

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

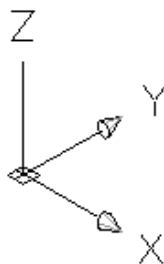


Figure 3-1
UCS at the
World
Coordinate
System

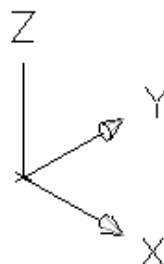


Figure 3-2
UCS Not at
the World
Coordinate
System

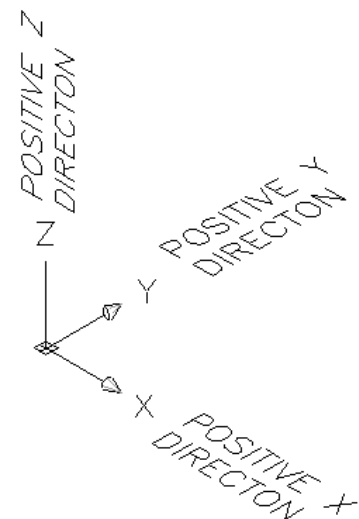
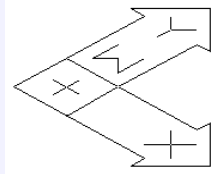


Figure 3-3
UCS Icon
Coordinate Directions

**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.

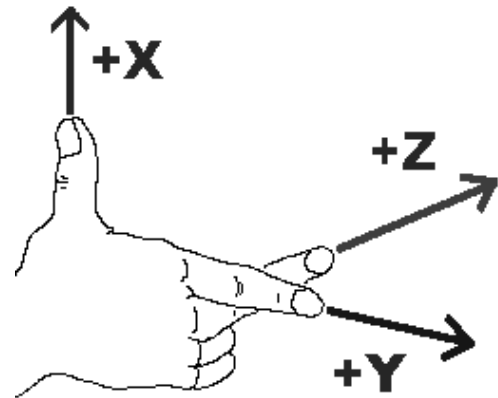


Figure 3-4
The Right-hand Rule

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 252. 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**

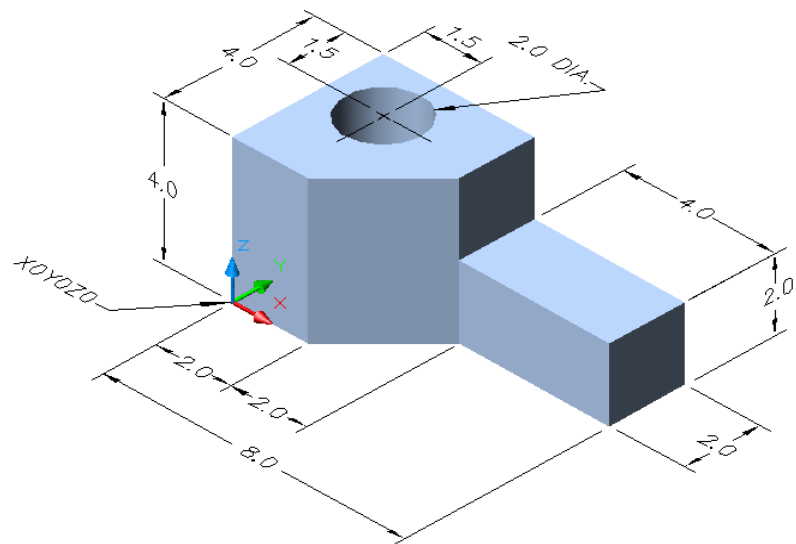
Drawing 3D Wireframe Models - UCS Located at the WCS

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.

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.



The Model

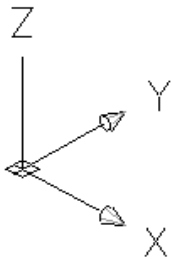


Figure Step 3

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 type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	253	Continuous
	Defpoints	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	white	Continuous
	Key	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	magenta	Continuous
	Layout Titleblock	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	white	Continuous
<input checked="" type="checkbox"/>	Model	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	red	Continuous

Figure Step 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.

