

AutoCAD 3D

Module 13

Surface Modeling - Part 2

Learning Outcomes

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

1. Describe a geometry defined mesh including a ruled surface, a revolved surface and a tabulated surface.
2. Describe and apply the commands RULESURF, REVSURF, and TABSURF to apply mesh surfaces to 3D models.

Geometry Defined Surface Meshes

Geometrically defined surface meshes use existing geometry that must be created before the surfaces. In almost all cases, you will use the wireframe of the model as the existing geometry. There are four geometrically defined surface meshes that can be created in AutoCAD. They are the ruled surface, revolved surface, tabulated surface and edge surface. The commands to create these meshes are RULESURF, REVSURF, TABSURF and EDGESURF. The EDGESURF command will be taught in Module 15.

To create a geometry defined surface mesh, start with the wireframe geometry and ensure it is on its own layer. Surface the wireframe model on all sides, making sure that all exposed sides have a surface covering them. Think of your model as an object you want to make water tight. Even the inside of a hole going through the model must have a surface on it. Place the surface meshes on their own layer. When you have surfaced the complete model, freeze the layer contain the wireframe or the geometry leaving only the layer with the surface mesh displayed.

Ruled Surface

A *ruled surface*, inserted with the RULESURF command, is the most commonly used method to surface a model. To place a ruled surface, simply select two lines, a line and an arc, two arcs or two circles to place the surface between. See Figure 13-1.

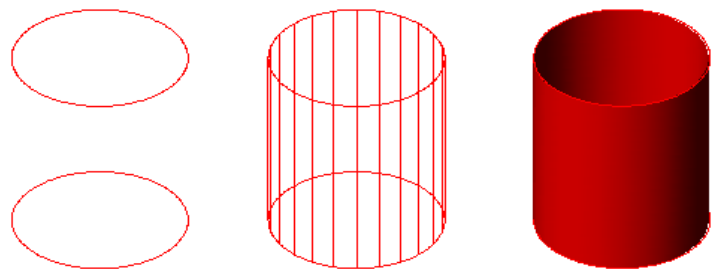


Figure 13-1
Ruled Surface
Surfaced

Revolved Surface

A *revolved surface*, inserted with the REVSURF command, is a surface created by revolving a path curve around an axis. The path curve can be a line, arc, circle or an open or closed 2D polyline or 3D polyline. See Figure 13-2. The axis must be a line or an open 2D or 3D polyline. If a polyline is used as the axis, the REVSURF command will simply use a straight line between the start point and end point of the polyline.

Wireframe

Shaded

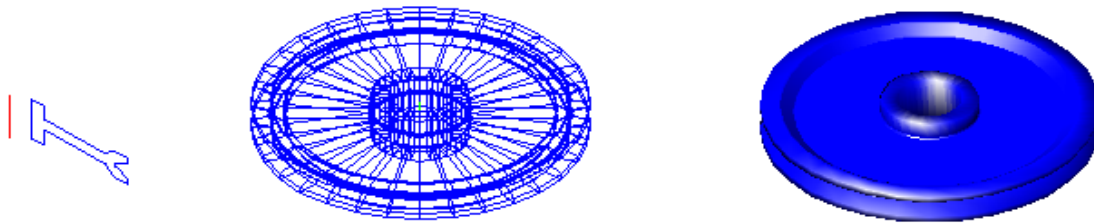


Figure 13-2
Revolved Surface

Path Curve and Axis

Surfaced

Shaded

Tabulated Surface

A *tabulated surface*, inserted with the TABSURF command, is a surface created by projecting a path curve along a direction vector. The path curve defines the surface of the mesh as it follows the vector. See Figure 13-3. The path curve can be a line, arc, circle, ellipse, or an open or closed 2D or 3D polyline. The direction vector can be a line or a polyline. If a polyline is used as the axis, the TABSURF command will simply use a straight line between the start point and end point of the polyline. The surface is drawn starting at the point on the path curve closest to the point selected by the user.

