

# AutoCAD 3D

## Module 3

### World Coordinate System

#### Learning Outcomes:

When you have completed this module, you will be able to:

1. Describe the world coordinate system, the UCS icon and the right-hand rule.
2. Draw 3D models with the UCS located at the world coordinate system.

#### The World Coordinate System

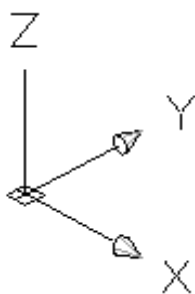
AutoCAD has two distinct three-dimensional coordinate systems: the World Coordinate System (WCS) and the User Coordinate System (UCS). The *World Coordinate System* is permanently located at the absolute coordinates X0Y0Z0. It is a fixed coordinate system which can never be moved. The WCS is not used to construct models.

The *User Coordinate System* is the coordinate system that is used to construct 3D models. The UCS can be placed exactly at the WCS or at any location in 3D space. In this module, you will be constructing models with the UCS located at the WCS. As you will see in Module 4 and 5, it is essential to be able to locate and orientate the UCS as required to construct most models.

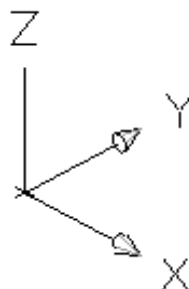
#### The UCS Icon

When the UCS is located at the world coordinate system, it will display a small square at the origin as you can see in Figure 3-1. If it is located at any other location, it will display a small plus sign as shown in Figure 3-2.

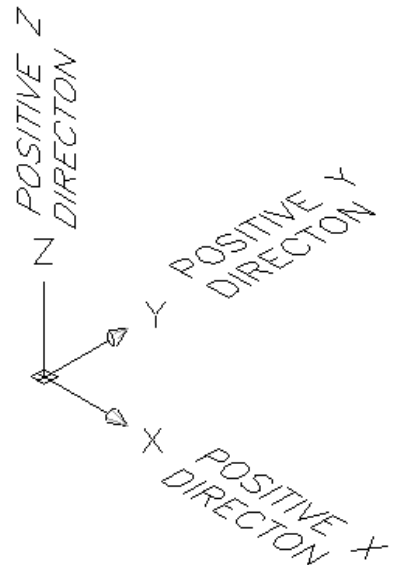
Figure 3-3 shows you the positive X, Y and Z directions indicated by the UCS icon. When you are constructing models it is very important to know which direction is positive and negative on all three axis



**Figure 3-1**  
UCS at the World  
Coordinate  
System



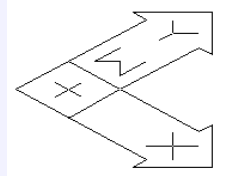
**Figure 3-2**  
UCS **Not** at  
the World  
Coordinate System



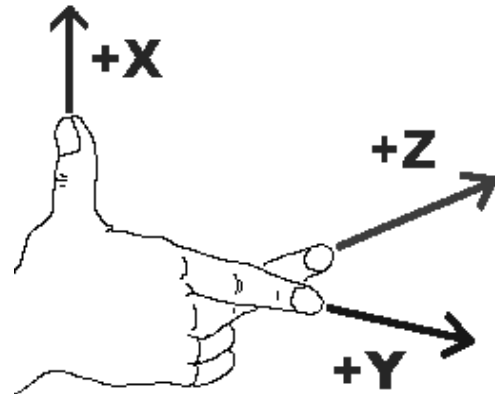
**Figure 3-3**  
UCS Icon  
Coordinate Directions

**MUST  
KNOW****For AutoCAD 2000 Users only.**

The only UCS icon that is available in AutoCAD 2000 is the 2D icon as shown to the right. AutoCAD 2000 users will have to use this icon along with the right-hand rule. When the UCS is at the WCS it displays a plus sign at as shown in the figure on the right. When there is no plus sign, it is NOT located at absolute X0Y0Z0.

**The Right-Hand Rule**

Even though the 3D UCS icon indicates the positive Z direction it is important to know how it is obtained. AutoCAD uses the *right-hand rule* to find the positive Z direction. To use the right-hand rule, you must first know the positive X and Y directions of the current UCS. Using your right hand, point your thumb in the direction of the positive X axis. Extend your index finger in the direction of the positive Y axis. Your middle finger indicates the direction of the positive Z axis. By rotating your hand, you can see how the X, Y and Z axes rotate as you change the UCS location and orientation. It is important to be able to visualize how and where to move the UCS as you construct more complicated models.



**Figure 3-4**  
The Right-hand Rule

**Drawing with the Z Coordinate**

While you were drawing in 2D, you only had to worry about entering the X and Y coordinates. Since you omitted the Z coordinate, AutoCAD used the default value of zero. When drawing in 3D, you must add the Z value in some coordinate input. For example, if you want to enter the coordinates X2Y3Z4, you would enter 2,3,4 if it is an absolute coordinate and @2,3,4 if it is a relative coordinate.

**Absolute X0Y0Z0**

The absolute coordinate 0,0,0 is the origin of the world coordinate system. This is the same point you were using in 2D when you entered 0,0. This is an important coordinate location as everything you draw in model space relates back to this location. Keep this in mind when drawing all future objects. It is especially important when you are constructing models that relate to real world locations. For example, when drawing a map, X0Y0Z0 is located at the equator and your model must be drawn in relation to that location.

**USER  
TIP**

Similar to working in 2D, it is important to save the objects you are drawing for construction purposes. In all lab exercises, create a layer named Construction, color 253. Draw all construction objects on this layer and do not delete them. When you have finished drawing the model, freeze layer Construction. When required, simply thaw the construction layer to display the construction objects.