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:

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

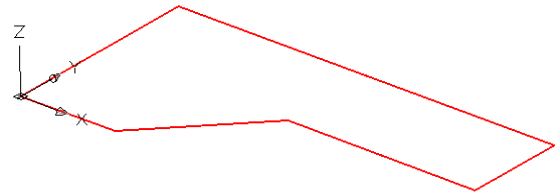


Figure Step 5

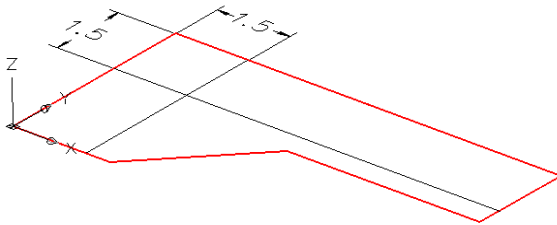


Figure Step 6

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.

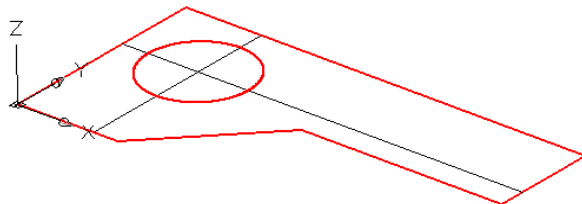


Figure Step 7

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.

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:

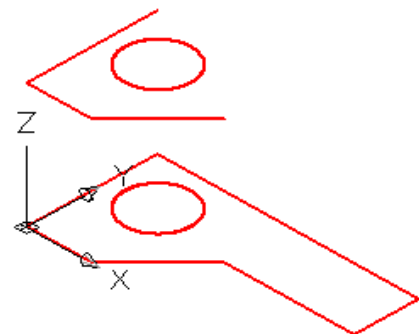


Figure Step 8

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

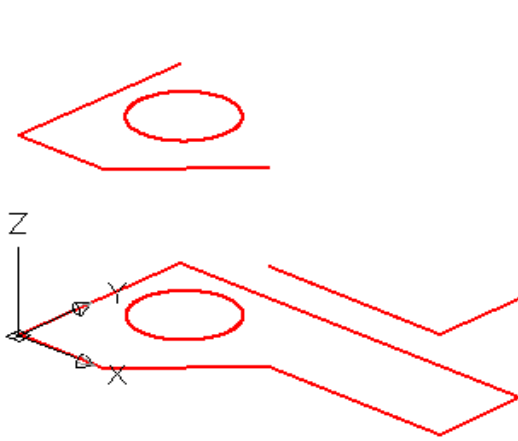


Figure Step 10

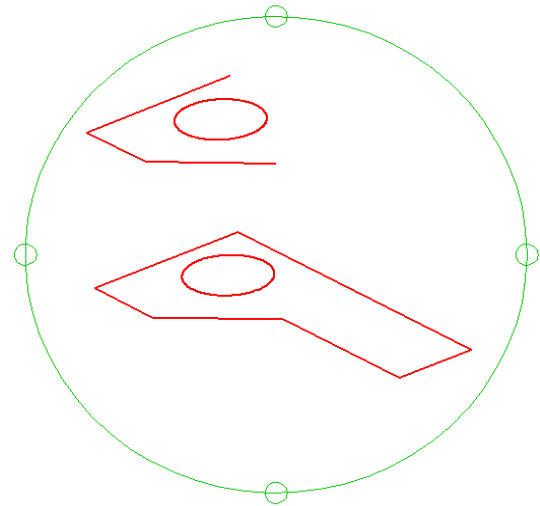


Figure Step 9

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.

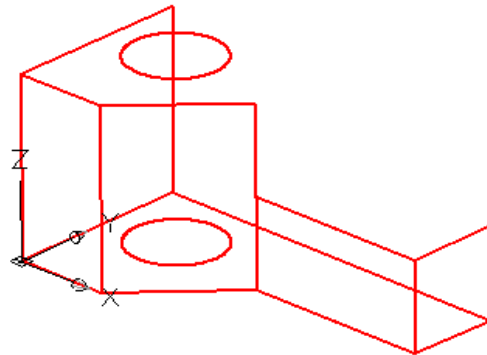


Figure Step 11

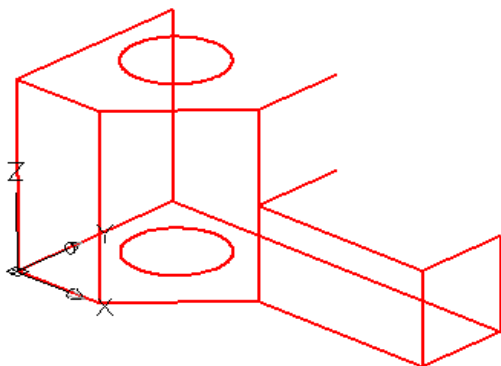


Figure Step 12

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.

