PROJECT EXERCISE

This project creates the bracket shown in Figure P15–1. The bracket is drawn entirely by means of AutoCAD solid-modeling features. Follow the steps, and you will be able to build the model by using various commands available in AutoCAD solid modeling.

Figure P15–1 Creating a bracket using solid modeling

Step 1: Begin a new drawing using the Quick Setup Wizard. Set Units to Decimal and Area to 22 by 17.

Step 2: Create the following layers with appropriate colors and linetypes:

<table>
<thead>
<tr>
<th>Layer Name</th>
<th>Color</th>
<th>Linetype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object</td>
<td>Red</td>
<td>Continuous</td>
</tr>
<tr>
<td>Border</td>
<td>Green</td>
<td>Continuous</td>
</tr>
<tr>
<td>Dim</td>
<td>Blue</td>
<td>Continuous</td>
</tr>
<tr>
<td>Viewports</td>
<td>Cyan</td>
<td>Continuous</td>
</tr>
</tbody>
</table>
Step 3: Invoke the **VPORTS** command to create four equal viewports. AutoCAD displays the Viewports dialog box, as shown in Figure P15–2.

![Figure P15–2  Viewports dialog box](image)

Select **Four: Equal** from the **Standard viewports:** list box and **3D** from the **Setup** option menu, as shown in Figure P15–2. Choose the **OK** button to create the viewports and close the Viewports dialog box. AutoCAD creates four viewports with orthographic views and sets the appropriate UCS orientation, as shown in Figure P15–3.

![Figure P15–3  Four viewports and appropriate UCS orientation](image)
Step 4: Make the upper right viewport current. Invoke the **Display UCS Dialog** from the UCS toolbar, as shown in Figure P15–4.

![Display UCS Dialog](image1)

**Figure P15–4** *Invoke the Display UCS Dialog from the UCS toolbar*

AutoCAD displays the UCS dialog box, as shown in Figure P15–5.

![UCS dialog box](image2)

**Figure P15–5** *UCS dialog box*

Select the Settings tab and set the **Save UCS with viewport** toggle button to off, as shown in Figure P15–5. Choose the **OK** button to close the UCS dialog box.

Step 5: Set Object as the current layer.

Begin the layout of the drawing by drawing four boxes using the **box** command:

Command: **box**  
Specify corner of box or [CEnter] <0,0,0>: 0,0,-2  
Specify corner or [Cube/Length]: l  
Length: 8  
Width: 7  
Height: 1
Command: box
Specify corner of box or [CEnter] <0,0,0>: 0,0,-1
Specify corner or [Cube/Length]: l
Length: 3
Width: 7
Height: 1

Command: box
Specify corner of box or [CEnter] <0,0,0>: 5,0,-3
Specify corner or [Cube/Length]: l
Length: 3
Width: 7
Height: 1

Command: box
Specify corner of box or [CEnter] <0,0,0>: 2.5,3.25,-1
Specify corner or [Cube/Length]: l
Length: .75
Width: .5
Height: 2

The preceding box constructions form the basic shape of the bracket, as shown in Figure P15–6.

Figure P15–6  Creating the basic shape of the bracket
Step 6: Invoke the CYLINDER command to create a cylinder:

Command: cylinder
Specify center point for base of cylinder or [Elliptical] <0,0,0>: 1.5,3.5
Specify radius for base of cylinder or [Diameter]: 1.25
Specify height of cylinder or [Center of other end]: 2

Step 7: Invoke the WEDGE command to create a wedge as shown in Figure P15–7:

Command: wedge
Specify first corner of wedge or [CEnter] <0,0,0>: 3.25,3.25,−1
Specify corner or [Cube/Length]: l
Length: 3.75
Width: .5
Height: 2

Figure P15–7 Creating the basic shape with cylinder and wedge of the bracket

Step 8: Invoke the UCS command to define UCS as follows:

Command: ucs
Enter an option New/Move/orthoGraphic/Prev/Restore/Save/Del/Apply/?/World
<World>: n
Specify origin of new UCS or [ZAxis/3point/OBject/Face/View/X/Y/Z]<0,0,0>: 3
Specify new origin point <0,0,0>: (select point 1 by using the object snap ENDpoint, as shown in Figure P15–8)
Specify point on positive portion of X-axis: (select point 2 by using the object snap ENDpoint, as shown in Figure P15–8)

Specify point on positive-Y portion of the UCS XY plane: (select point 3 by using the object snap ENDpoint, as shown in Figure P15–8)

