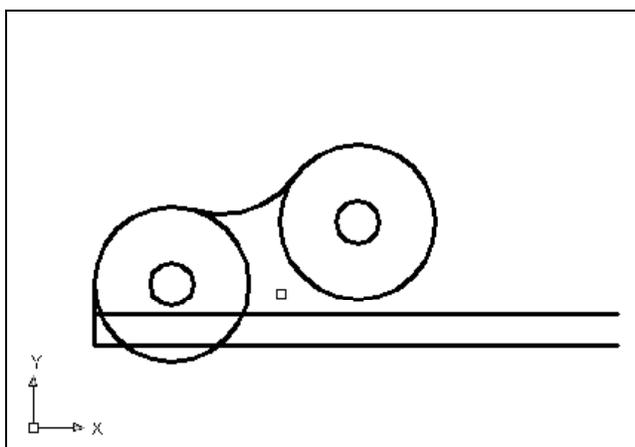
**Figure 10.4 – Fillet Arc between Circles**

You can create the arc between the two 25mm circles using the Fillet tool on the Modify toolbar. Type “R” for radius and 30 and press ENTER to advance to the second half of the Fillet command. At the prompt, “Select first object or [Polyline/Radius/ Trim]” select the top-right quadrant of the left circle and at the second prompt, “Select second object:” select the left-top quadrant of the left circle. A 30 mm arc will appear between the two circles as shown in Figure 10.4.



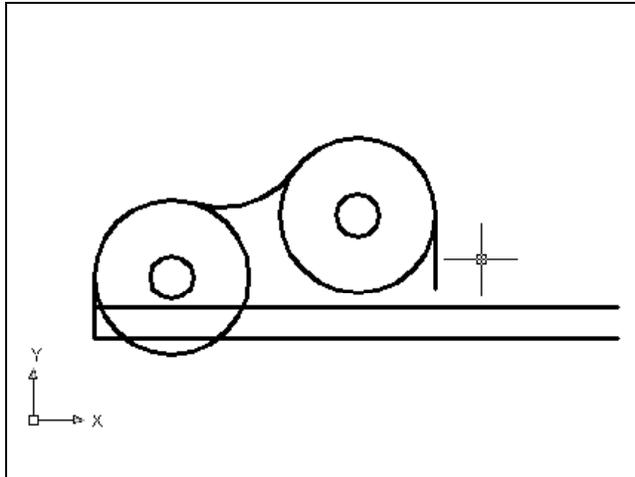
**Figure 10.5 – Draw Line and Centerline**

Next, draw a line off the left quadrant of the left circle, 20 units downward, and another line of undetermined length all the way to the right of the graphical display screen. Using the Line tool on the Draw toolbar, and the Quadrant Object Snap, select the west quadrant of the left circle, then with Ortho set to “On”, and using the mouse to point the line downward type 20 and Enter. Pick a point with the left button of the mouse across the screen as far to the right as you can go and hit ENTER to end the Line command as shown in Figure 10.5.



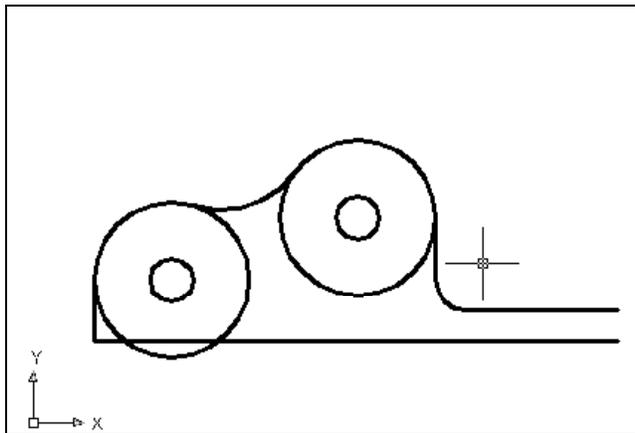
**Figure 10.6 – Offset the Centerline**

The first line drawn 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 by 10 mm. Select the Offset Tool on the modify Toolbar, then at the prompt: “Specify offset distance or [Through] <Through>:” type 10 and hit ENTER. Select the centerline and for the object to offset and above the line when prompted to point to the side to offset as shown in Figure 10.6.



Draw another line of undetermined length by selecting the Line tool on the Draw toolbar. Using the Quadrant Object Snap, starting from the east quadrant of the right circle and with the Ortho button “On”, select below the initial starting point, picking with the left mouse button and ENTER to close out of the Line command as shown in Figure 10.7. Did you notice that four lines were drawn in consecutive order to maximize the efficiency of command repeatability? One line was created using the Offset Tool, which is very effective.