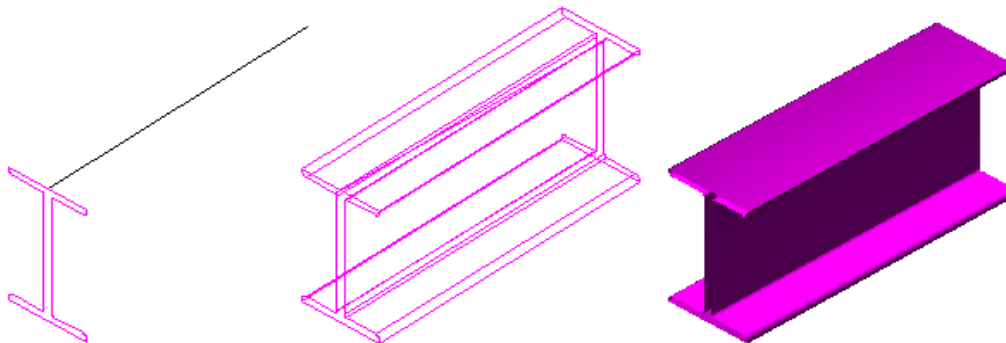


Figure 13-3
Tabulated Surface

Path Curve and Direction Vector

Surfaced

Shaded

Setting the Mesh Density

The *mesh density* represented by the lines, circles or arcs that make the rows and columns of the surface mesh are controlled with the system variables SURFTAB1 and SURFTAB2. On flat surfaces, the density of the mesh is not that important but with curved or irregular shaped surfaces, the density is very important since the higher the setting, the more segments are used when creating circles and arcs. If the mesh is not dense enough, small gaps will be left where a curved surface meets a flat surface. See Figure 13-4.