**Figure P15–8 Defining a UCS by 3 points**

**Step 9:** Invoke the `pline` command to draw a polyline to the given coordinates, as shown in Figure P15–9:

Command: `pline`  
Specify start point: `3.5,2`  
Current line-width is 0.0000  
Specify next point or [Arc/Close/Halfwidth/Length/Undo/Width]: `@1<180`  
Specify next point or [Arc/Close/Halfwidth/Length/Undo/Width]: `@0.5<270`  
Specify next point or [Arc/Close/Halfwidth/Length/Undo/Width]: `@-0.5,-1`  
Specify next point or [Arc/Close/Halfwidth/Length/Undo/Width]: `@0.5<-90`  
Specify next point or [Arc/Close/Halfwidth/Length/Undo/Width]: `@1.5<0`  
Specify next point or [Arc/Close/Halfwidth/Length/Undo/Width]: `c` (ENTER)
Step 10: Invoke the *REVOLVE* command to revolve the polyline just created into a solid, as shown in Figure P15–10:

Command: *revolve*

Current wire frame density: ISOLINES=4
Select objects: I
Select objects: (ENTER)
Specify start point for axis of revolution or define axis by [Object/X (axis)/Y (axis)]: 3.5,2
Specify endpoint of axis: @2<270
Specify angle of revolution <360>: 180
Step 11: Set the UCS to world coordinates systems and invoke the SPHERE command to create two spheres.

Command: `ucs`
Enter an option New/Move/orthoGraphic/Prev/Restore/Save/Del/Apply/?/World]
<World>; (ENTER)
Command: `sphere`
Specify center of sphere <0,0,0>: 1.5,1.125,-0.5
Specify radius of sphere or [Diameter]: 1

Copy the sphere to a displacement of 0,4.75, as shown in Figure P15–11.

Command: `copy`
Select objects: 1
Select objects: (ENTER)
Specify base point or displacement, or [Multiple]: 0,0
Specify second point of displacement or <use first point as displacement>: 0,4.75

Figure P15–11 Copying a sphere to a specified displacement

Step 12: Invoke the CONE command to draw two cones, as shown in Figure P15–12.

Command: `cone`
Specify center point for base of cone or [Elliptical] <0,0,0>: 1.5,1.125,-2
Specify radius for base of cone or [Diameter]: 0.75
Specify height of cone or [Apex]: -3

Copy the cone to a displacement of 0,4.75.
Figure P15–12  *Drawing two cones using the CONE command*

**Step 13:** Starting at 0,0,–5, create a box that is 3 x 7 x 2, as shown in Figure P15–13.

Figure P15–13  *Creating a box with starting point 0,0,–5 and dimensions of 3 x 7 x 2*

**Step 14:** Create a 0.5-radius cylinder, centered at 1.5,3.5,–2, to a height of 4, as shown in Figure P15–14.
Figure P15–14 Creating a 0.5 cylinder centered at 1.5, 3.5, −2 and with a height of 4

Step 15: Create a cylinder with radius 1, centered at 1.5, 3.5, 1.75 to a height of 0.25, as shown in Figure P15–15.

Figure P15–15 Creating a 0.5 cylinder centered at 1.5, 3.5, 1.75, with a height of 0.25 and a radius of 1
Step 16: Create a cylinder with radius 0.25, centered at 6.5,1.0,–3 to a height of 2, as shown in Figure P15–16.

Copy the cylinder to a displacement of 0,4.

Figure P15–16 Creating a cylinder centered at 6.5,1.0,–3, with a height of 2 and a radius of 0.25

Step 17: Invoke the **TORUS** command to create a torus, as shown in Figure P15–17:

Command: **torus**
Specify center of torus <0,0,0>: 1.5,3.5,1.5
Specify radius of torus or [Diameter]: 1.25
Specify radius of tube or [Diameter]: 0.25

Step 18: Select the connected boxes (except the box that was drawn in Step 13), the wedge, the large cylinder, the spheres, and the cones for use with the **UNION** command.

Command: **union**
Select objects: (select the boxes, wedge, large cylinder, spheres, and cones, and press ENTER)
Step 19: Select the resulting solid in response to the first `SUBTRACT` prompt, and then selecting the remaining primitives to be subtracted from it.

Command: `subtract`
Select solids and regions to subtract from …
Select objects: (select the solid resulting from STEP 18)
Select objects: (ENTER)
Select solids and regions to subtract …
Select objects: (select the remaining primitives)
Select objects: (ENTER)

The drawing should look like Figure P15–18.
Figure P15–18 Subtracting the primitives from the newly created solid using the SUBTRACT command

Step 20: Select the faces, as shown in Figure P15–19, for the chamfer and fillet. Use the CHAMFER and FILLET commands with 0.25 as the chamfer values and the radii on the respective selected objects. The end result should look like Figure P15–20.