**Figure 10.7 – Draw a Line Off of a Circle**



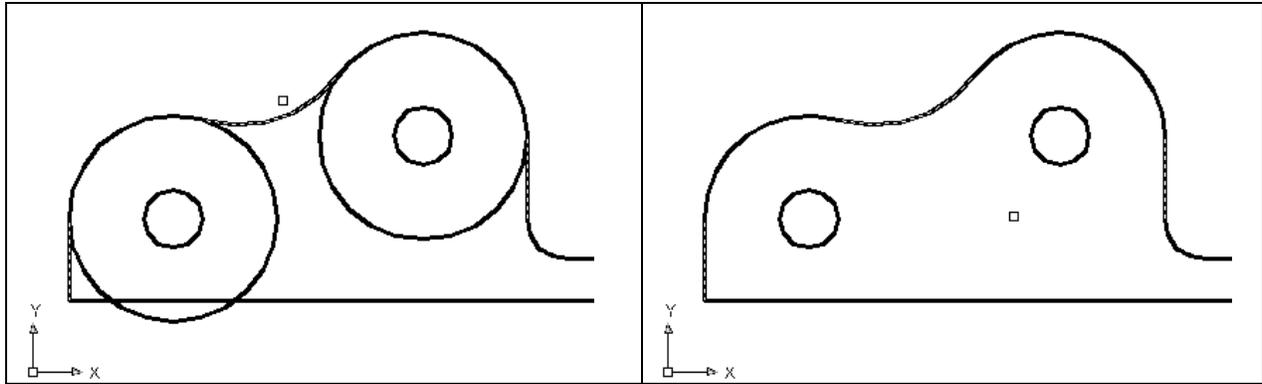
Draw a 10mm Arc between the 10 mm offset and the previously drawn lines by using the Fillet Command. Select the Fillet Tool on the Modify toolbar, typing “R” for radius and 10. Pick the top or previous line and the right side of the offset line and a 10 mm arc will appear while trimming the offset line back to the arc and extending the vertical line to the arc as shown in Figure 10.8. The top view of the Bracket is coming into shape.

**Figure 10.8 – Fillet Two Lines**

## 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 on the Modify toolbar, and at the prompt “Select cutting edges,” pick the three objects shown as dotted lines in Figure 10.9. Next, to remove the circular segments, press ENTER to continue with this two part command and “Select object to trim or shift-select to extend or [Project /Edge/Undo]:” will appear on the command text line. Pick the portion of the circle that does not appear on the perimeter of the bracket, and the top view of the bracket will appear as shown in Figure 10.10.





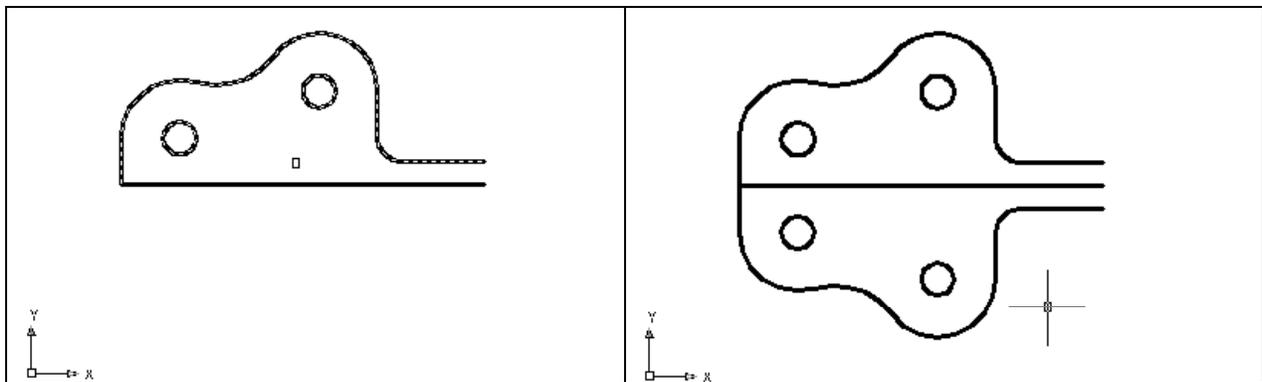
**Figure 10.9 – Select Trimming Entities**

**Figure 10.10 – Trim Circles**

**\* World Class CAD Challenge 02-19 \* - Create a New file using the Metric template, and draw the 10 entities shown in Figure 10.10 in 50 seconds. Continue this drill four times, each time completing the drawing under 50 seconds to maintain your World Class ranking.**

## 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 calculation. In other words, this is a simple view to assemble. Now to double the entity count, you will use the Mirror tool on the Modify toolbar to copy nine objects across the centerline. At the prompt to select objects, pick all the entities except for the centerline (Figure 19.11), and then hit ENTER to proceed to the second half of the Mirror command. “Specify first point of mirror line:” by picking the left endpoint of the centerline and “Specify second point of mirror line:” by picking the right endpoint of the centerline. The default to delete the source objects is no, so at the prompt “Delete source objects? [Yes/No] <N>:”, just ENTER and the mirrored and duplicated entities from the top half will appear on the bottom half of the top orthographic view. (See Figure 10.12) Zoom extents if necessary to view the entire drawing.



**Figure 10.11 – Selecting the Entities for Mirroring**

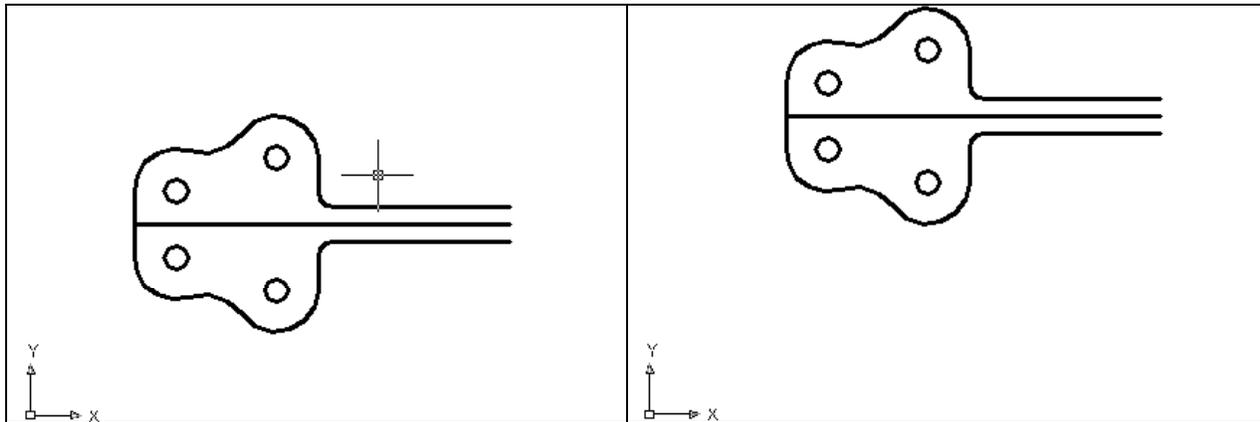
**Figure 10.12 – Finishing the Mirror Process**

