C h a p t e r

10

The Bracket Problem

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

- **Creating a Drawing using a template**
- **Creating a Top Orthographic View**
- **Using the Copy 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**
- **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 from the new Front View**
- **Creating an Arc from a Line to a Circle**
- **Using the Extend tool**
- **Using the Trim tool**
- **Moving entities from one layer to another**

The bracket problem is the fourth and final problem in your basic CAD training and it is just as important to achieve these drawing standards as it was in the first three problems: the rectangular, circular problem, and borders. While 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 will help you attain the World Class standard.

Creating a Drawing using a Template

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You will begin the Bracket problem by selecting a template you created in a previous assignment. Figure 10.1 shows the "Select template" window, opened by selecting the New tool on the Quick Access Toolbar. Browse and find the "Metric.dwt" template you just made in the last chapter. Click Open to open the template.
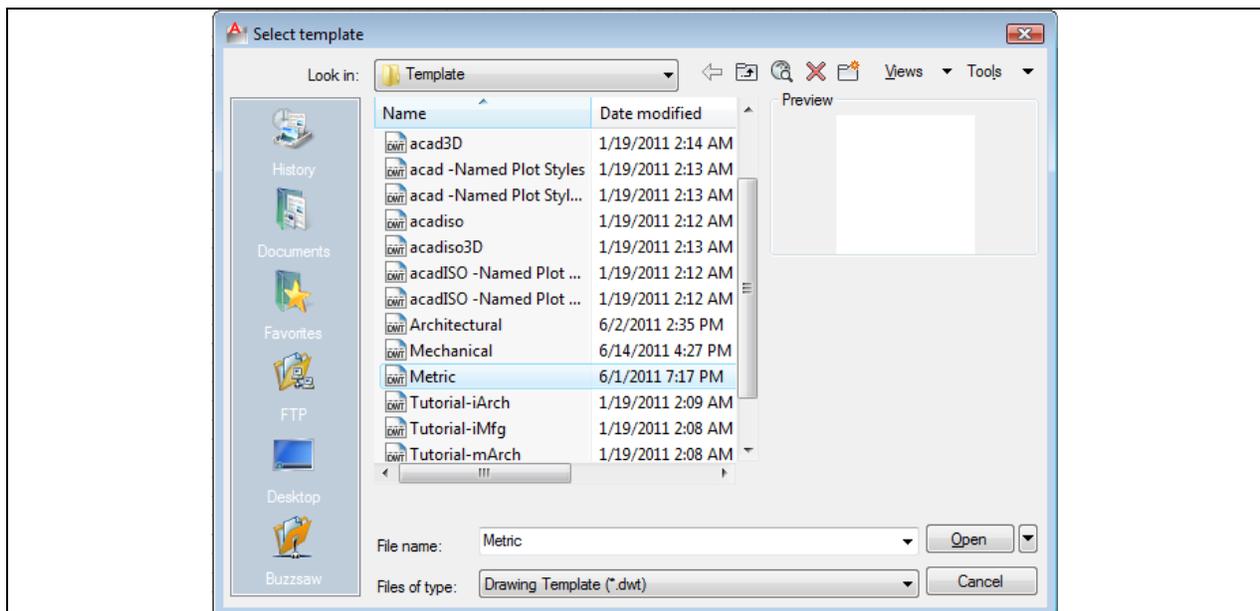

Figure 10.1 - Starting the drawing using the Metric template

Remember, your drawing times will be greatly decreased because the drawing Layers, Dimension Styles, and Limits are already calibrated in this template.

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   ⌾ Copy
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.
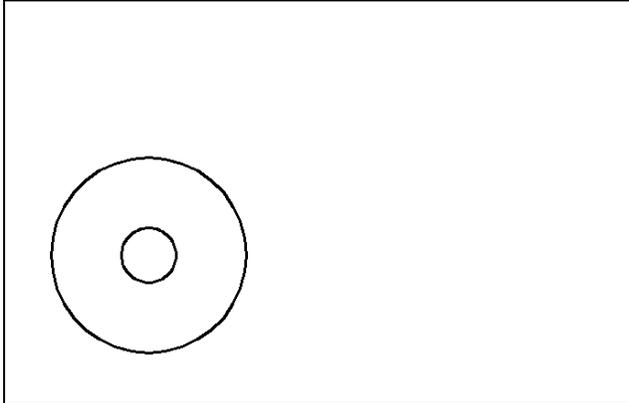
You need to copy both circles together 60 mm to the right and 20 mm up. You can do this by selecting the Copy tool on the Modify panel. Pick both circles and hit ENTER to advance to the second half of the Copy command. At the prompt "specify base point or displacement," select anywhere on the display screen. You will use relative coordinates to come the two circles.   At   the   "second   point   of displacement," type "@60,20" and hit ENTER.