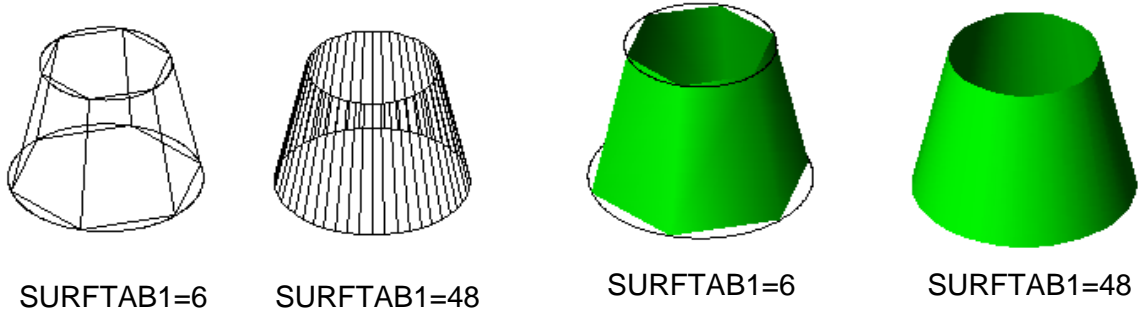


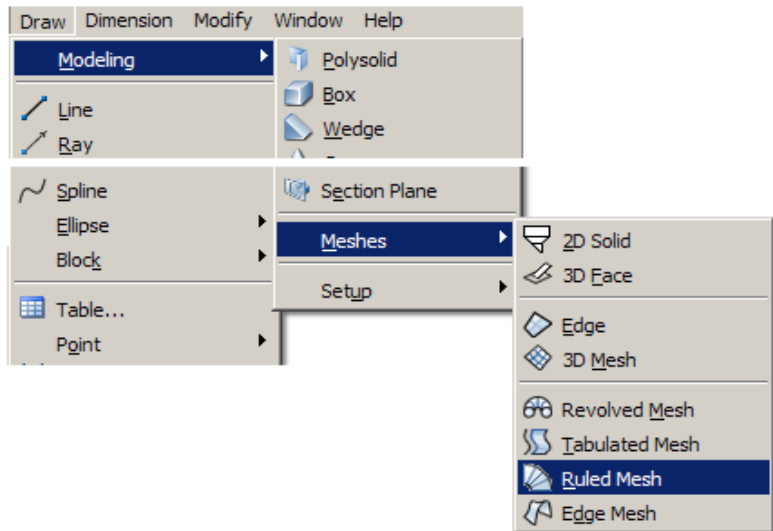
Figure 13-4
SURFTAB Settings

AutoCAD Command: **RULESURF**

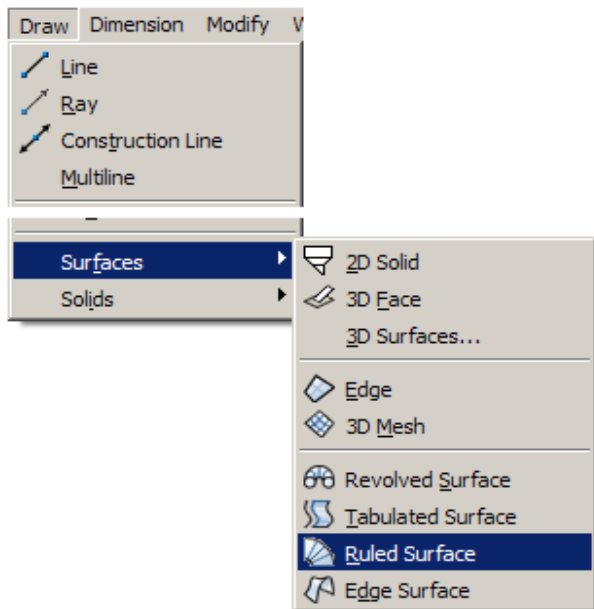
The RULESURF command is used to create a rule surface between two existing edges.

Shortcut: none

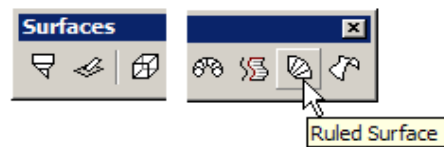
SURFTAB1 = YES
SURFTAB2 = No Effect



2007-2010



2000-2006



2000-2002



2004-2006

WORK ALONG

Using the RULESURF Command

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

Step 2 Save and name the drawing AutoCAD 3D Workalong 13-1.

Step 3 Create layers Construction, Model, Surface, and Surface Off as shown in Figure Step 3.

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
☰	Surface	☀	☀	🔒	151	Continuous
☰	Surface Off	☀	☀	🔒	71	Continuous

Figure Step 3

Step 4 Draw a wireframe model of the multiview drawing shown below. Draw it on layer Model. See Figure Step 4.

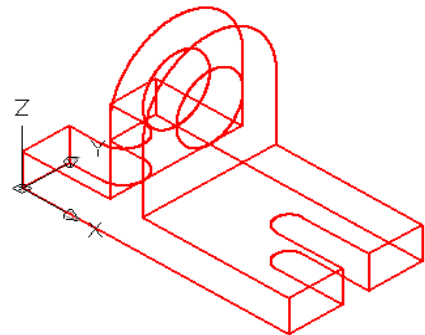
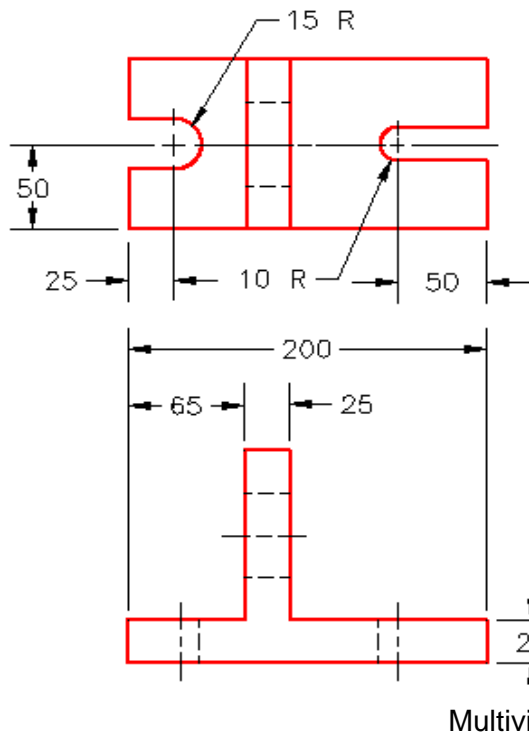


Figure Step 4

Step 5 Set the system variable SURFTAB1 to 24 as shown below:

Command: **SURFTAB1**
 Enter new value for SURFTAB1 <8>: **24**
 Command:

Step 6 On layer Construction, draw a line along the top edge of each side of the model as shown in Figure Step 6.