## Creating a Front Orthographic View Using Construction Lines

Back the drawing off by picking the Zoom Out tool once from the Zoom toolbar on the Standard toolbar (See Figure 10.13). Some designers will put the Zoom toolbar on their periphery of their graphical screen, so that all of the zoom and pan options are available.



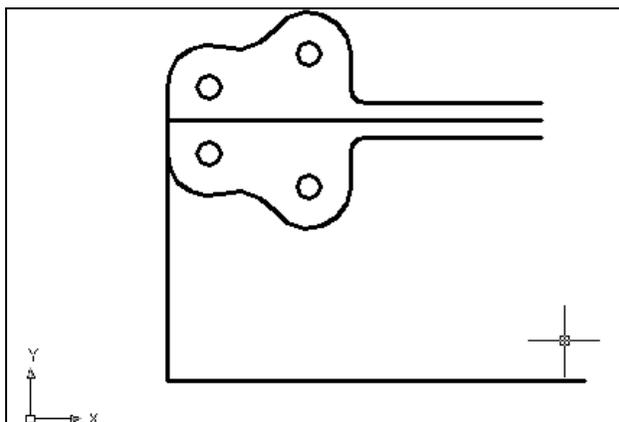
Now the drawing can be panned. Go to the Pan button and by holding down the left mouse button go under the object and pan upward. Right click the mouse button to view the submenu and click Exit to end the command. (See Figure 10.14)



**Figure 10.13 – Zooming Out One Time**

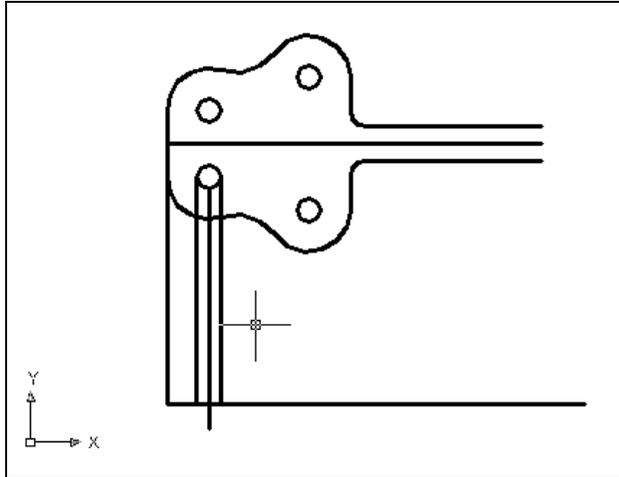
**Figure 10.14 – Panning the Top Orthographic View into Position**

Once in awhile, you will be required to draw free hand in AutoCAD, 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 command to adjust for your oversight. Make your best guess and continue to draw.



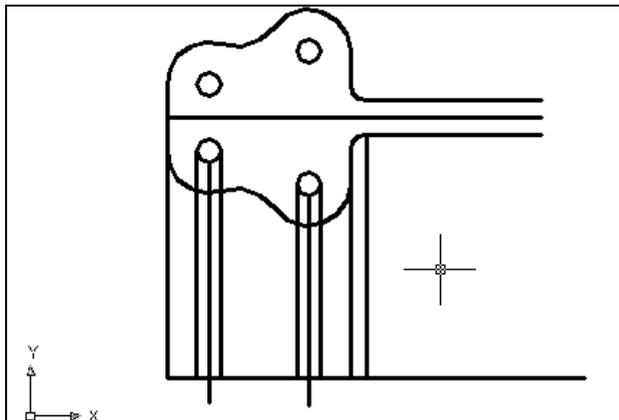
**Figure 10.15 – Drawing the Left Boundary and Bottom Lines of the Front View**

Now you will add construction lines to create the front orthographic view. Go to the Line tool on the Draw toolbar, select the command and go to bottom of the left line of the top view, selecting the bottom of the line with Endpoint osnap. Pull the line down to the bottom of the graphical display with your mouse, far enough to view the object, since this is a multi view problem. Draw a baseline over to the right and press the enter key twice to stay in the Line command. (See Figure 10.15)



**Figure 10.16 – Lines from the Left Circle**

You are still in the Line command, so draw another construction line by selecting the west quadrant of the bottom circle and drawing down to the perpendicular of the baseline. Press the Enter key twice. Draw the next line off the south quadrant of the circle, which will later become a centerline, ending the line a small distance past the baseline. Press the enter key twice to stay in the Line command. Draw another construction line at the east quadrant of the circle, drawing down perpendicular to the baseline and press the Enter key twice. (See Figure 10.16)



**Figure 10.17 – 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 20mm radius arc which will be drawn from the endpoint of the arc to the perpendicular point on the baseline. Finally, draw the last line from the right side of the 10 mm radius fillet to the perpendicular point of the baseline. (See Figure 10.16)

## Using the Offset Tool on the Front Orthographic View

Select the Offset tool on the Modify toolbar. On the command line, you are asked for the offset distance. Type “15” and press Enter. Pick the bottom line and offset the next line a little above the baseline. A new line will be added to the drawing 15mm above the baseline. (See Figure 10.18) We will offset another line to make the centerline of the bracket’s loop, so to stay in the command by pressing the Enter key twice. After pressing the enter key twice and typing in the next offset distance of 150, press Enter at the command line. Offset the line coming off the south quadrant of the left hole by selecting this centerline and then picking to the right of the quadrant (See Figure 10.18). This newest line in your drawing will be used as a guide to draw the two circles making up the loop of the bracket.