Figure 10.2 – The first two circles
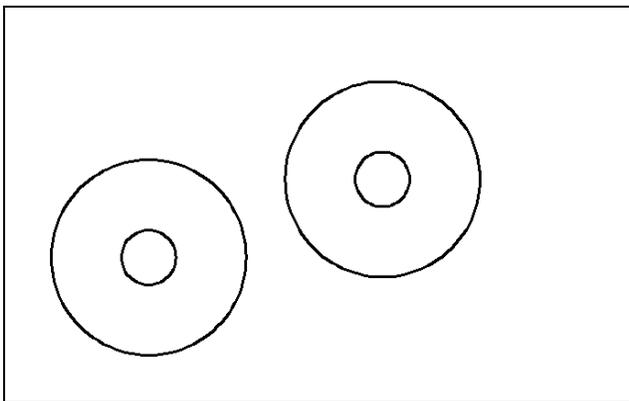
An identical set of circles will appear 60 mm to the right and 20 mm up, relative to the first set. This is a very powerful type of movement technique because you can both move and copy an entity simultaneously with one command sequence.
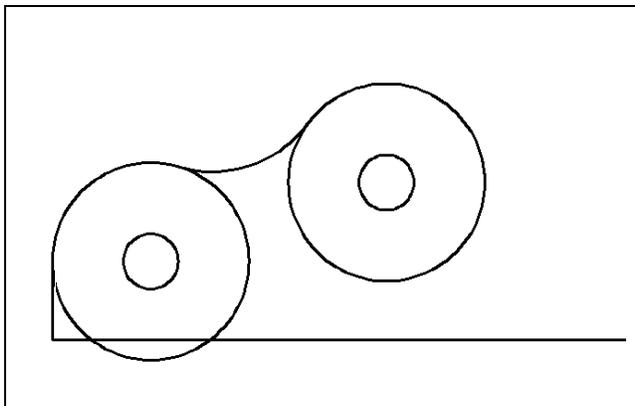
Figure 10.3 – The copied circles

Placing an Arc between Circles using the Fillet Command

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Previously you used the Fillet command to create radial entities between two straight   ◰ Fillet
lines, but now you will learn that an arc can also 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 a starting point, end point, and radius involved mathematical
calculation. Many of these tedious precision calculations are eliminated by using the
Fillet command.
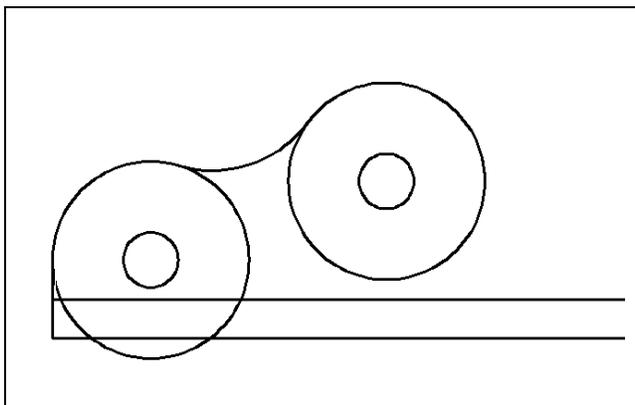
Figure 10.4 – Filleted arc between circles
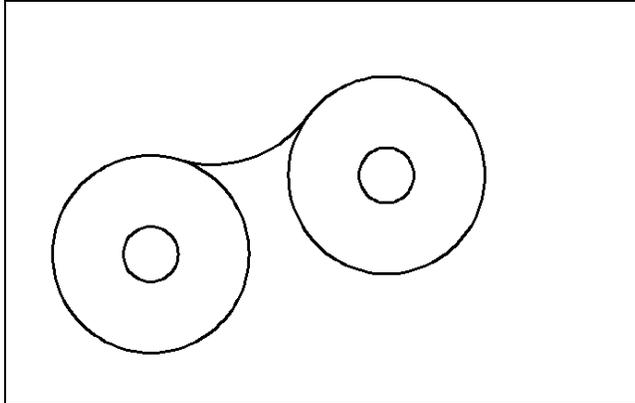
You can create the arc between the two 25mm circles by using the Fillet tool on the Modify panel. Type "R" for radius, then 30 and hit ENTER to advance to the second half of the Fillet command. At the prompt, "Select first object or [Polyline/Radius/ Trim]" select the top-right quadrant of the left circle 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.

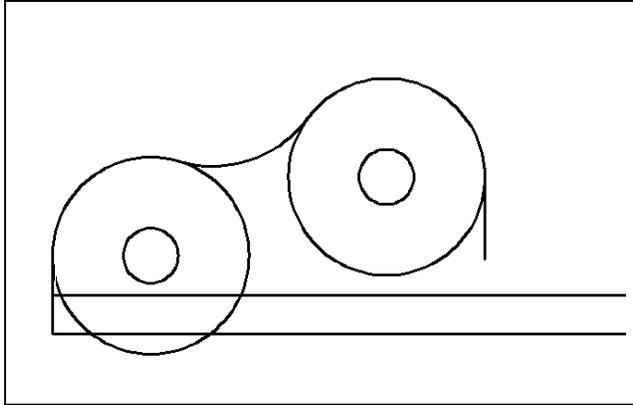**Figure 10.5 – A line and centerline**

Next, draw a line 20 units downward from the left quadrant of the left circle and another line of undetermined length all the way to the right of the graphical display screen. Using the Line tool on the Draw, select the west quadrant Osnap of the left circle, and with Ortho set to "On," drag the line downward, type 20, and hit ENTER. Now pick another point 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 – The offset centerline**

The first line you drew is a part of the Bracket, while the second line will become the centerline of the symmetrical part. You will form the locking loop of the bracket by offsetting the centerline 10 mm. Select the Offset tool on the Modify panel and at the prompt "Specify offset distance or [Through] <Through>:" type 10 and hit ENTER. Select the centerline as the object to offset and then select above the line when prompted to create a new line as shown in Figure 10.6.

Draw another line of any length by selecting the Line tool on the Draw panel. Starting from the east quadrant of the right circle and with the Ortho mode toggled "On," select the second endpoint below the initial starting point and hit ENTER to close out of the Line command (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 also very effective.