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.

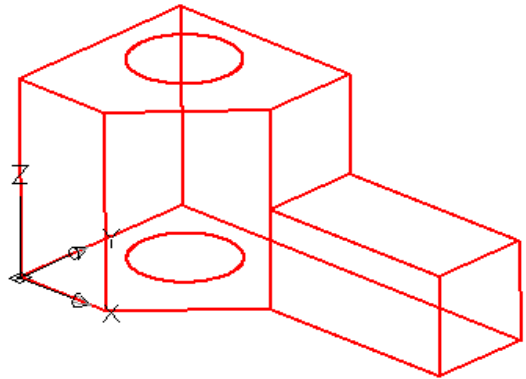


Figure Step 13

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.

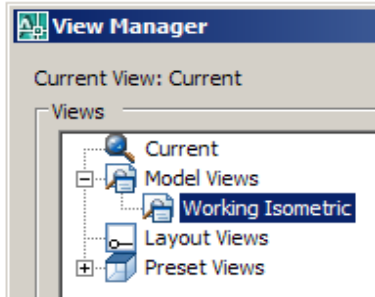


Figure Step 14 (2007-2010)

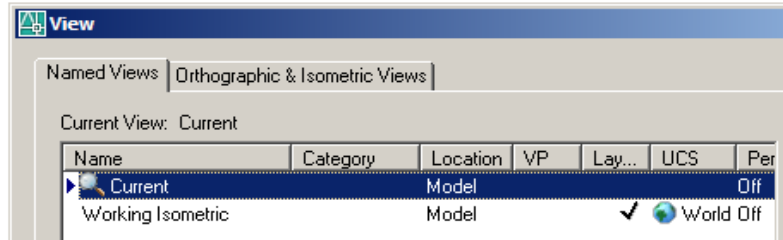


Figure Step 14 (2000-2006)

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



Figure Step 15A

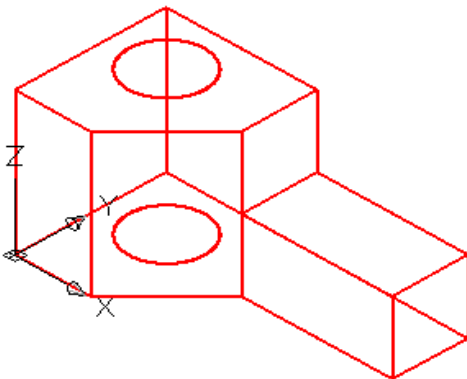


Figure Step 15B

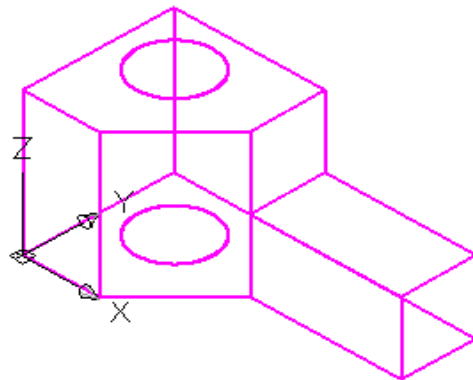


Figure Step 16

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.