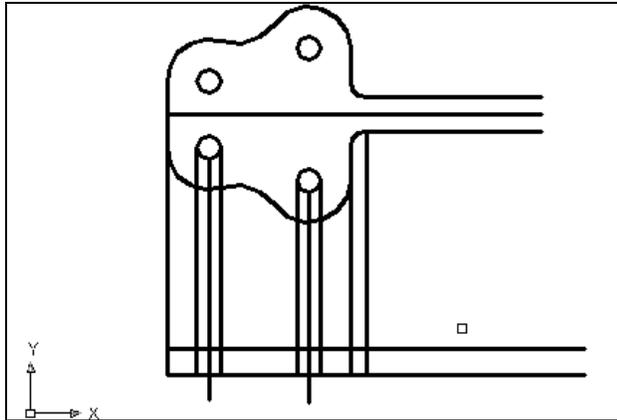


Figure 10.18 – Offset a Line 15 mm

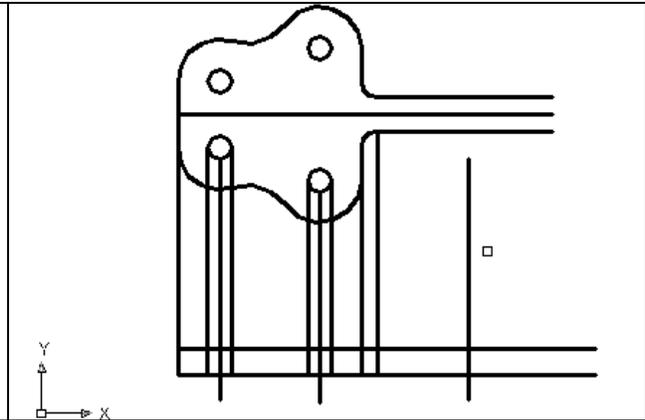


Figure 10.19 – Offset a Line 150 mm

**\* World Class CAD Challenge 10-20 \*** - Create a New file using the Metric template, and draw the 31 entities shown in Figure 10.18 in 2 minutes 35 seconds. Continue this drill four times, each time completing the drawing under 2 minutes 35 seconds to maintain your World Class ranking.

## 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 Osnaps or a relative coordinate using the Move command. Now that you know the exact setting for the vertical centerline of the loop, you will place the circles on the intersection of the baseline and the centerline. Then you will move the south quadrant of the loop (2 circles) to the baseline.

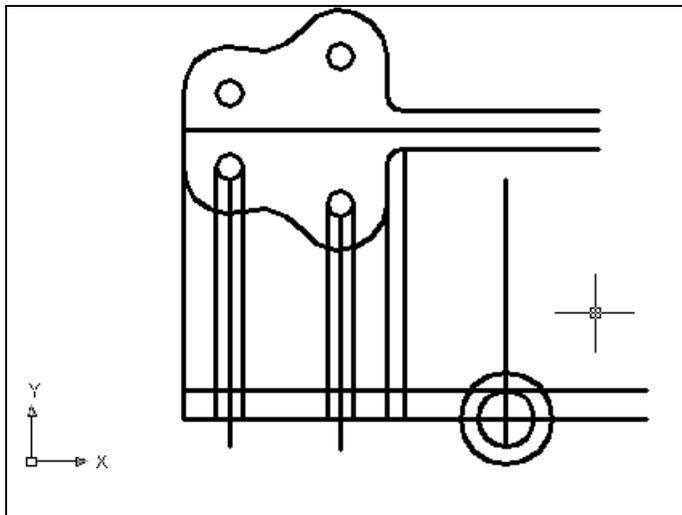


Figure 10.20 – Adding Two Circles

Select the Circle tool on the Draw toolbar. Bring your mouse over to the right line and pick the intersection of the construction line you just placed and the end point line. Select the intersection for the circle, and then type in 25 in the command line to specify a radius of 25mm for the outer circle. Repeat the Circle command by pressing Enter twice, specify the center point as the same intersection and type the radius of the two circles by typing in 15. Press the Enter key to exit the command. (See Figure 10.19)

Now move both of the circles by choosing the Move command icon. After selecting the two circles, specify the first base point by selecting the south quadrant of the larger circle.

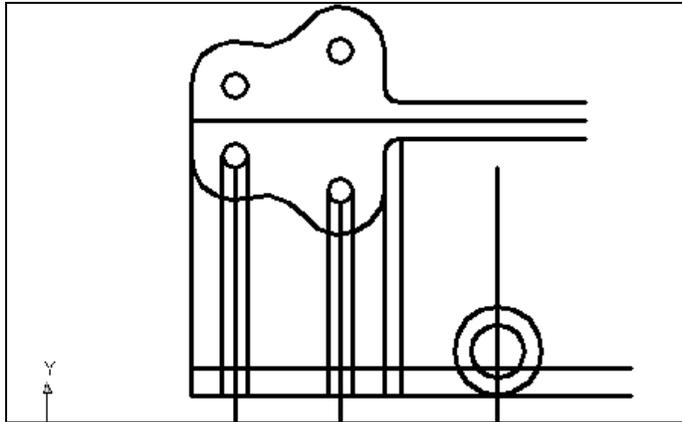


Figure 10.21 – Moving the Circles to the Baseline

For the second point of displacement pick the perpendicular point on the baseline of the front view. As you can see in Figure 10.20, the larger circle is now tangent to the baseline of the front view of the bracket. In previous problems, the use of Move and Copy were dependent on you typing numeric distances, but in this exercise, you can see the power of the Object Snaps in moving entities along their geometric interfaces.