**WORK  
ALONG**

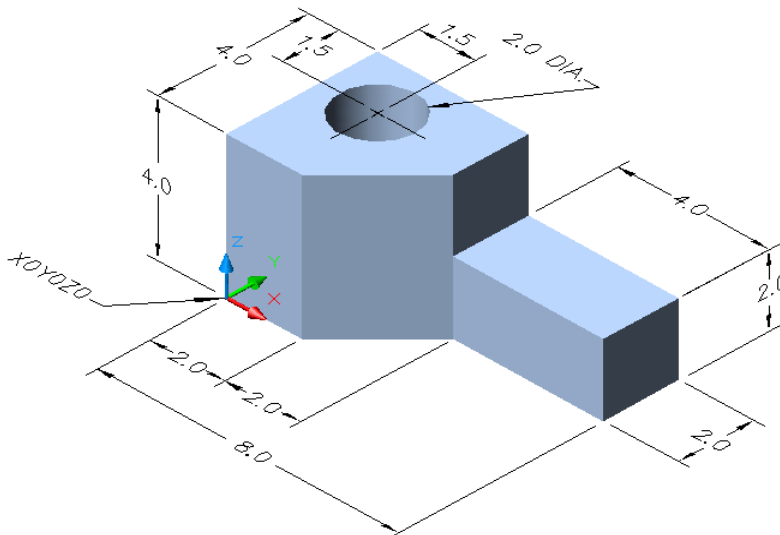
**Drawing 3D Wireframe Models - UCS Located at the WCS**

**Step 1** Using the NEW command, start a new drawing using the template Module Template 3D English.

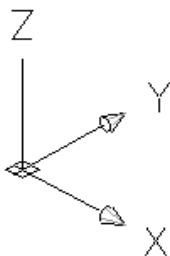
**Step 2** Save and name the drawing AutoCAD 3D Workalong 03-1. Save it in the folder: CAD Courses/AutoCAD 3D/Lab Exercises.

**Author's Comments**

Constructing models with the UCS located at the WCS is not the best method of constructing models. As a learning tool for this module, it keeps model building simple. This will help you when you draw your first few models.



**The Model**



**Figure Step 3**

**Step 3** Set the current view to SE Isometric and ensure the UCS Icon is enabled (On) and the Origin is enabled as shown in Module 1 page 1-4. See Figure Step 3.

**Step 4** Create layers Model and Construction as shown in Figure Step 4.

Status	Name	On	Freeze	Lock	Color	Linetype
	0	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	white	Continuous
	Construction	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	253	Continuous
	Defpoints	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	white	Continuous
	Key	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	magenta	Continuous
	Layout Titleblock	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	white	Continuous
	Model	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	red	Continuous

**Figure Step 4**

...continued on page 3-4

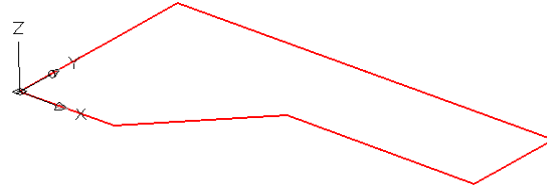
**MUST  
KNOW**

AutoCAD has two distinct three-dimensional coordinate systems. The world coordinate system (WCS) and the user coordinate system (UCS). The world coordinate system is located at the absolute coordinates X0Y0Z0. It is a fixed coordinate system and cannot be moved. The WCS cannot be used to construct models. The user coordinate system is the coordinate system that is used to construct 3D models. The UCS can be placed exactly at the WCS or at any location in 3D space.

## Drawing 3D Wireframe Models - UCS Located at the WCS - Continued

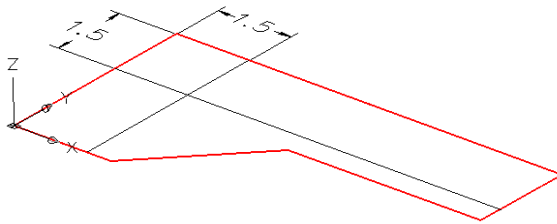
**Step 5** Set the current layer to **Model**. Enter the **LINE** command as shown below to start the construction of the model. See Figure Step 5.

Command: **LINE**  
 Specify first point: **0,0,0**  
 Specify next point or [Undo]: **@2,0**  
*(Since you are working at Z zero, you can omit the Z value.)*  
 Specify next point or [Undo]: **@2,2**  
 Specify next point or [Close/Undo]: **@4,0**  
 Specify next point or [Close/Undo]: **@0,2**  
 Specify next point or [Close/Undo]: **@-8,0**  
 Specify next point or [Close/Undo]: **C**  
 Command:



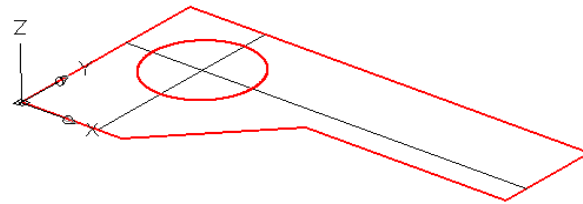
**Figure Step 5**

*(Draw the object that is located on the XY axis as you did in 2D.)*



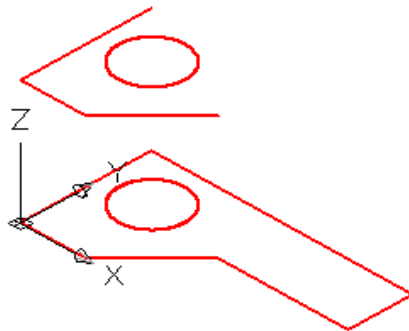
**Figure Step 6**

**Step 6** Using the **OFFSET** command, offset the two lines 1.5 units as shown in Figure Step 6. Change the layer properties of the two lines to layer **Construction**.