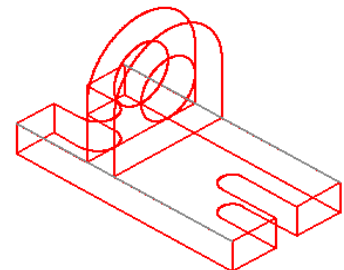


Figure Step 6

Author's Comments: Sometimes construction lines must be drawn on the wireframe to make it easier to insert surfaces.

Step 7 Set layer Surface as the current layer and enter the REVSURF command shown below. See Figure Step 7A and 7B.

Command: **RULESURF**
 Current wire frame density: SURFTAB1=24
 Select first defining curve: **P1**
 Select second defining curve: **P2**
 Command:

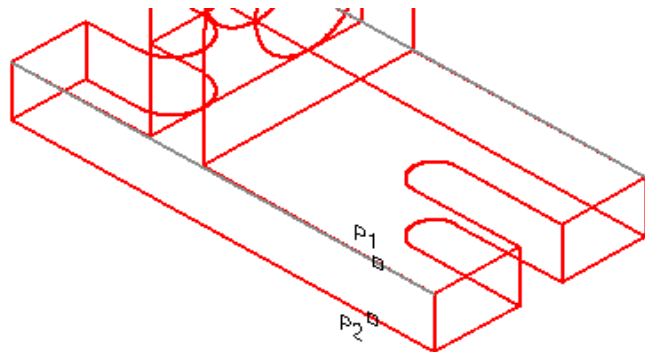


Figure Step 7A

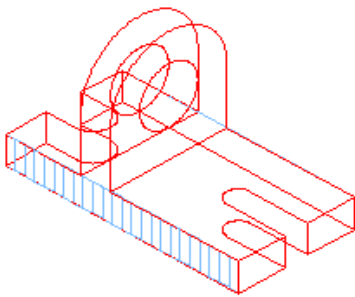


Figure Step 7B

Step 8 Repeat the RULESURF command and insert surfaces all around the edge of the model as shown in Figure Step 8.

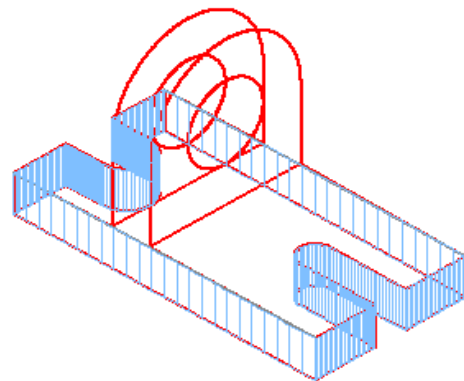
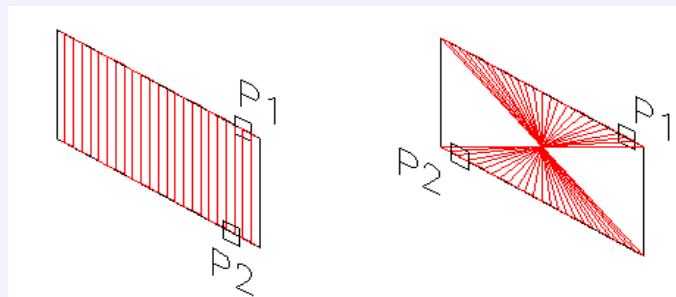


Figure Step 8

MUST KNOW

When using the RULESURF command, ensure that you select the objects closest to matching ends. If opposite ends are selected, the mesh will twist as shown in the figure on the right.



Step 9 Turn layer Surface Off off and lock layer Model and Construction as shown in Figure Step 9. Select all of the surfaces you just inserted and change their layer to Surface Off.

Stat	Name	On	Freeze	Lock	Color	Linetype
0	Construction				white	Continuous
	Defpoints				253	Continuous
	Key				white	Continuous
	Layout Titleblock				magenta	Continuous
	Model				white	Continuous
	Surface				red	Continuous
	Surface Off				151	Continuous
					71	Continuous

Figure Step 9

Author's Comments: Here a little trick is used to help in surfacing the model. Temporarily change the layers of newly created surfaces to a layer that is turned off. That way, the surfaces do not display and get in the way while you are inserting additional surfaces on the model. When all of the surfaces are inserted to complete the model, turn layer Surface Off on again and change the layer of all surfaces back to layer Surface. The reason layer Model and Construction are locked is to make it easier to select the surfaces using windows when changing their layer property.