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

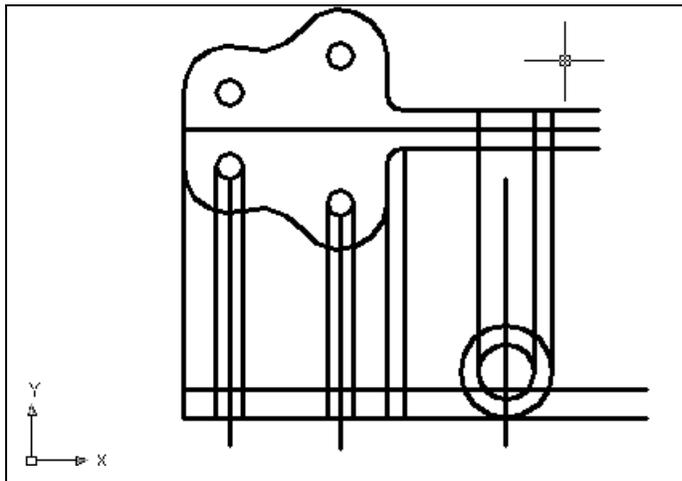


Figure 10.22 – Projecting Lines to the Top View

With the Line command, draw a construction line by selecting the east quadrant of the outer circle and drawing up to the perpendicular point of the upper line in the top view. Press the Enter key twice to repeat the Line command. Draw the next line off the east quadrant of the inner circle to the perpendicular point of the upper line. Draw a third line, but this time from the west quadrant of the inner circle as shown in Figure 10.21. These lines will assist in finishing the work on the top view.

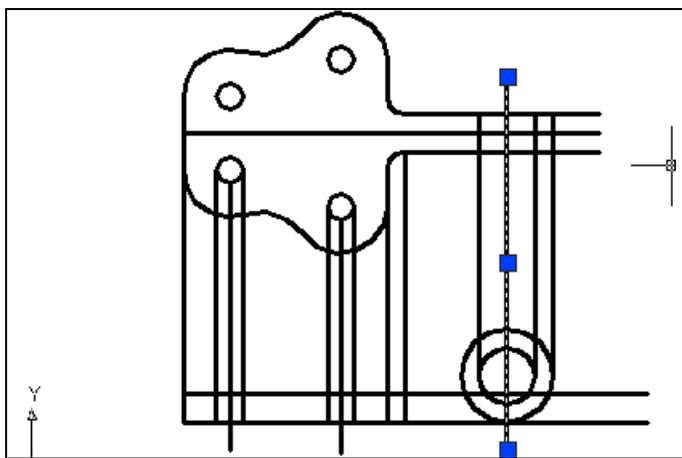
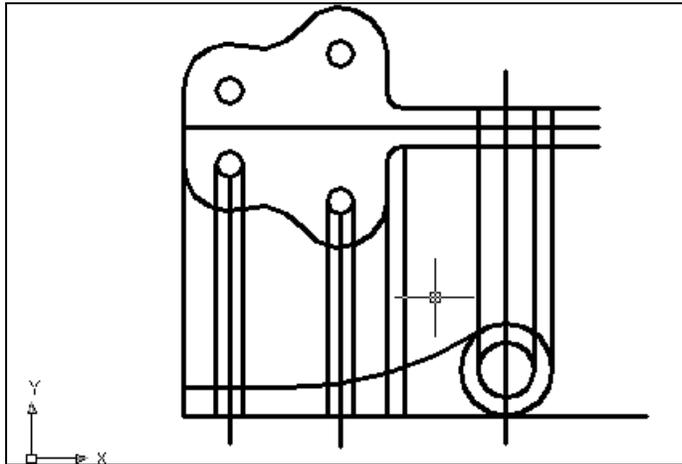


Figure 10.23 – Projecting the Centerline

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. Click on the centerline to highlight it and activate the grips as shown in Figure 10.22. Click in the blue box at the top of the centerline. Move the line up past the object line on the top view about a quarter of an inch and press the escape key twice. There will many times you will modify a drawing entity by using the grip handles.

## 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 of the loop. Go to the Fillet tool on the Modify toolbar to create a new Fillet. Type in R for Radius at the Command line and then type in your fillet, which is 200. Press the Enter key twice. Pick the top line segment at the bottom view and the outside circle to create the 200-radius arc as shown in Figure 10.23.

Figure 10.24 – Making a 200 Radius Arc

## Using the Extend Command

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, pull your construction line all the way up to the top view, and press Enter (See Figure 10.25). This process makes a line that will allow you to extend two lines from the loop in the top view.