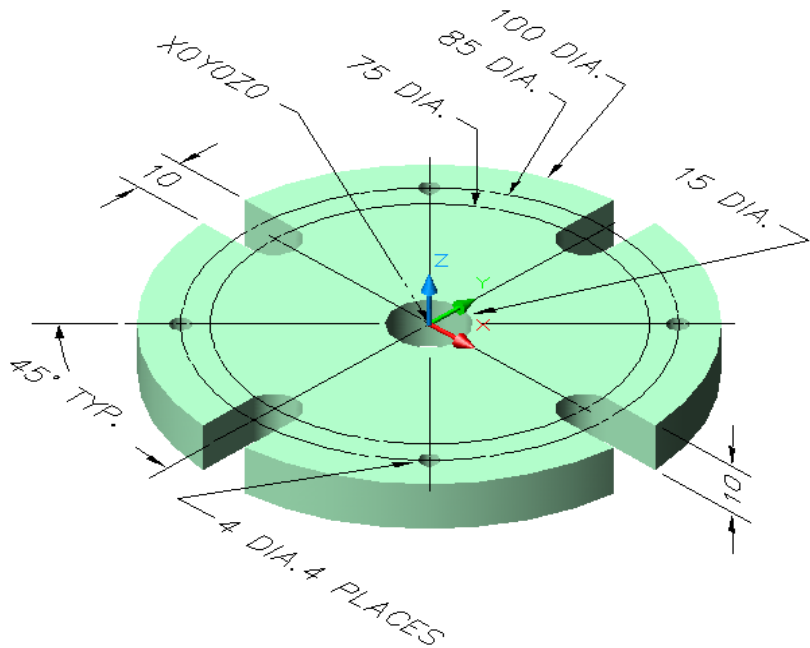
**WORK
ALONG**

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				white	Continuous
	Construction				253	Continuous
	Defpoints				white	Continuous
	Key				magenta	Continuous
	Layout Titleblock				white	Continuous
	Model				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.

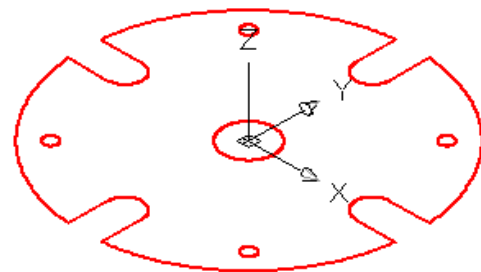


Figure Step 5

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:

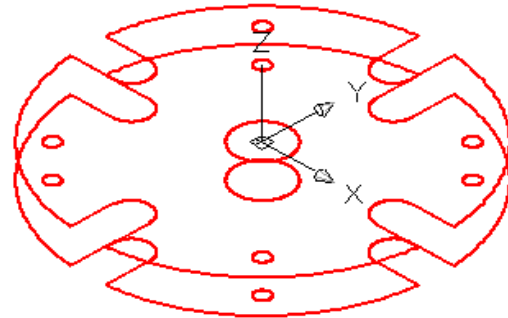


Figure Step 6

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

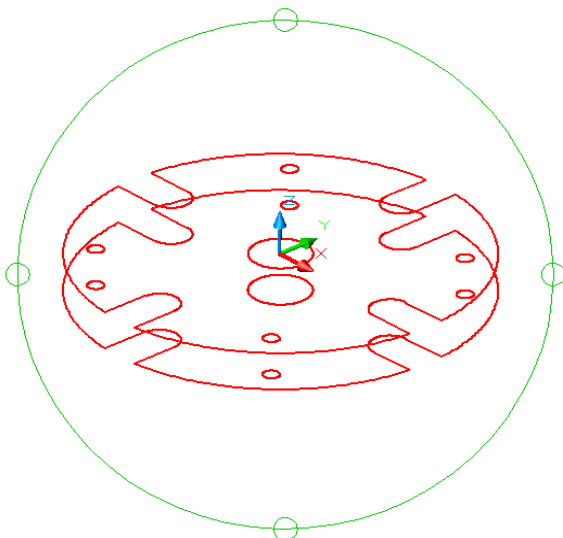


Figure Step 7

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

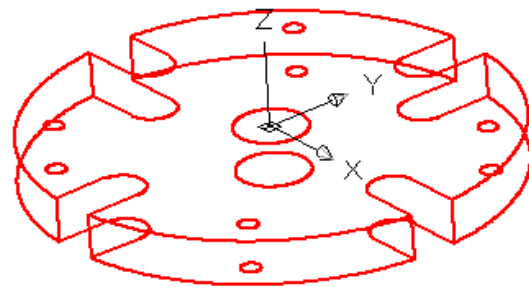


Figure Step 8

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.