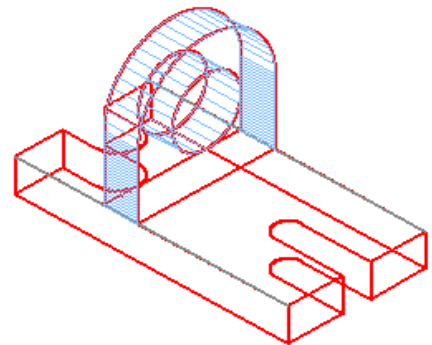


Figure Step 10

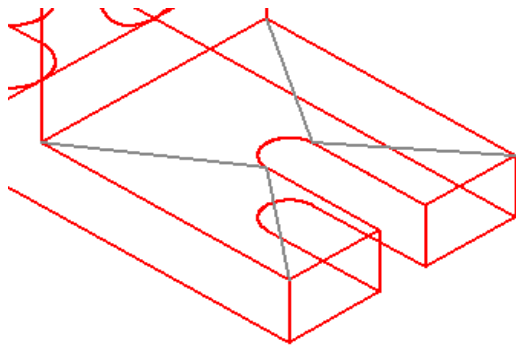


Figure Step 12

Step 10 Using what you just learned, insert ruled surfaces around the top of the object as shown in Figure Step 10. Surface the inside of the hole also.

Step 11 Change the layer of the surfaces you inserted in Step 10 to layer Surface Off

Step 12 On layer Construction, draw the construction lines on the top surface as shown in Figure Step 12. Ensure you snap to the endpoints of the lines and arcs.

Step 13 On layer Surface, use the RULESURF command to insert the surfaces as shown in Figure Step 13. Change the surfaces the layer Surface off.

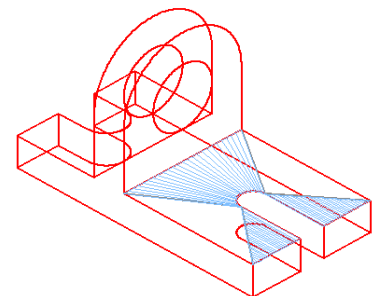


Figure Step 13

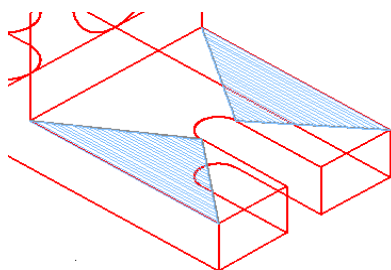


Figure Step 14

Step 14 On layer Surface, use the RULESURF command to draw surfaces as shown in Figure Step 14. Change the layer of the surfaces to layer Surface off.

Step 15 On layer Construction, draw an arc on the top half of the circle as shown in Figure Step 15. Ensure you snap to the quads of the circle. To do that, you will have to locate the UCS on the same plane as the circle.

Step 16 On layer Surface, insert a ruled surface between the arcs as shown in Figure Step 16.

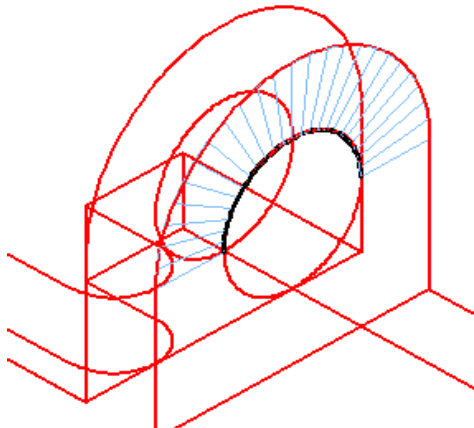


Figure Step 16

Step 18 Draw two construction lines and a construction arc on the bottom half of the circle as shown in Figure Step 18.