Figure 10.7 – A line off of a circle
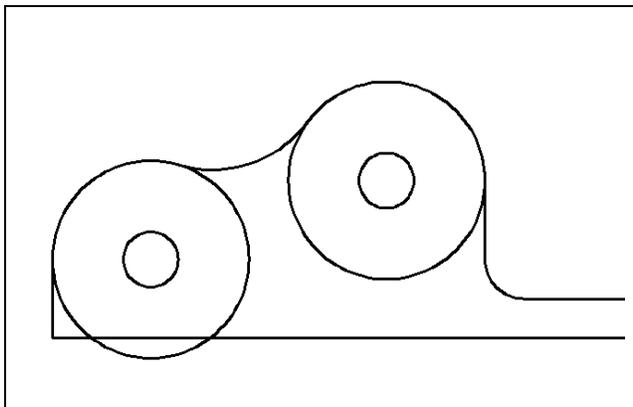
Draw a 10 mm arc between the 10 mm offset and the previously drawn line by using the Fillet command. Select the Fillet tool on the Modify panel, type "R" for radius, and then type 10. Pick the vertical line you just drew as the first entity and then the right side of the offset line. A 10 mm arc will appear while the offset line will be trimmed back to the arc and the vertical line will extend to the arc as shown in Figure 10.8. The top view of the Bracket is coming into shape.

Figure 10.8 – Filleting two lines

Using the Trim Tool to turn Circles into Arcs

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The Trim tool can be utilized to modify basic circles into arcs through precision selection of entities. 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 panel and at the prompt to "Select cutting edges," pick the three objects shown with dotted lines in Figure 10.9. Next, hit 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 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.
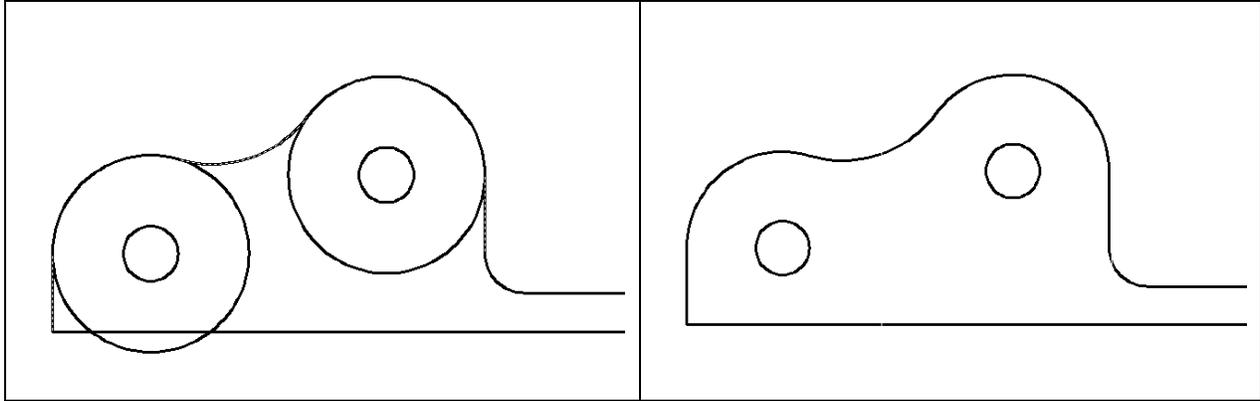
-/-- Trim

Figure 10.9 – Selecting trimming entities   **Figure 10.10 – The trimmed 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 in less than 50 seconds to maintain your World Class ranking.

Using the Mirror Tool to Copy Entities across the Centerline

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The strategy of the Bracket problem is to draw the top half of the top view first because 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 you will use the Mirror tool on the Modify panel to copy a symmetrical detail across the centerline. At the prompt to select objects, pick all the entities except for the centerline (Figure 10.11), 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 hit ENTER and the mirrored and duplicated entities from the top half will appear on the bottom half of the top orthographic view (Figure 10.12). Zoom extents if necessary to view the entire drawing.
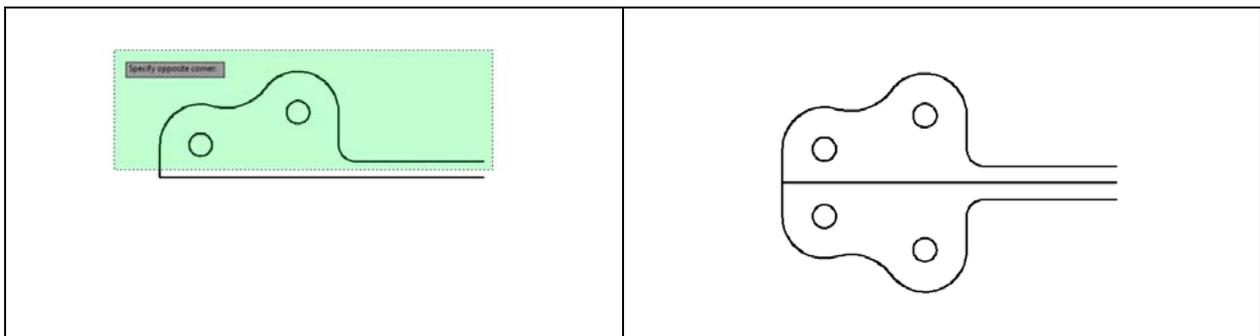

Figure 10.11 – Selecting the entities   **Figure 10.12 – Finishing the mirror process**

Creating a Front Orthographic View Using Construction Lines

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Expand your view of the drawing by selecting the Zoom Realtime tool once from the navigation bar on the right side of the screen (Figure 10.13). Click and hold anywhere in the drawing area, and drag the cursor down to zoom out.