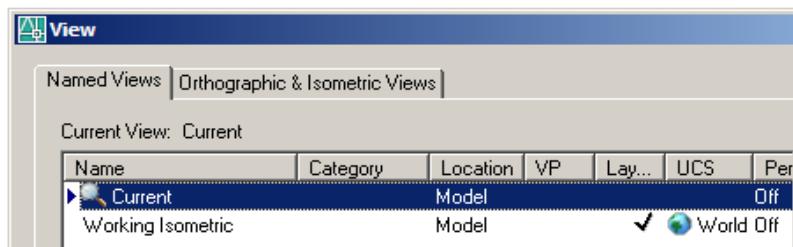


Figure Step 9 (2000-2006)

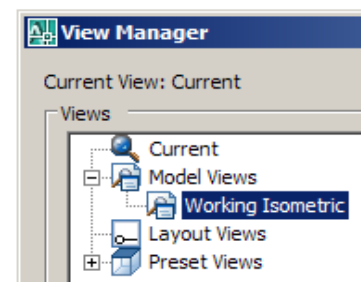


Figure Step 9 (2007-2010)

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



Figure Step 10A

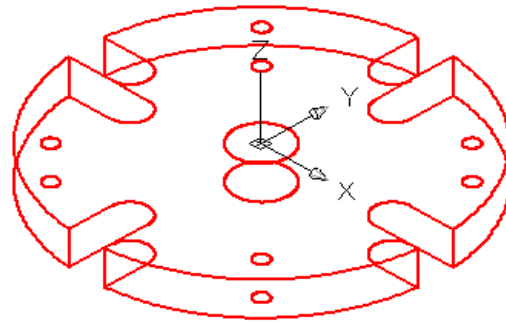


Figure Step 10B

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.

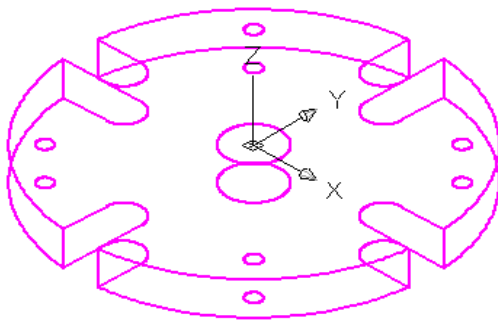


Figure Step 11

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.**

Name	Template	Units
AutoCAD 3D Lab 03-1	3D Layout English	Inches

Instructions:

Step 1 Save and name the drawing AutoCAD 3D Lab 03-1 as shown above.

Step 2 Draw all construction objects on layer Construction.

Step 3 Draw all model objects on layer Model.

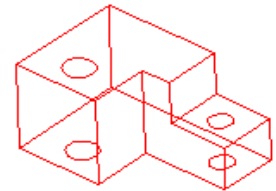
Step 4 Start your model with the view in SE Isometric. If required, rotate it slightly with 3DORBIT to help the line of sight.

Step 5 Draw a wireframe model of the object below.

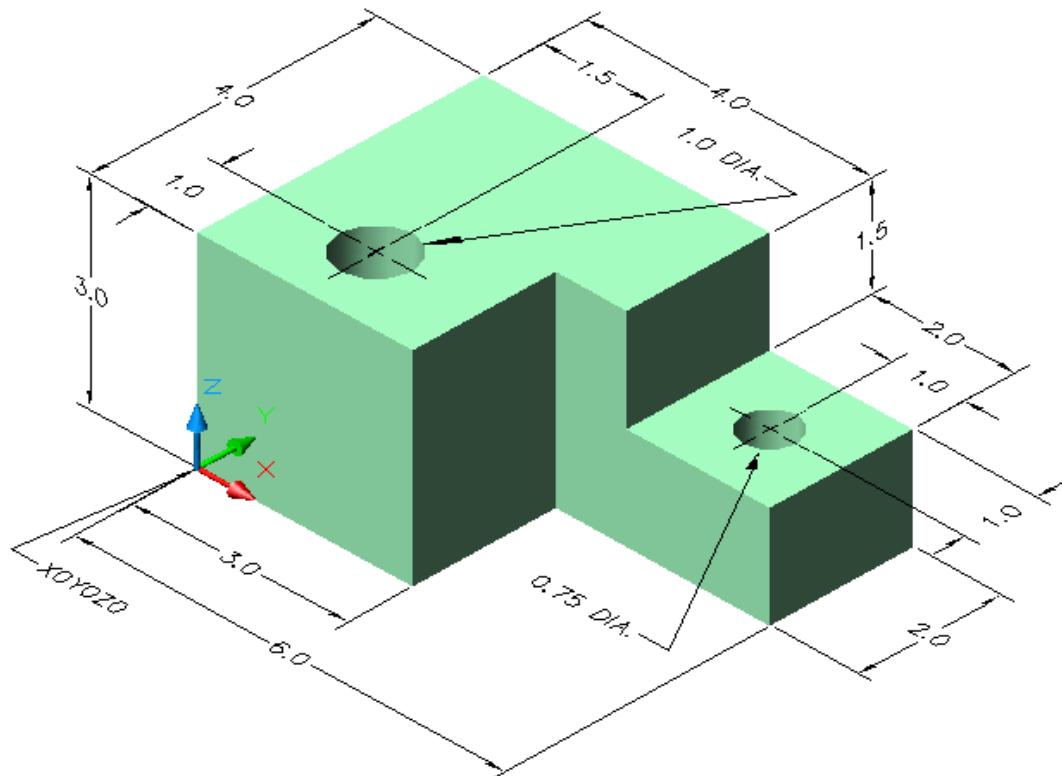
Step 6 Save the isometric working view with the name Working Isometric.