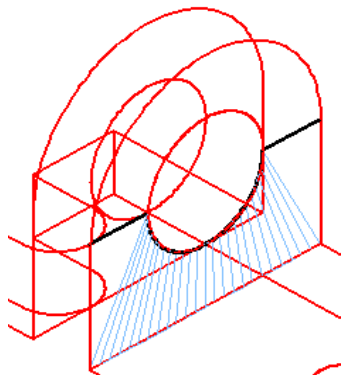


Figure Step 19

Step 19 On layer Surface, insert a ruled surface as shown in Figure Step 19.

Step 20 On layer Surface, insert the rule surfaces as shown in Figure Step 20.

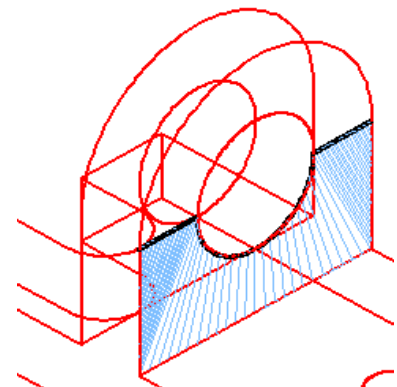


Figure Step 20

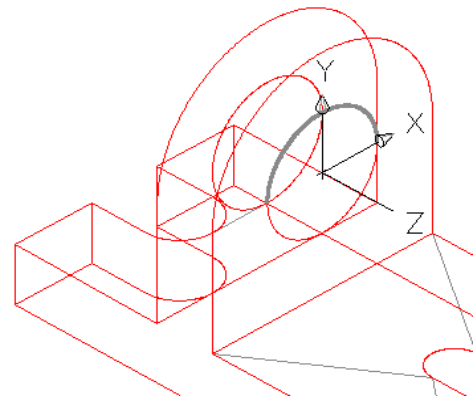


Figure Step 15

Author's Comments: Ensure you select the arc instead of the circle under it. Sometime this can be tricky.

Step 17 Change the layer of the surface you just drew to layer Surface Off.

Step 21 Change the layer of the existing surfaces to layer Surface until your model matches Figure Step 21.

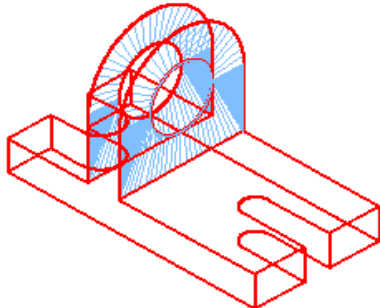


Figure Step 22

Author's Comments: To help you surface a model faster, you can copy surfaces from one side of a model to another if they are identical.

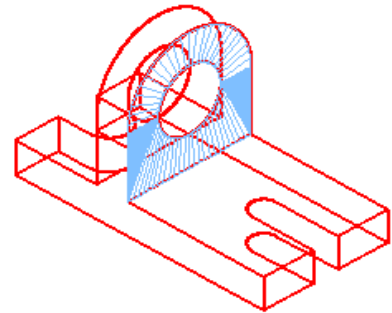


Figure Step 21

Step 22 Copy the surfaces from the front side of the model to back side as shown in Figure Step 22.

Step 23 Using what you just learned, complete surfacing the model as shown in Figure Step 23. Ensure you surface the bottom of the model.

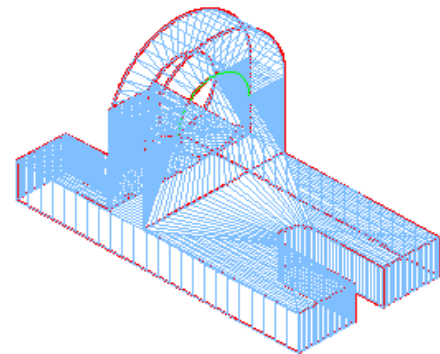


Figure Step 23

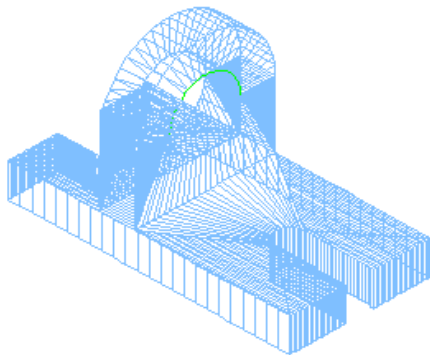


Figure Step 24

Step 24 Turn off all the layers except layer Surface and your model should appear as shown in Figure Step 24.