Next, select the Pan tool from the navigation bar. Selecting below the bracket, Click and hold down the left mouse button. Drag upward to move the bracket to the top of the drawing area, leaving you with room below to begin the front orthographic view (Figure 10.14). Hit Escape to exit the Pan command
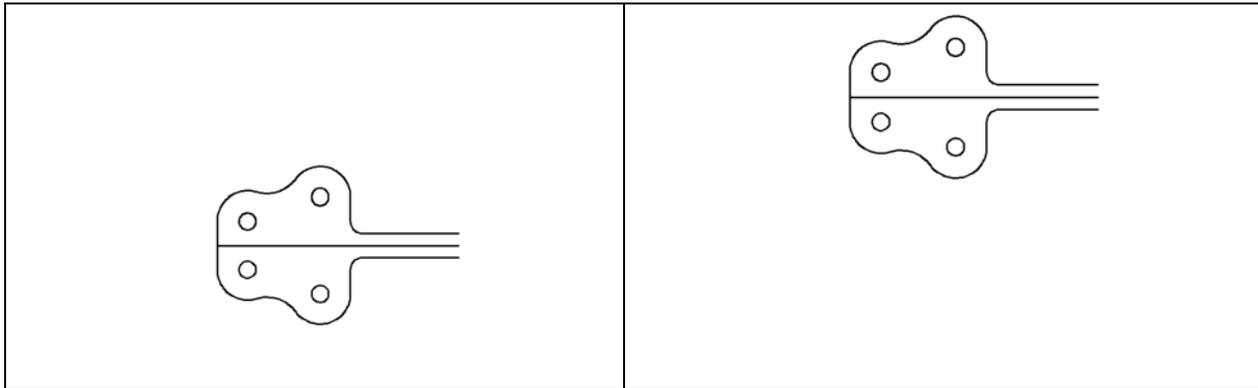

Figure 10.13 – Zooming out   **Figure 10.14 – Panning into position**

While in the past you created the majority of the lines or other entities with exact precision, once in a while you will be required to draw freehand in AutoCAD. When freehanding 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 for now and continue to draw.
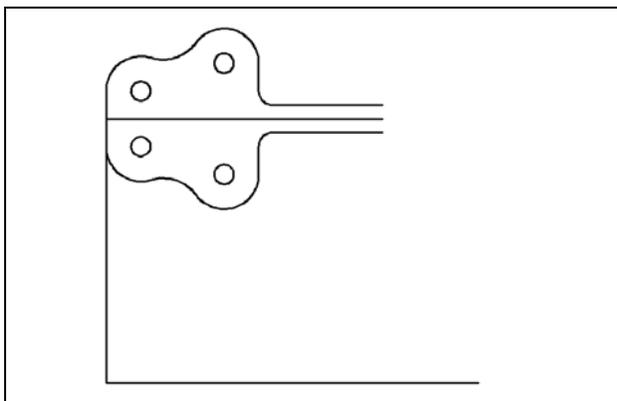
To add construction lines to create the front orthographic view, go to the Line tool on the Draw panel, select the command and go to bottom of the left line of the top view, selecting the bottom of the line with Endpoint Osnap. Pull the line down to the bottom of the graphical display with your mouse. Also draw a baseline over to the right and hit ENTER twice to stay in the Line command (Figure 10.15).

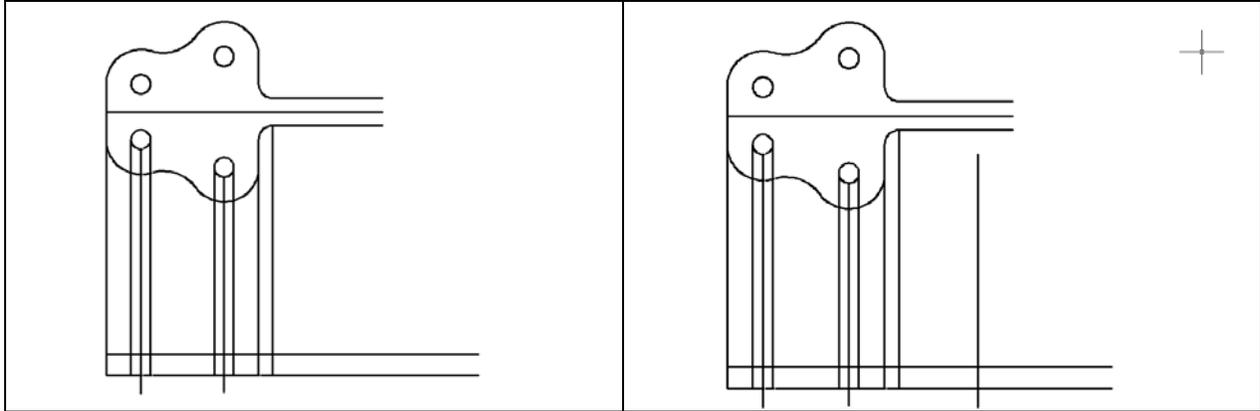**Figure 10.15 –Lines of the front view**

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 draw down to the parallel Osnap point of the baseline. Hit ENTER twice to continue. Draw the next line, which will later become a centerline, from the south quadrant of the circle and ending a small distance past the baseline. Again, hit ENTER twice to resume the command. Draw another construction line from the east quadrant of the circle down perpendicular to the baseline and hit ENTER twice again (Figure 10.16).

Figure 10.17 – More projection lines

Continue to draw construction lines projecting from the west, south and east quadrants of the second small circle. Draw another projection line in this set at the right side of the 20 mm-radius arc 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 (Figure 10.16).