Figure P15–19 Using the CHAMFER and FILLET commands to chamfer and fillet the faces
Figure P15–20  *The solid after chamfering and filleting the faces*

**Step 21:** Make the upper right viewport active. Invoke the `HIDE` command, and the result is as shown in Figure P15–21.

Figure P15–21  *Completed solid after using the HIDE command*

**Step 22:** Set Viewports as the current layer. Invoke the `LAYOUTWIZARD` command to create a layout to plot model. AutoCAD displays the Create Layout - Begin dialog box, as shown in Figure P15–22.
Chapter 15 • AutoCAD 3D

Figure P15–22 Create Layout - Begin dialog box

Type Chapter15 Project Layout in the Enter a name for the new layout you are creating edit field, as shown in Figure P15–22. Choose the Next > button, and AutoCAD displays the Create Layout - Printer dialog box, as shown in Figure P15–23.

Figure P15–23 Create Layout - Printer dialog box

Select a printer from the Select a configured for a new layout list box. In Figure 15–24, hp7580b.pc3 is selected. Choose the Next > button, and AutoCAD displays the Create Layout - Paper Size dialog box, as shown in Figure P15–24.
Select a paper size to be used in plotting. In Figure 15–25, ANSI C (22.00 x 17.00 Inches) is selected. Choose the Next > button, and AutoCAD displays the Create Layout – Orientation dialog box, as shown in Figure P15–25.

Select the Landscape radio button, as shown in Figure P15–25. Choose the Next > button, and AutoCAD displays the Create Layout – Title Block dialog box, as shown in Figure P15–26.
Select the appropriate title block for the selected paper size. In Figure P15–26, **ANSI C title block.dwg** is selected. Choose the **Next >** button, and AutoCAD displays the Create Layout – Define Viewports dialog box, as shown in Figure P15–27.
Select the **Std. 3D Engineering Views** radio button in the Viewport setup section of the dialog box, as shown in Figure P15–27. Choose the **Next >** button, and AutoCAD displays the Create Layout – Pick Location dialog box, as shown in Figure P15–28.

![Create Layout – Pick Location dialog box](image)

**Figure P15–28**  *Create Layout – Pick Location dialog box*

Choose the **Select Location <** button.

AutoCAD prompts:

Specify first corner: **1.5, 2.5**
Specify opposite corner: **20, 14**

AutoCAD displays the Create Layout – Finish dialog box. Choose the **Finish** button. AutoCAD displays 3 orthographic views and an isometric view in four viewports.

Set the Layer object as the current layout and turn off the viewport layer.

Invoke the **PLOT** command and plot the drawing.

**Step 22:**  Save and close the drawing.
EXERCISE 15–1

Layout the objects shown in 3D form for Exercises 15–1 to 15–5. Create the drawings to the given dimensions. Display the drawing with VPOINT in four different views. Select the HIDE command for one of the views.

Figure Ex15–1
EXERCISE 15–2

Figure Ex15–2
EXERCISE 15–3

Figure Ex15–3
Figure Ex15–4
EXERCISE 15–5

Figure Ex15–5
EXERCISE 15–6

Layout the 4" 150# Slip-on flange drawing shown in Figure 15–6 to the given dimensions.

Figure Ex15–6 Slip-on flange
EXERCISE 15–7

Layout the Clevis drawing shown in Figure 15–7 to the given dimensions.

Figure Ex15–7  Clevis
EXERCISE 15–8

Layout the drawing shown in Figure 15–8 to the given dimensions.

Figure Ex15–8
EXERCISE 15–9

Layout the drawing shown in Figure 15–9 to the given dimensions.

Figure Ex15–9
**EXERCISE 15–10**

Layout the drawing shown in Figure 15–10 to the given dimensions.

*Figure Ex15–10*
EXERCISE 15–11

Layout the drawing shown in Figure 15–11 to the given dimensions.

Figure Ex15–11
EXERCISE 15–12

Layout the drawing shown in Figure 15–12 to the given dimensions.

Figure Ex15–12
EXERCISE 15–13

Create the drawing shown in Figure 15–13 of the tank with supports on a slab.

Figure Ex15–13  Tank with supports on a slab
EXERCISE 15–14

Create the drawing of the 2", 3", 4" & 6" schedule 80 pipe on concrete supports.

Figure Ex15–14  2", 3", 4" & 6" schedule 80 pipe on concrete supports
EXERCISE 15–15

Create the pressure vessel drawing shown in Figure 15–15.

**Hint:** All extension pipes are 8" O.D.

---

**Figure Ex15–15** Pressure vessel