Step 7 Freeze layer Construction.

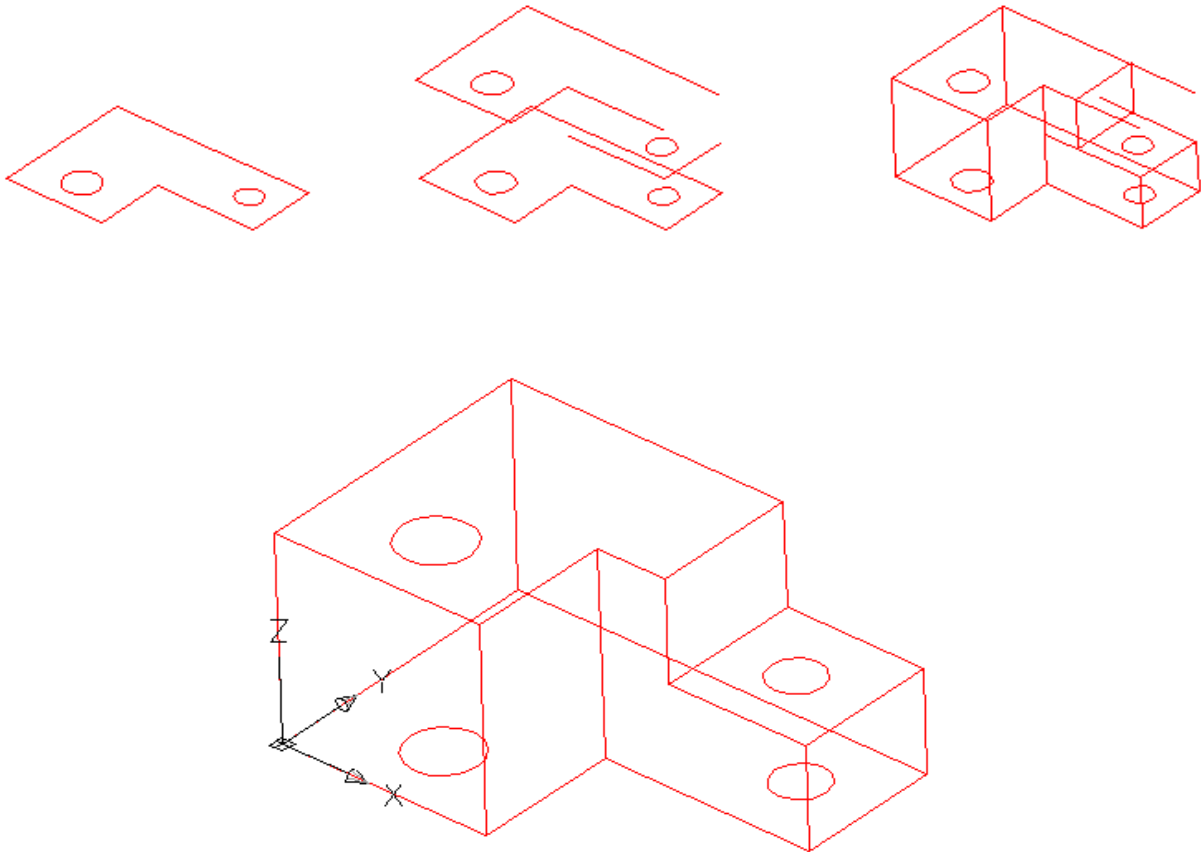
Step 8 Check the model with the key.