Using the Offset Tool on the Front Orthographic View

Select the Offset tool on the Modify panel. On the command line, you are asked for the offset distance. Type "15" and hit ENTER. Pick the bottom line and offset the next line a little above the baseline. A new line will be added to the drawing 15 mm above the baseline (Figure 10.18). Offset another line to make the centerline of the bracket's loop, so stay in the command by hitting the ENTER key twice. Type in the next offset distance of 150 and hit ENTER at the command line. Offset the line coming off of the south quadrant of the left hole by selecting this centerline and then picking to the right of the it (Figure 10.19). 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 – Offsetting a line 15 mm   **Figure 10.19 – Offsetting 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 in less than 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 Move command along with Osnaps or a relative coordinate. Now that you know the exact setting for the vertical centerline of the loop, you can 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.
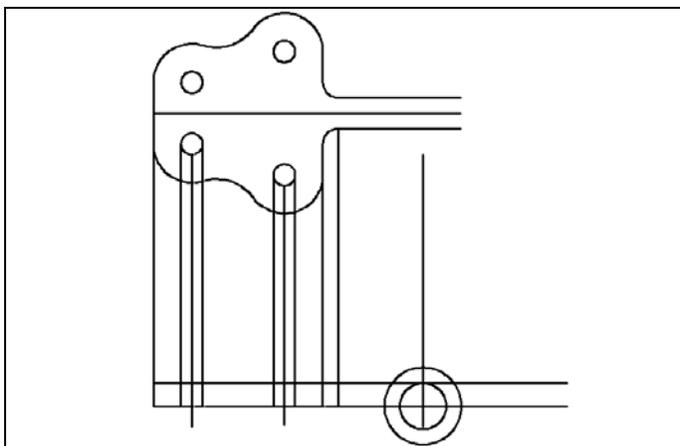
Select the Circle tool on the Draw panel. Select the intersection of the construction line you just placed and the baseline of the front view. Type 25 in the command line to specify a radius of 25 mm for the outer circle. Repeat the Circle command by hitting ENTER twice. Specify the center point as the same intersection and type the radius of the circle by typing in 15. Hit the ENTER key to exit the command (Figure 10.20).

Figure 10.20 – Adding two circles

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

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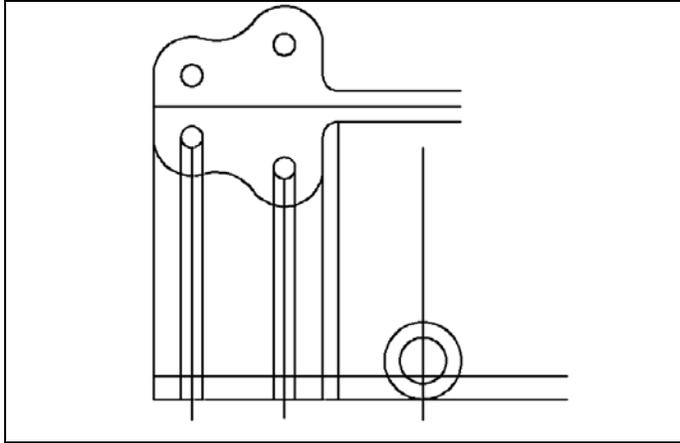
For the second point of displacement, pick the perpendicular point on the baseline of the front view. As you can see in Figure 10.21, the larger circle is now tangent to the baseline of the front view of the bracket. In previous problems, the use of Move and Copy were dependent on you typing numeric distances, but in this exercise, you can see the power of Object Snaps in moving entities.

Figure 10.21 – Moving the circles to the baseline

Finishing the Top View by Projecting from the New Front View
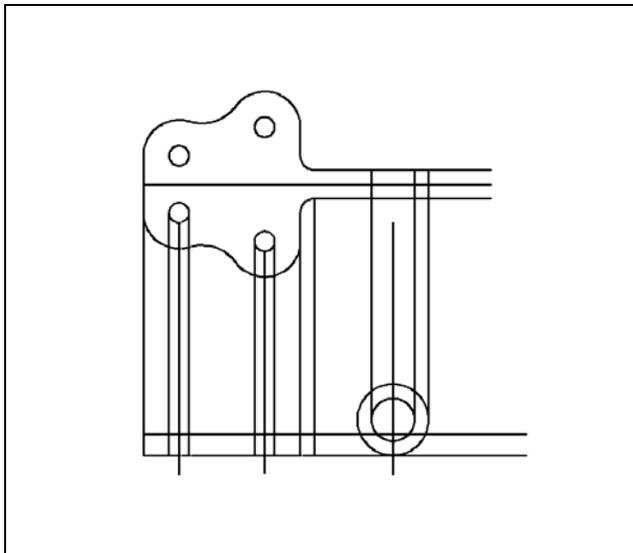
Draw a construction line by selecting the east quadrant of the outer circle and drawing up to the perpendicular point of the upper line in the top view using the Line command. If the lines on the top view do not extend far enough, select them individually and use the blue grips to extend them to the right. Hit the ENTER key twice to repeat the Line command. Draw the next line from 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 10.22. These lines will assist in finishing the work on the top view.

Figure 10.22 – Projecting lines to the top view
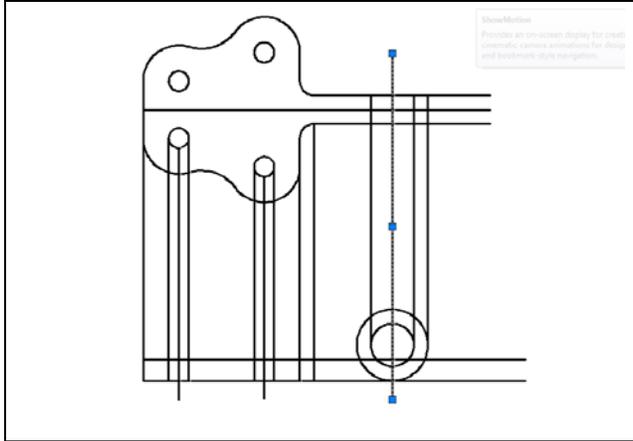
You will need to show a centerline on the top view, so borrow the centerline of the two circles that make the loop of the bracket. Click on the centerline to highlight it and activate the grips. Click the blue box at the top of the centerline. Move the line up past the object line on the top view about a quarter of an inch and click with the left mouse button to place it in its new position as shown in Figure 10.23. Hit escape to deselect the centerline. There will many times you will modify a drawing entity by using the grips.