Use the Extend tool on the Modify toolbar. The command line first asks for a boundary edge, so select the construction line just created and press Enter. Select the bottom and top lines to the right so they extend to the construction line. (See Figure 10.26)

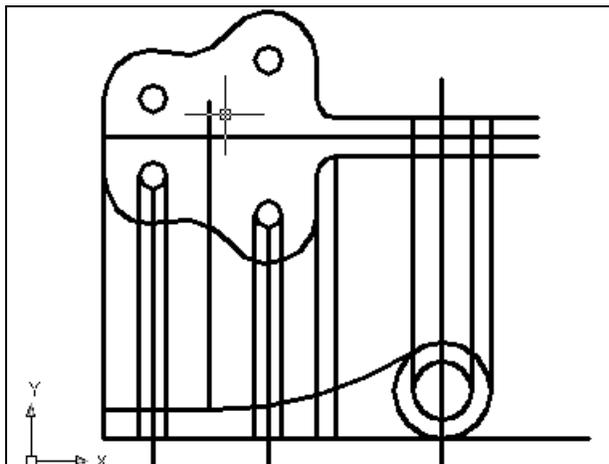


Figure 10.25 – Drawing an Extension Line

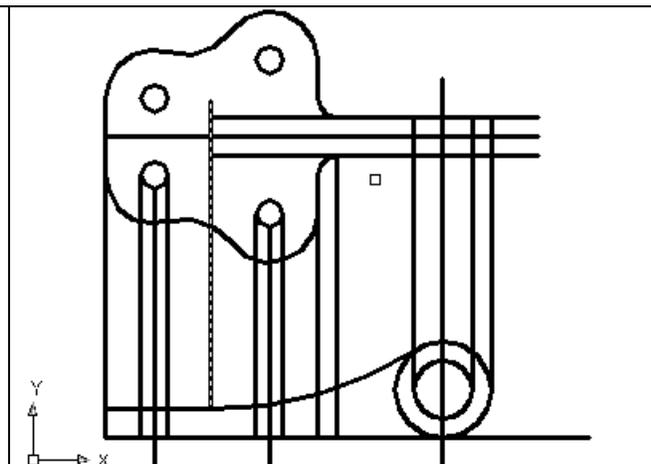
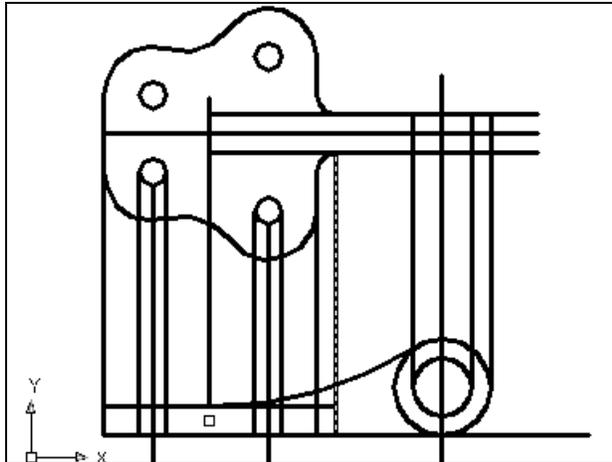
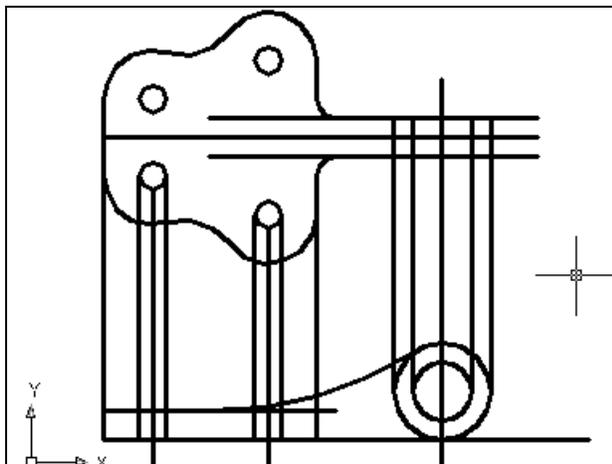


Figure 10.26 – Extending Two Lines



**Figure 10.27 – Extending One Line**

Press Enter twice to stay in the command and select the boundary edge as shown in figure 10.27 (shown as dotted), and press Enter. Select the top line of the front view to extend to your boundary line. In your drawing, the front view now shows that the surface containing the four holes goes past the 200 mm arc and ends where the 10 mm arc penetrates the loop. This may be hard to visualize in your first orthographic projection, but with practice, the process will become easier. Press Escape to get out of the command.



**Figure 10.28 – Erasing the Boundary Lines**

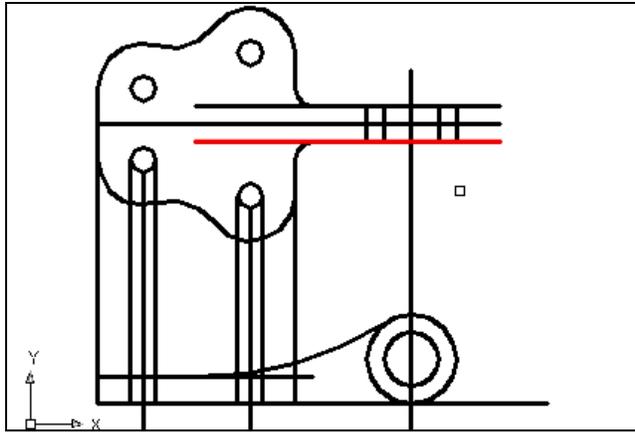
Now you need to remove the two construction lines forever, so the Erase tool on the Modify toolbar is your choice. After selecting the Erase tool, select the line segments that were used as boundaries for the extensions. Press the Enter key and they will disappear. Also, add one final construction line by selecting the Line tool. Draw a line from the west quadrant of the outer circle up to the top line of the top view. Your drawing should now look like the one in Figure 10.28.