**Figure Step 7**

**Step 7** Using the **CIRCLE** command, draw a 2 diameter circle with its center located at the intersection of the two construction lines as shown in Figure Step 7.



**Figure Step 8**

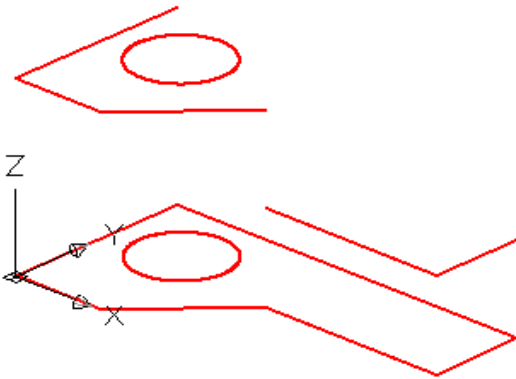
**Step 8** Enter the **COPY** command shown below. Copy the three lines and the circle 4 units in the positive Z direction as shown in Figure Step 8.

Command: **COPY**  
 Select objects:  
*(Select the three lines and the circle as shown in Figure Step 8.)*  
 Select objects:  
 Specify base point or displacement, or [Multiple]: **0,0,0**  
 Specify second point of displacement or <use first point as displacement>: **@0,0,4**  
*(Copy the 4 objects 4 units in the positive Z direction. Looking at the UCS or using the right-hand rule will indicated if it is a positive or negative direction.)*  
 Command:

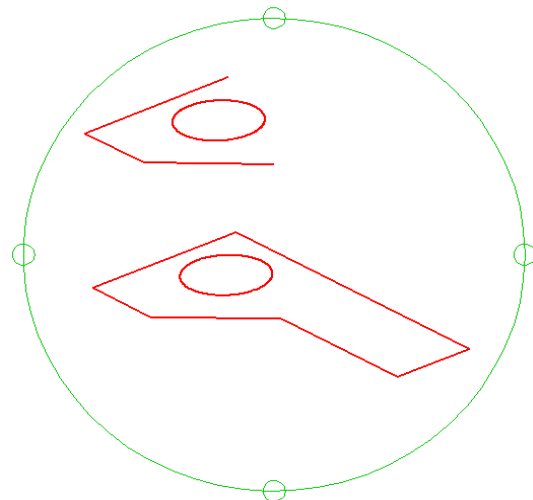
...continued on page 3-5

## Drawing 3D Wireframe Models - UCS Located at the WCS - Continued

**Step 9** Using the 3DORBIT command, rotate the model slightly. See Figure Step 9.



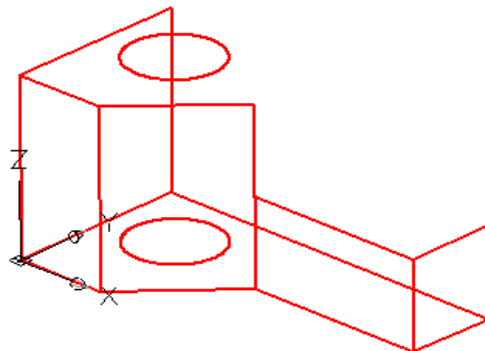
**Figure Step 10**



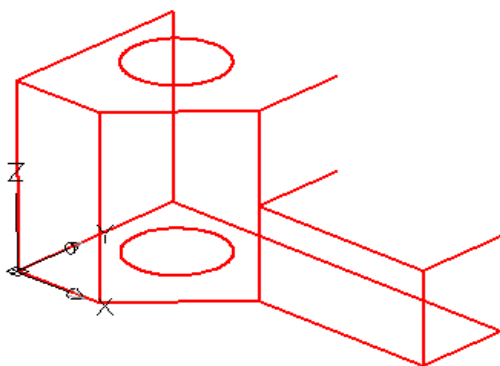
**Figure Step 9**

**Step 10** Using the COPY command, copy the 2 lines 2 units in the positive Z directions as shown in Figure Step 10.

**Step 11** Using the LINE command, draw six lines between the ends of the existing lines as shown in Figure Step 11. Ensure you snap to the ends of the lines.



**Figure Step 11**



**Figure Step 12**

**Step 12** Using the COPY command, copy the short line located at the right end of the model twice as shown in Figure Step 11. Ensure you use snap mode to locate the lines exactly.

...continued on page 3-6

## Drawing 3D Wireframe Models - UCS Located at the WCS - Continued

**Step 13** Using the LINE command, draw three lines between the ends of the existing lines as shown in Figure Step 13. Ensure you snap to the ends of the existing lines.

**Step 14** Using the VIEW command, save the current view with the name Working Isometric as shown in Figure Step 14. If you have trouble doing this, see Module 1 page 1-9 and 1-10.