Figure 10.23 – Projecting the Centerline

Creating an Arc from a Line to a Circle
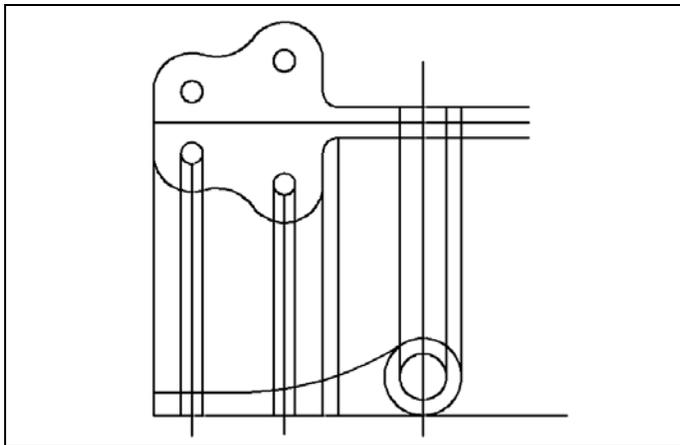
There is a 200 mm radius arc that goes from the top of the bracket to a tangent point of the loop. Select to the Fillet tool on the Modify panel to create a new fillet. Type R for Radius at the command line and then type your fillet radius which is 200, and hit ENTER. Pick the top horizontal line segment of the front view and the outside circle to create the 200-radius arc shown in Figure 10.24.

Figure 10.24 – Creating a 200 radius arc

Using the Extend Command

You need to show the same detail in the top view that you added with the 200 mm arc drawn in the front view. First select 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 hit ENTER (Figure 10.25). This process makes a line that will allow you to extend two lines from the loop in the top view.

Select the Extend tool on the Modify panel (expand the Trim tool). The command line first asks for a boundary edge, so select the construction line just created and hit ENTER. Select the bottom and top lines to the right so they extend to the construction line (Figure 10.26).
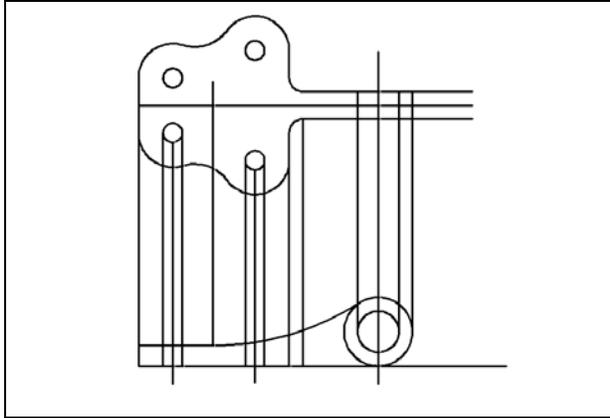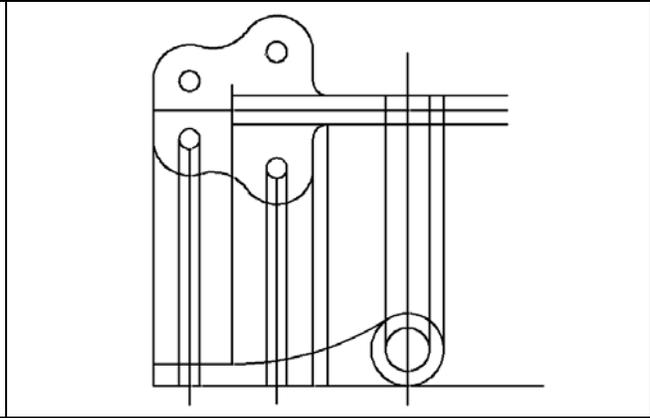
Figure 10.25 – Drawing an extension line
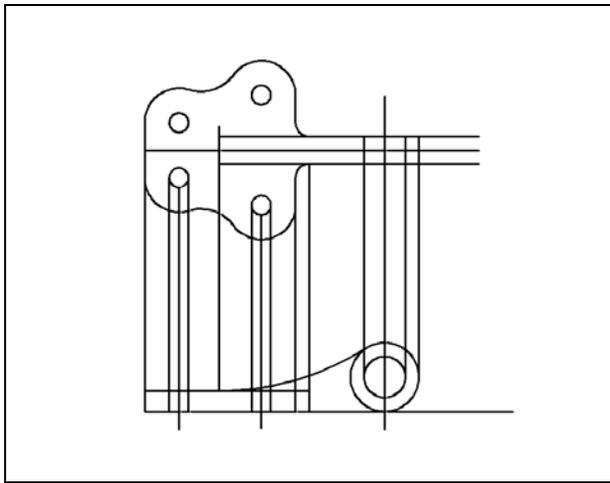

Figure 10.26 – Extending two lines

Figure 10.27 – Extending one line

Hit ENTER twice to stay in the command, select the vertical line extending from the 10 mm radius as the boundary edge, and hit ENTER. Select the top line of the front view to extend to your boundary line as shown in Figure 10.27. 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. Hit ESCAPE to exit the command.
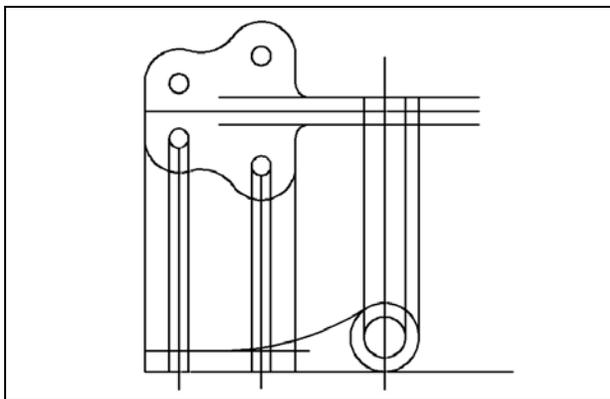

Figure 10.28 – Erasing boundary lines

Now you need to remove the two construction lines, so select the Erase tool on the Modify panel. After selecting the Erase tool, select the line segments that were used as boundaries for the extensions. Hit the ENTER key and they will disappear.