## Using the Trim Tool

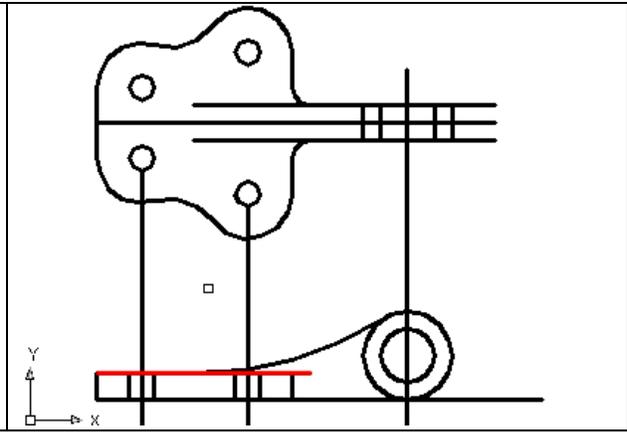
Select the Trim tool on the Modify toolbar and pick the bottom line (shown in red) in figure 10.29 representing the loop in the top view. After selecting the cutting line, press Enter and trim the four lines that were drawn from the circles that make up the loop in the front view.



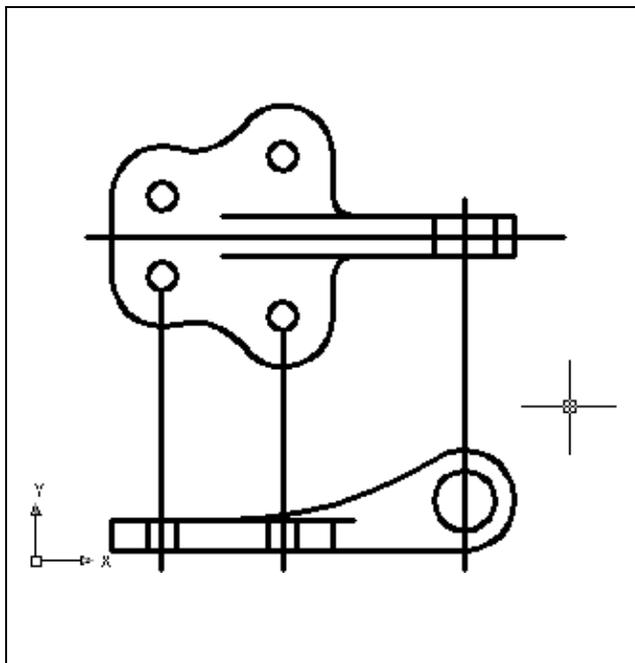
Press the Enter key twice to stay in the command and select top line on the front view (shown in red) as the new cutting edge (See Figure 10.30). After selecting the cutting line, press Enter and trim the six lines that were drawn from the circles showing the loop in the front view, but not the centerlines.



**Figure 10.29 – Trim Four Lines**



**Figure 10.30 – Trimming Six Lines**



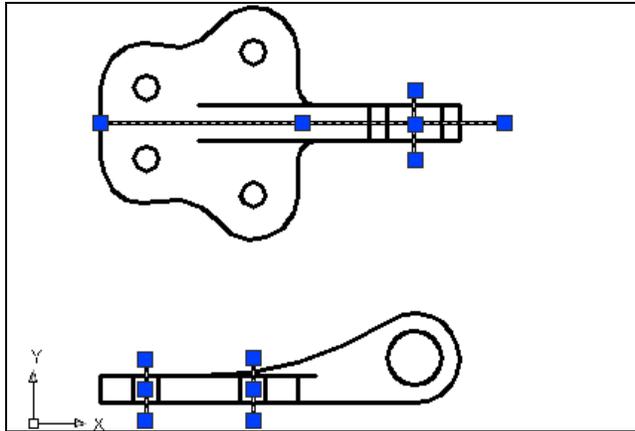
**Figure 10.31 – Trimming Two Objects**

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. Select the Trim tool on the Modify toolbar and pick all lines, arcs and circles by windowing the entire front view. After selecting the cutting objects, press Enter and trim the line and inside the circle. Also trim the two lines extending past the end of the loop on the top view drawing as shown in figure 10.31. Lastly, you can see in this figure and on your graphic display that the centerlines need to extend only a couple of millimeters past the outside perimeter of the part. Select each line and use the blue grips to adjust the centerlines to be visually correct. You may need to modify your osnap settings to make this task easier.

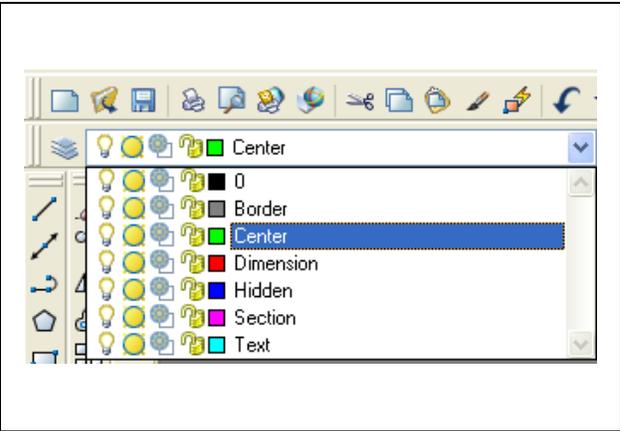
## Moving Entities from One Layer to Another

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 a line, then selecting a layer in the Layer window. The line is removed from the present layer and placed in the newly selected layer.