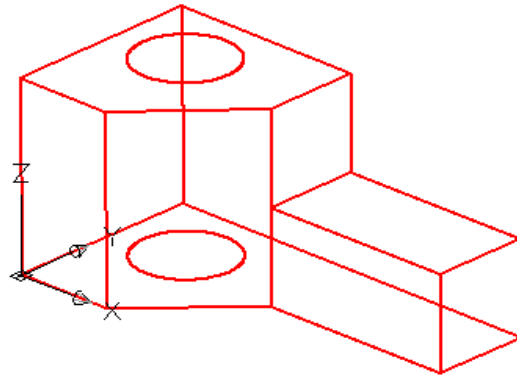


Figure Step 13

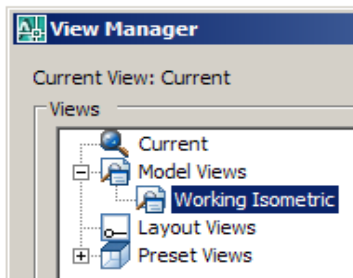


Figure Step 14 (2007)

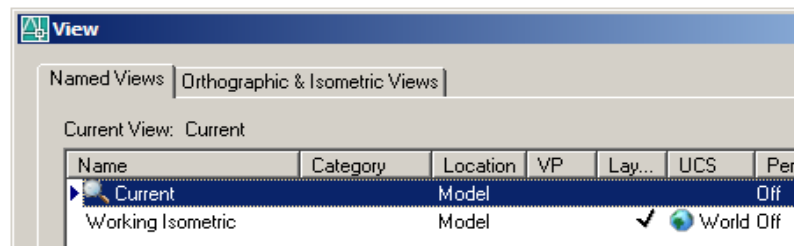


Figure Step 14 (2000-2006)

**Step 15** Change the view to SE Isometric. See Figure Step 15A and 15B.

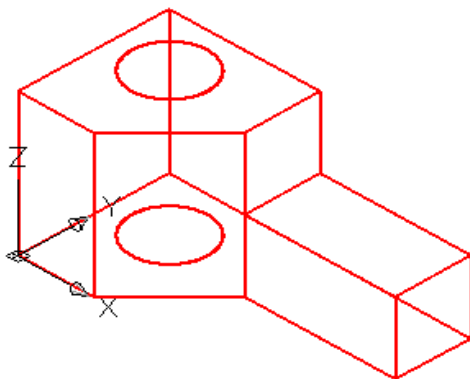


Figure Step 15B



Figure Step 15A

**Step 16** Insert the key AutoCAD 3D Workalong 03-1. It will overlay the model with a magenta model as shown in Figure Step 16. If you require help doing this, redo Module 2.

**Step 17** Save and close the drawing.

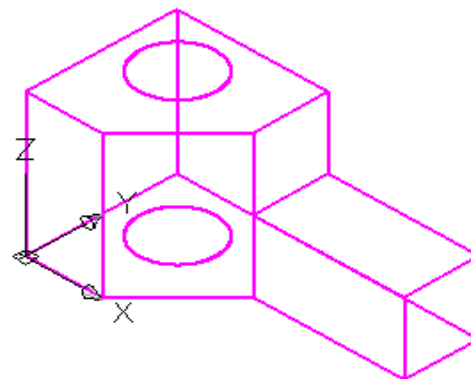


Figure Step 16

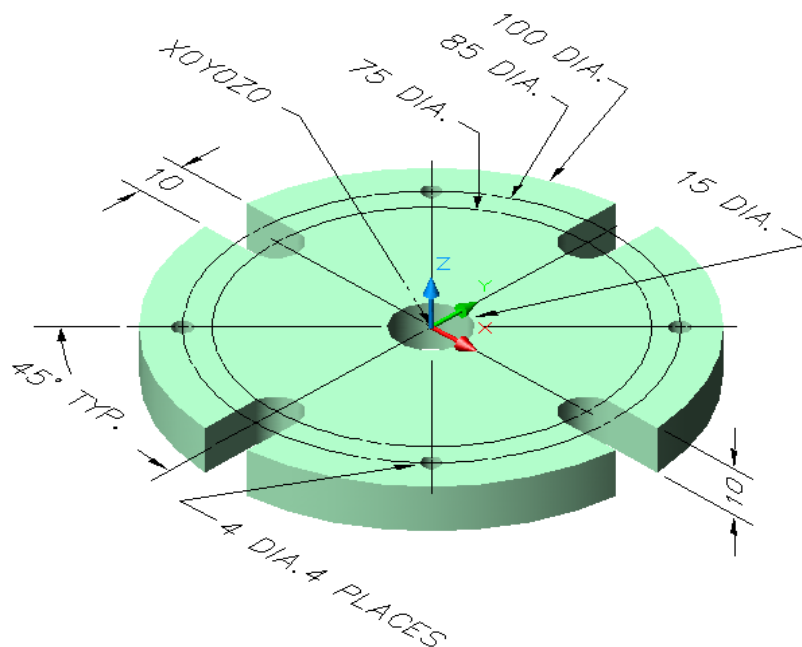
**WORK  
ALONG**

**Drawing 3D Wireframe Models - UCS Located at the WCS**

**Step 1** Using the NEW command, start a new drawing using the template Module Template 3D Metric.

**Step 2** Save and name the drawing AutoCAD 3D Workalong 03-2. Save it in the folder: CAD Courses/AutoCAD 3D/Lab Exercises.

**Step 3** Set the current view to SE Isometric and ensure the UCS Icon is On and the Origin is enabled as shown in Module 1 page 1-4.



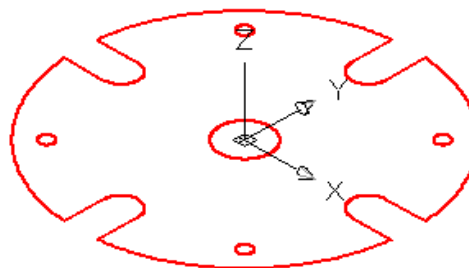
**The Model**

Status	Name	On	Freeze	Lock	Color	Linetype
0		On	Off	Off	white	Continuous
	Construction	Off	On	Off	253	Continuous
	Defpoints	Off	On	Off	white	Continuous
	Key	Off	On	Off	magenta	Continuous
	Layout Titleblock	Off	On	Off	white	Continuous
✓	Model	On	Off	Off	red	Continuous

**Figure Step 4**

**Step 4** Create layers Model and Construction as shown in Figure Step 4.

**Step 5** On layer Model, draw the shape of the top of the object as shown in Figure Step 5. You should use the ARRAY command to speed up the construction.