Using the Trim Tool

Select the Trim tool on the Modify panel and pick the bottom line (shown in red) in ⌐-- Trim Figure 10.29 representing the loop in the top view. After selecting the cutting line, hit ENTER and trim the three lines that were drawn from the circles that make up the loop in the front view.

Hit 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 (Figure 10.30). After selecting the cutting line, hit ENTER and trim the six lines that were drawn from the circles showing the loop in the front view, but not the centerlines.
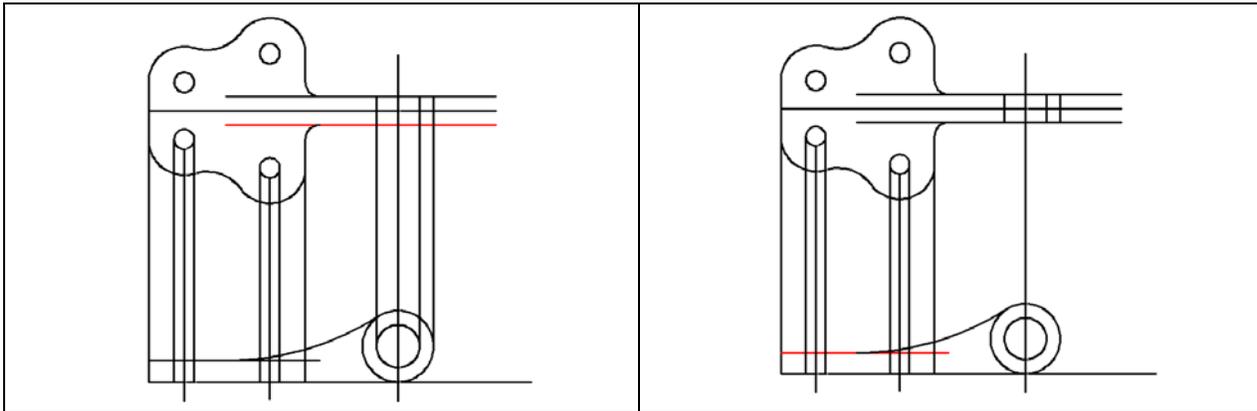

Figure 10.29 – Four lines trimmed
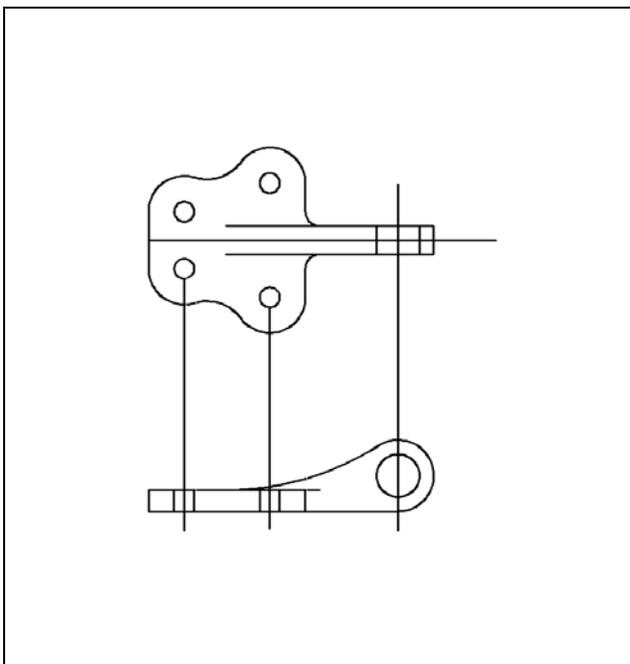

Figure 10.30 – Trimming six lines

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 panel and hit ENTER to select all lines, arcs and circles as cutting objects. After selecting the cutting objects, 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

Now you can 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. Moving an entity from one layer to another is as simple as selecting the entity and then selecting a layer in the Layer Control list box. The entity is removed from the present layer and placed in the newly selected layer.

Select the four lines shown in Figure 10.32. After creating the selection set of lines, pick the Center layer in the Layer Control list box. 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 (Figure 10.34).
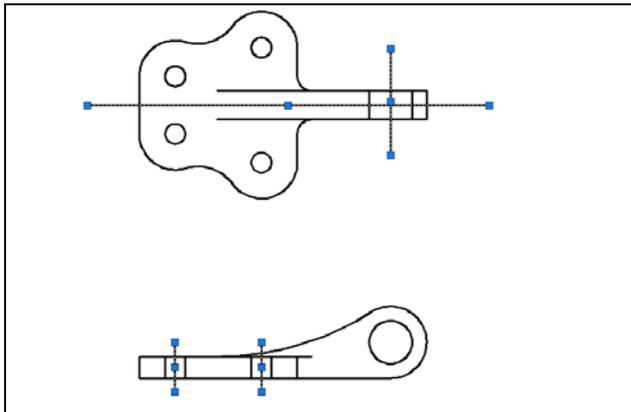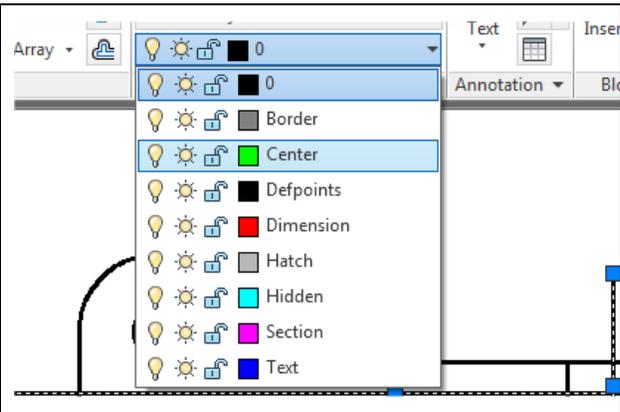