Completed
Wireframe Model



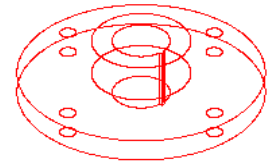
Construction Techniques: The following steps are the construction technique suggested by the author to help you learn how to construct objects using AutoCAD. It is only the suggested method and if you can complete the drawing accurately using a different construct technique, that is what is important.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



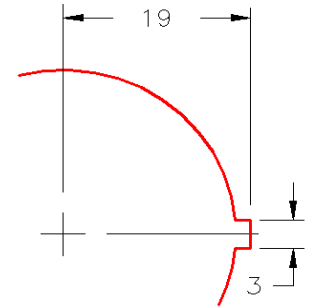
Lab Exercise 3-2		Time Allowed: 45 Min.
Name	Template	Units
AutoCAD 3D Lab 03-2	3D Layout Metric	Millimeters

Instructions:

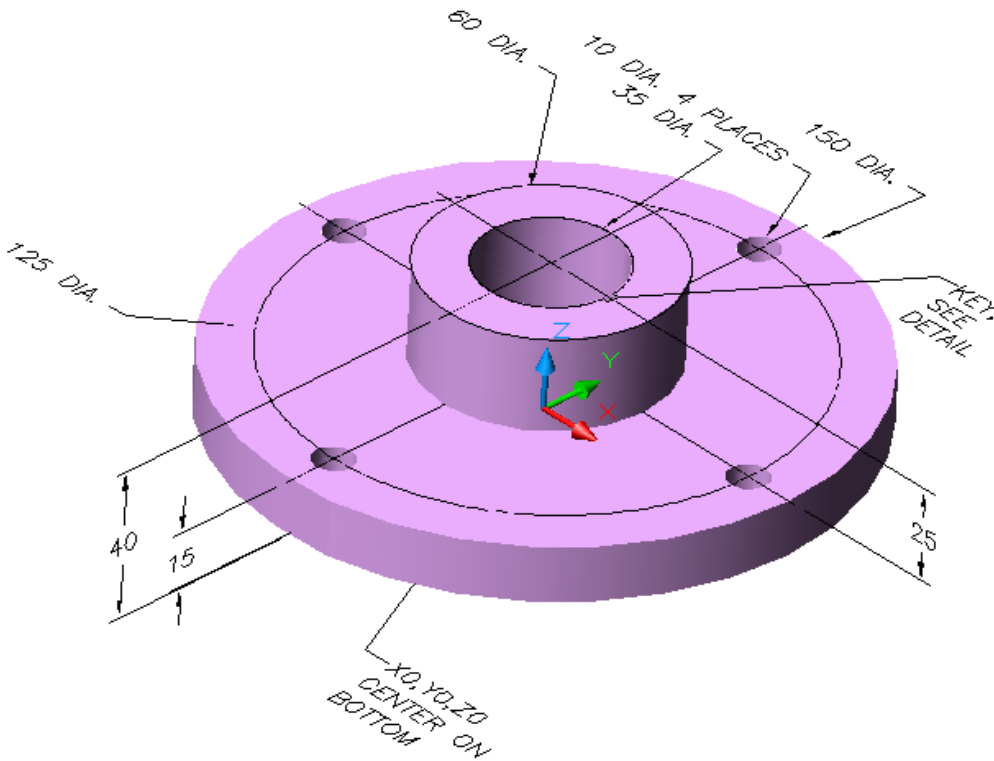
- Step 1** Save and name the drawing AutoCAD 3D Lab 03-2 as shown above.
- Step 2** Draw all construction objects on layer Construction.
- Step 3** Draw all model objects on layer Model.
- Step 4** Start your model with the view in SE Isometric. If required, rotate it slightly with 3DORBIT to help the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