**Figure Step 5**

...continued on page 3-8

## Drawing 3D Wireframe Models - UCS Located at the WCS - Continued

**Step 6** Using the COPY command, shown below, copy all of the objects 10 units in the negative Z direction as shown in Figure Step 6.

Command: **COPY**

Select objects:

(Select all objects)

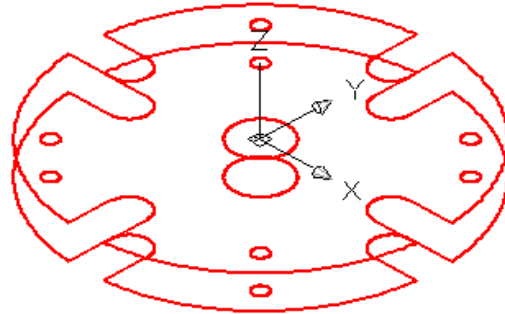
Select objects:

Specify base point or displacement, or [Multiple]:

**0,0,0**

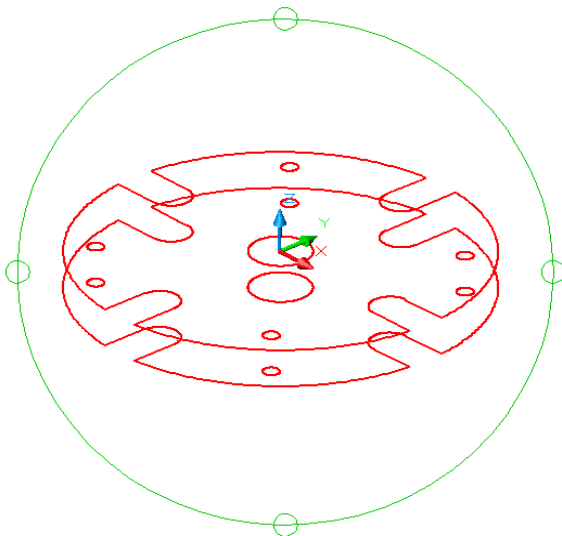
Specify second point of displacement or <use first point as displacement>: **@0,0,-10**

Command:



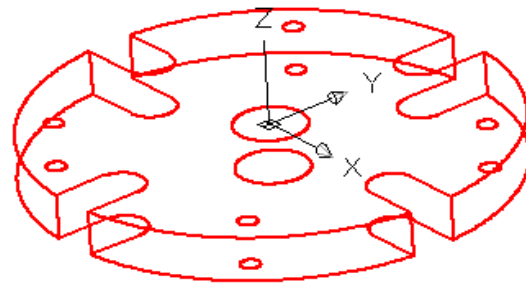
**Figure Step 6**

**Step 7** Using the 3DORBIT command, rotate the model slightly until it appears similar to Figure Step 7.



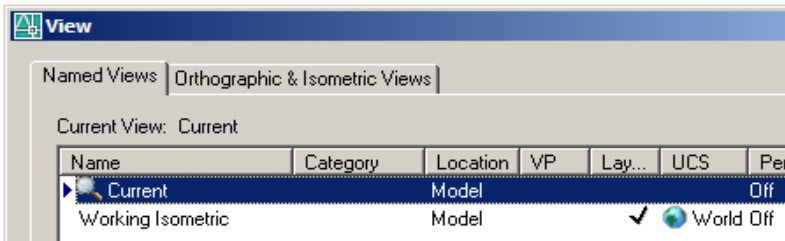
**Figure Step 7**

**Step 8** Draw the vertical lines to complete the wireframe model as shown to Figure Step 8.

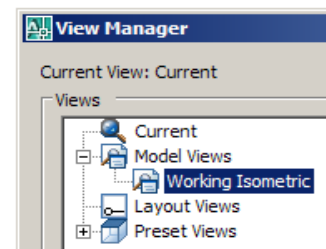


**Figure Step 8**

**Step 9** Using the VIEW command, save the current view with the name Working Isometric as shown in Figure Step 9. If you have trouble doing this, see Module 1 page 1-9 and 1-10.



**Figure Step 9 (2000-2006)**



**Figure Step 9 (2007)**

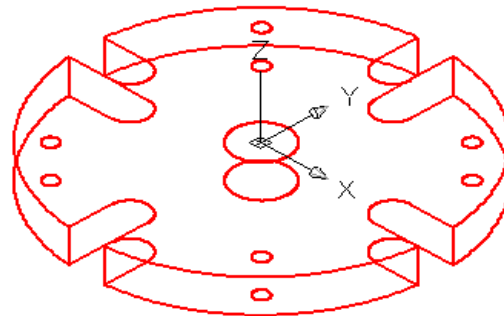
...continued on page 3-9

## Drawing 3D Wireframe Models - UCS Located at the WCS - Continued

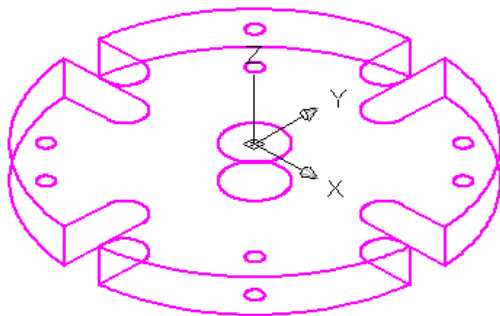
**Step 10** Change the view to SE Isometric as shown in Figure Step 10A and 10B.