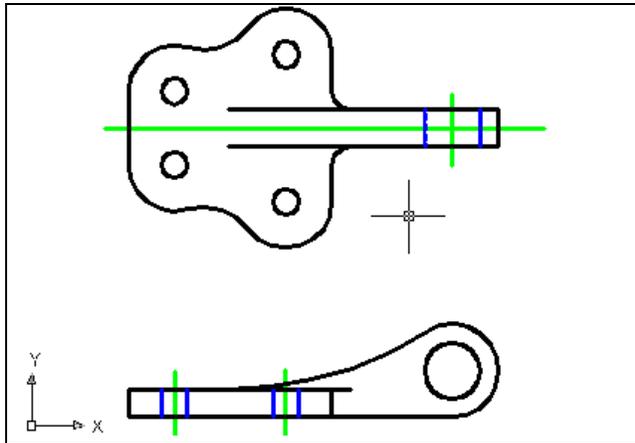
So, without being in an AutoCAD command, select the four lines shown in figure 10.32. After creating the selection set of lines, pick the Center layer in the Layer display window. All four lines will be removed from Layer 0 and will move to the Center layer. The lines will be green and have the center linetype. (See Figure 10.33)



**Figure 10.32– Selecting Centerlines**



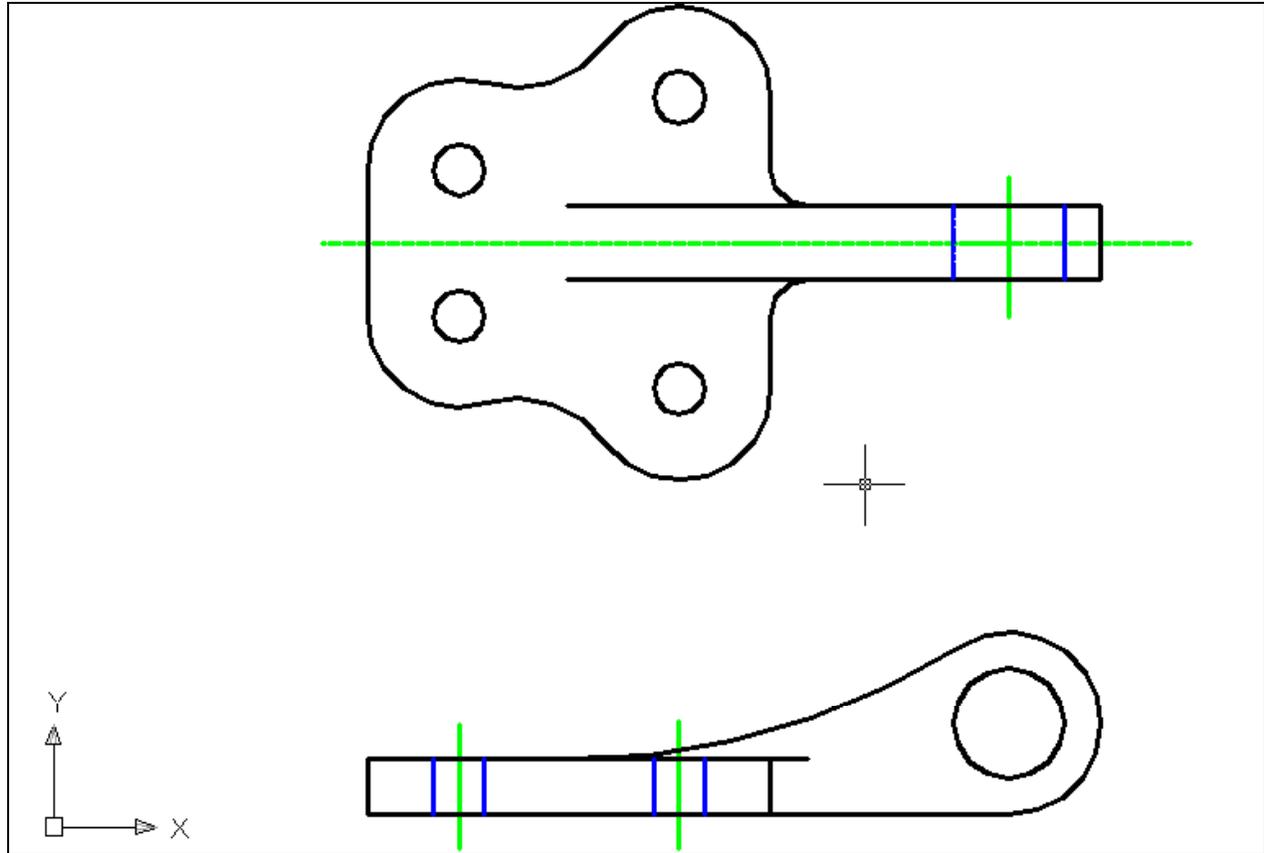
**Figure 10.33 – Changing to Center Layer**



**Figure 10.34 – Changing to Hidden Layer**

Now select the six blue lines shown in figure 10.34. After creating the selection set of lines, pick the Hidden layer in the Layer display window. All six lines will be removed from Layer 0 and now reside on the Hidden layer. The lines will be blue and have the hidden linetype. 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 World Class CAD standards.

Figure 10.35 shows the complete display of a properly drawn Bracket problem for your preview.



**Figure 10.35 – The Bracket Problem**

**\* World Class CAD Challenge 02-21\* - Create a New file using the Metric template, and draw the 39 entities shown in Figure 10.35 in 3 minutes 15 seconds. Continue this drill four times, each time completing the drawing under 3 minutes 15 seconds to maintain your World Class ranking.**