Figure 10.32– Selecting the centerlines
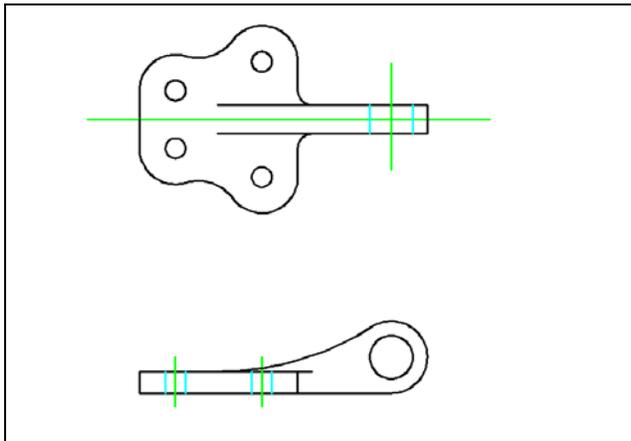

Figure 10.33 – Changing to center layer

Figure 10.34 – Changing to hidden layer

Select the six blue lines shown in Figure 10.34. After creating the selection set of lines, pick the Hidden layer in the Layer Control list box. All six lines will be removed from Layer 0 and now reside on the Hidden layer. The lines will be cyan 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 and accuracy of World Class CAD standards.

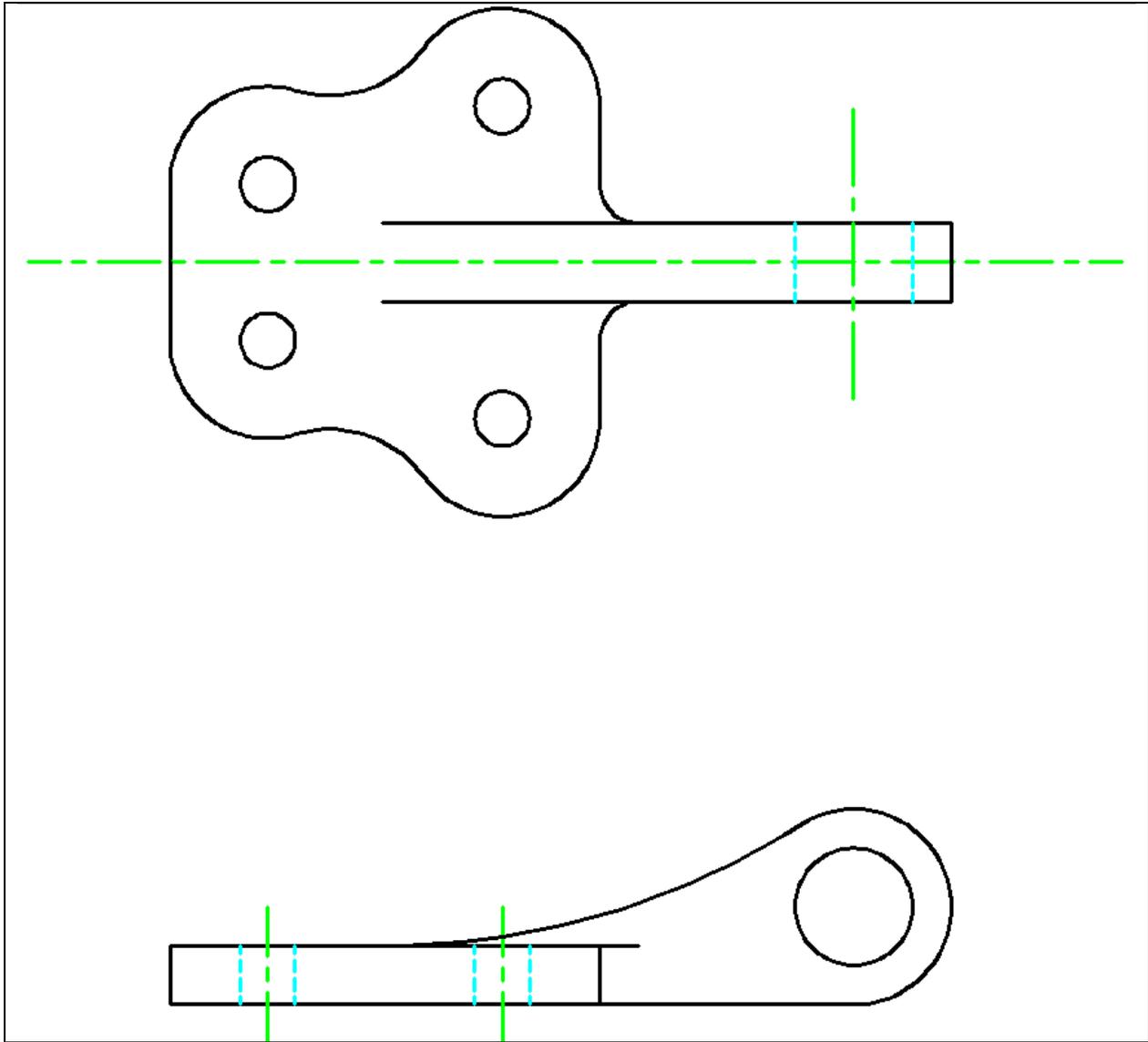Figure 10.35 shows a properly drawn Bracket problem for your reference.

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 in less than 3 minutes 15 seconds to maintain your World Class ranking.