**Figure Step 10A**



**Figure Step 10B**



**Figure Step 11**

**Step 11** Insert the key AutoCAD 3D Workalong 03-2. It will overlay the model with a magenta model as shown in Figure Step 11. If you require help doing this, redo Module 2.

**Step 12** Save and close the drawing.

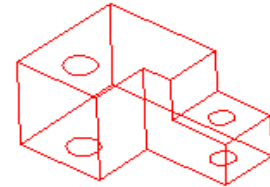
### The Key Principles in Module 3

1. AutoCAD has two distinct three dimensional coordinate systems: the World Coordinate System (WCS) and the User Coordinate System (UCS).
2. The World Coordinate System is permanently located at the absolute coordinates X0Y0Z0. It is a fixed coordinate system which can never be moved. The WCS is not used to construct models.
3. The User Coordinate System is the coordinate system that you will be using to construct 3D models. The UCS can be placed exactly at the WCS or at any location in 3D space.
4. AutoCAD uses the right-hand rule to find the positive Z direction. To use the right-hand rule, you must first know the positive X and Y directions of the current UCS. Using your right hand, point your thumb in the direction of the positive X axis. Extend your index finger in the direction of the positive Y axis. Your middle finger indicates the direction of the positive Z axis.
5. The absolute coordinate 0,0,0 is the origin of the world coordinate system. This is the same point you were using in 2D when you entered 0,0. This is an important coordinate location as everything you draw in model space relates back to this location.

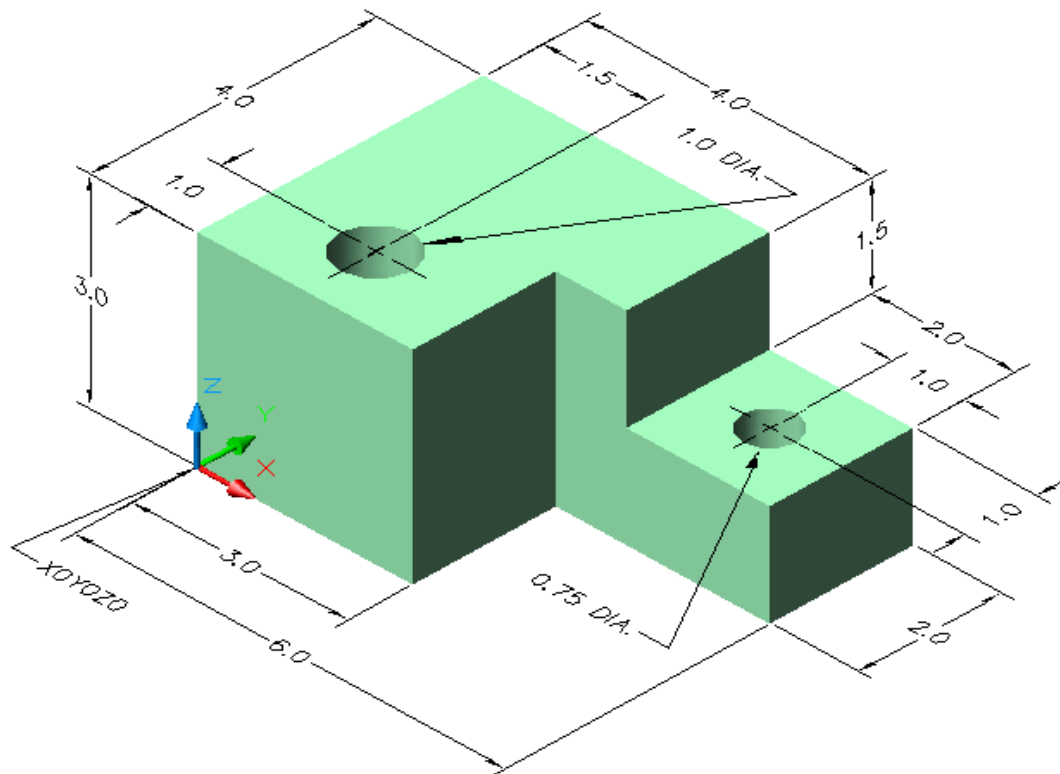
Lab Exercise 3-1		Time Allowed: 45 Min.	
Drawing Specifications			
Name	Template	Units	Text Style
AutoCAD 3D Lab 03-1	Module Template 3D English	Inches	N/A
Note: Color, Linetype, and Lineweight are all <u>ByLayer</u> unless otherwise instructed.			
Layering Scheme			
Objects on Layer	Name	Color	Linetype
Construction objects	Construction	253	Continuous
Model space objects	Model	Red	Continuous

**Instructions:**

1. Save and name the drawing AutoCAD 3D Lab 03-1 as shown above.
2. Draw all construction objects on layer Construction.
3. Draw all model objects on layer Model.
4. Start your model with the view in SE Isometric. If required, rotate it slightly with 3DORBIT to help the line of sight.
5. Draw a wireframe model of the object below.
6. Save the isometric working view with the name Working Isometric.
7. Freeze layer Construction.
8. Change the current UCS to World and check the model with the key.