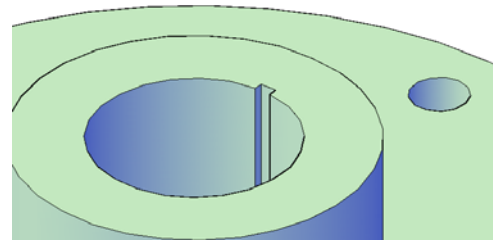
Completed Wireframe Model



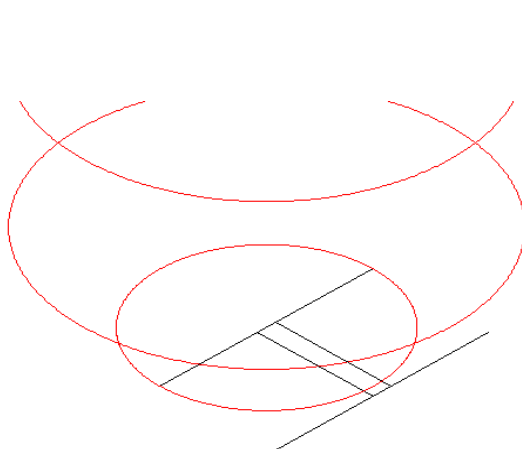
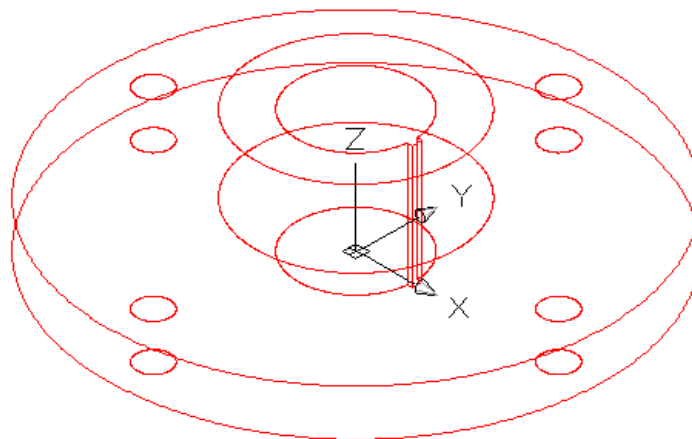
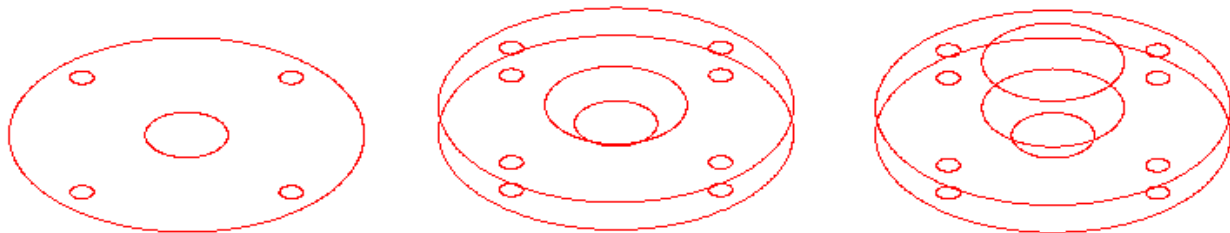
Key Detail



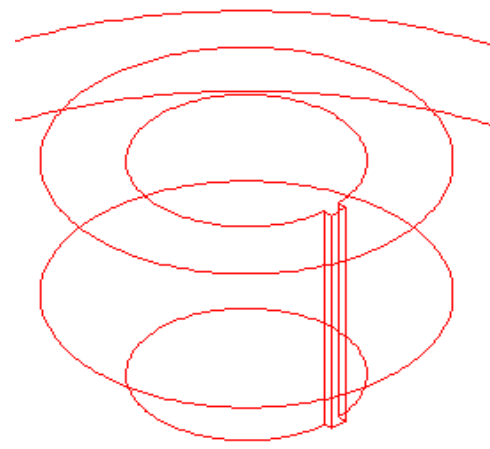
Construction Techniques: The following steps are the construction technique suggested by the author to help you learn how to construct objects using AutoCAD. It is only the suggested method and if you can complete the drawing accurately using a different construct technique, that is what is important.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



View of Keyway - Rotated



Construction lines to Draw the Key



The Finished Key