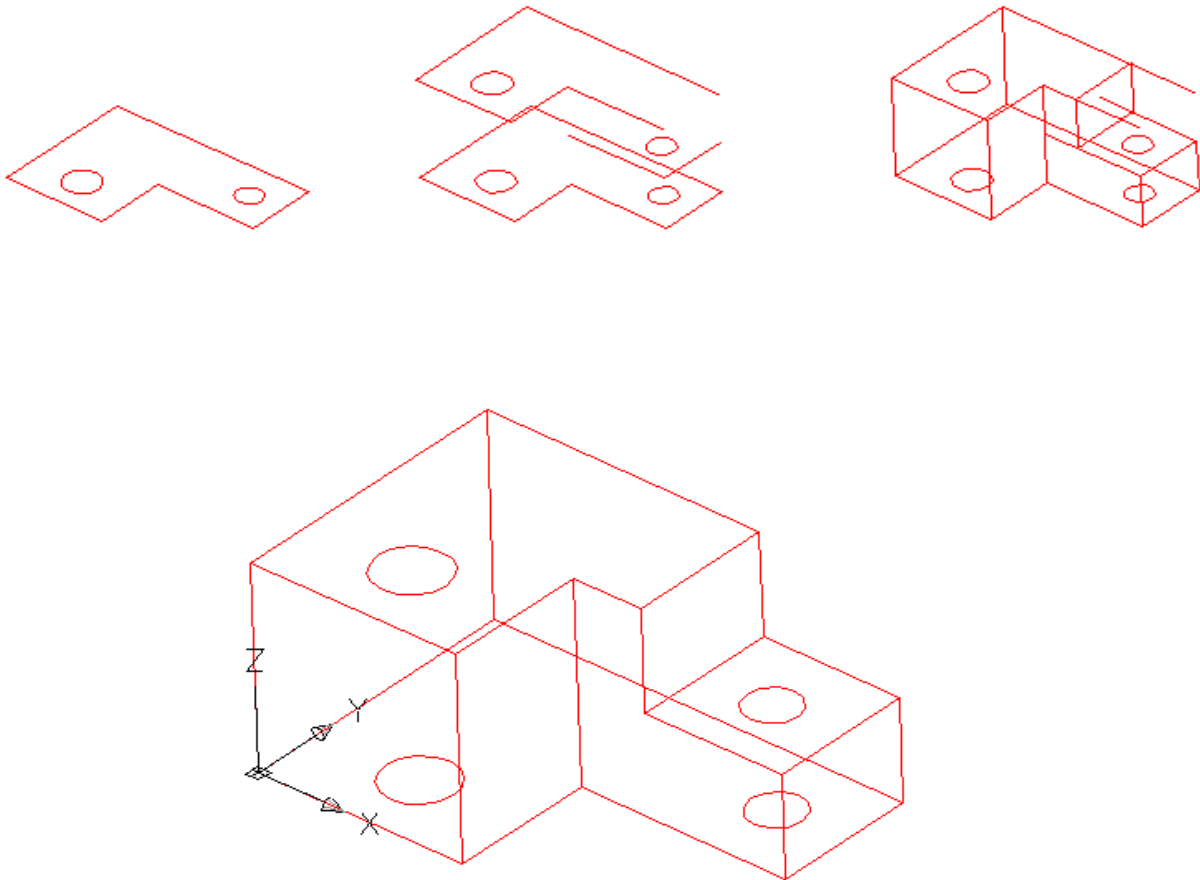


Completed  
Wireframe Model



## Construction Techniques

The following steps are the construction technique suggested by the author to help you learn how to construct objects using AutoCAD. It is only the suggested method and if you can complete the drawing accurately using a different construct technique, that is what is important. You may want to compare your construction technique with the authors.



**Lab Exercise 3-2****Time Allowed: 45 Min.****Drawing Specifications**

Name	Template	Units	Text Style
AutoCAD 3D Lab 03-2	Module Template 3D Metric	Millimeters	N/A

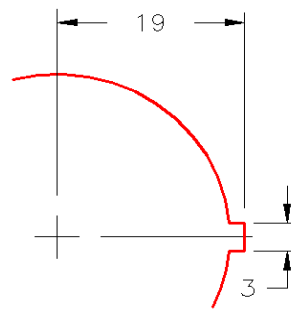
Note: Color, Linetype, and Lineweight are all ByLayer unless otherwise instructed.

**Layering Scheme**

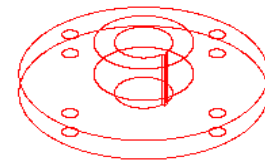
Objects on Layer	Name	Color	Linetype
Construction objects	Construction	253	Continuous
Model space objects	Model	Red	Continuous

Instructions:

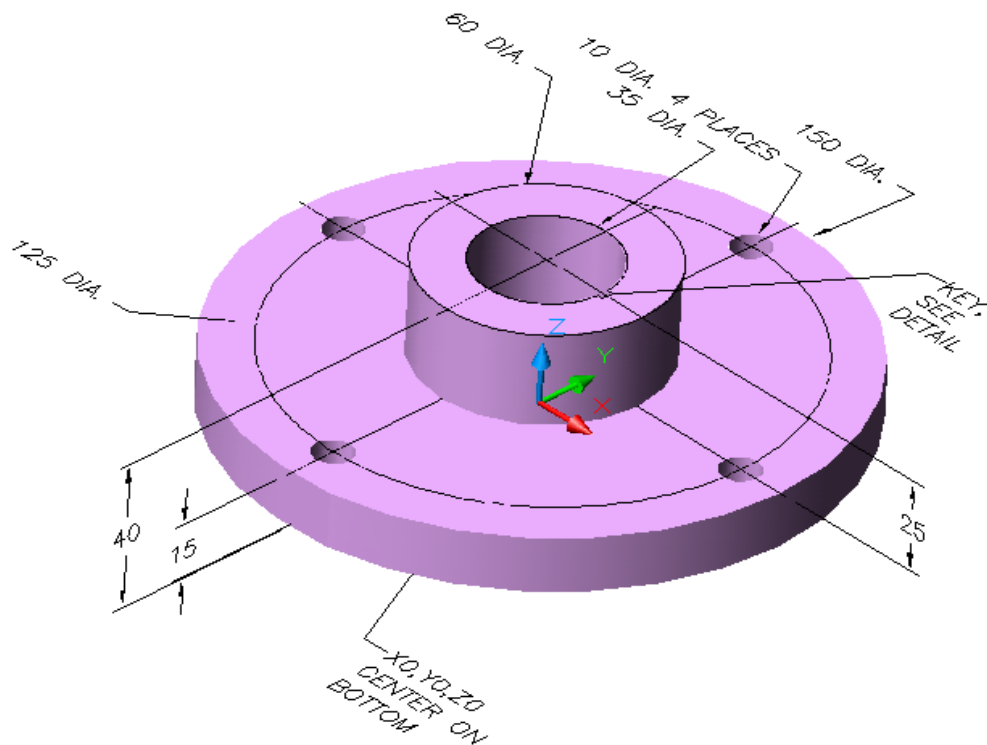
1. Save and name the drawing AutoCAD 3D Lab 03-2 as shown above.
2. Draw all construction objects on layer Construction.
3. Draw all model objects on layer Model.
4. Start your model with the view in SE Isometric. If required, rotate it slightly with 3DORBIT to help the line of sight.
5. Draw a wireframe model of the object below.
6. Save the isometric working view with the name Working Isometric.
7. Freeze layer Construction.
8. Change the current UCS to World and check the model with the key.



Key Detail

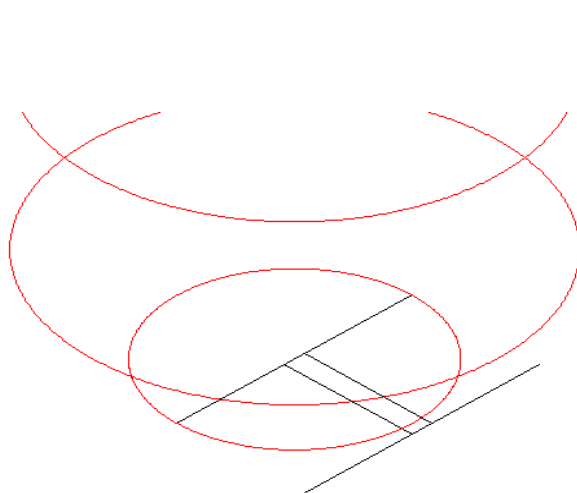
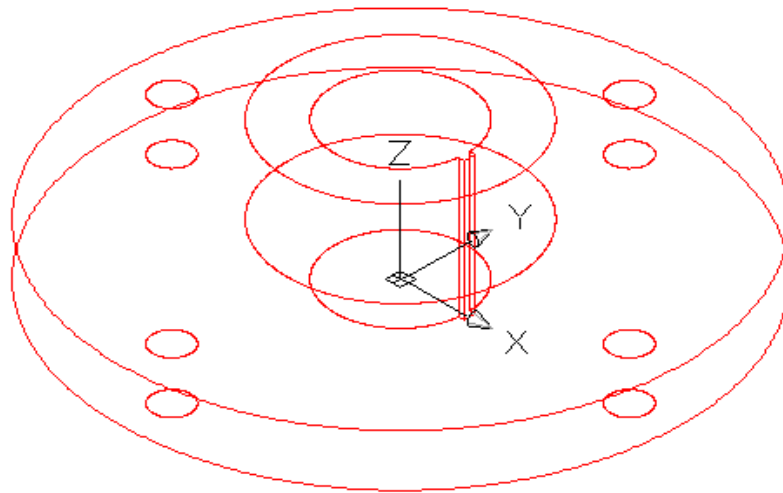
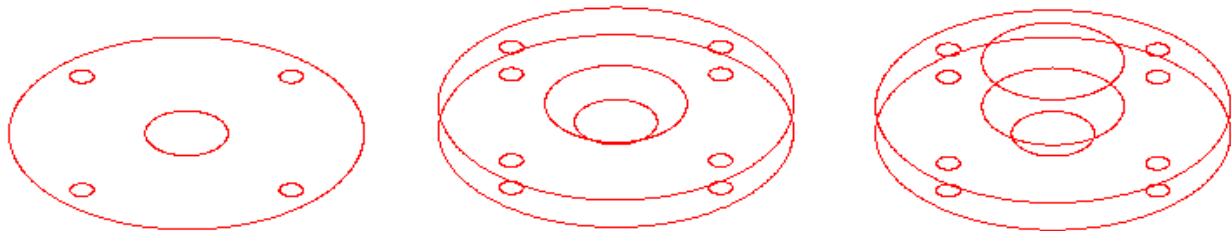


Completed Wireframe Model

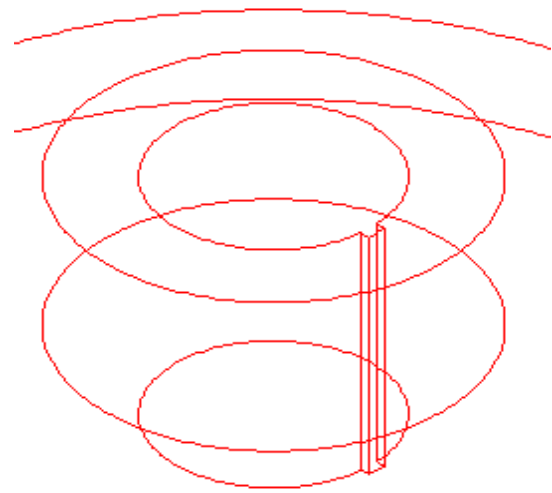


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Construction lines to Draw the Key



The Finished Key