Step 25 Shade the model and it should appear as shown in Figure Step 25.

Step 26 Save and close the drawing.

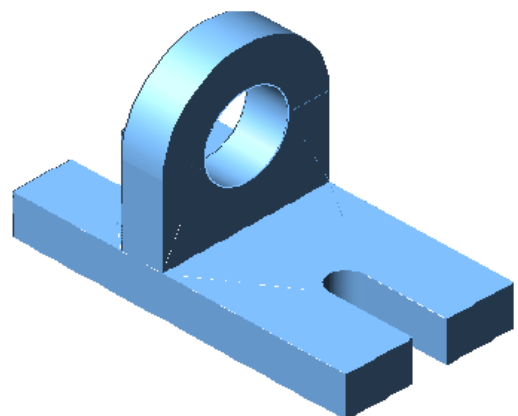


Figure Step 25

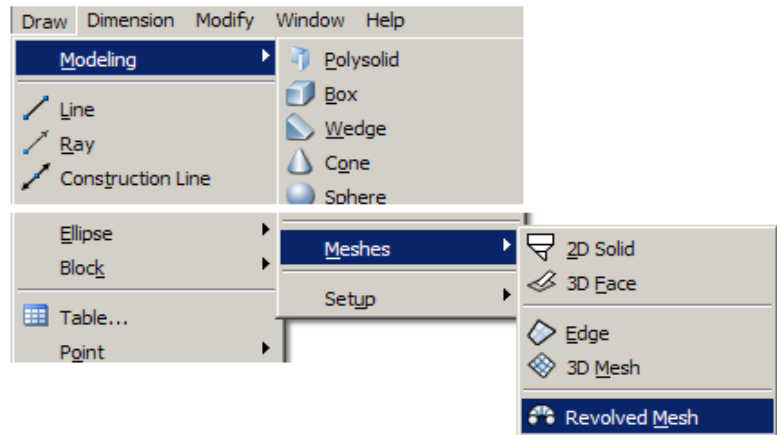
AutoCAD Command: **REVSURF**

The REVSURF command is used to create a surface of revolution by revolving an existing path curve around an axis.

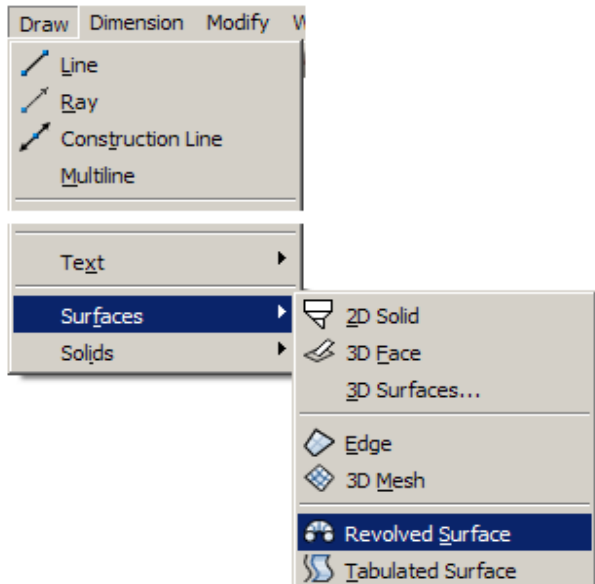
Shortcut: none

SURFTAB1 = YES

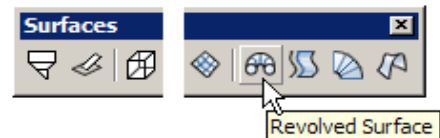
SURFTAB2 = YES



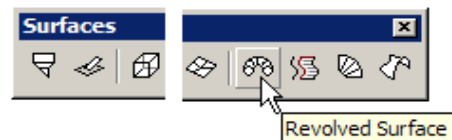
2007-2010



2000-2006



2004-2006



2000-2002

WORK ALONG

Using the REVSURF Command

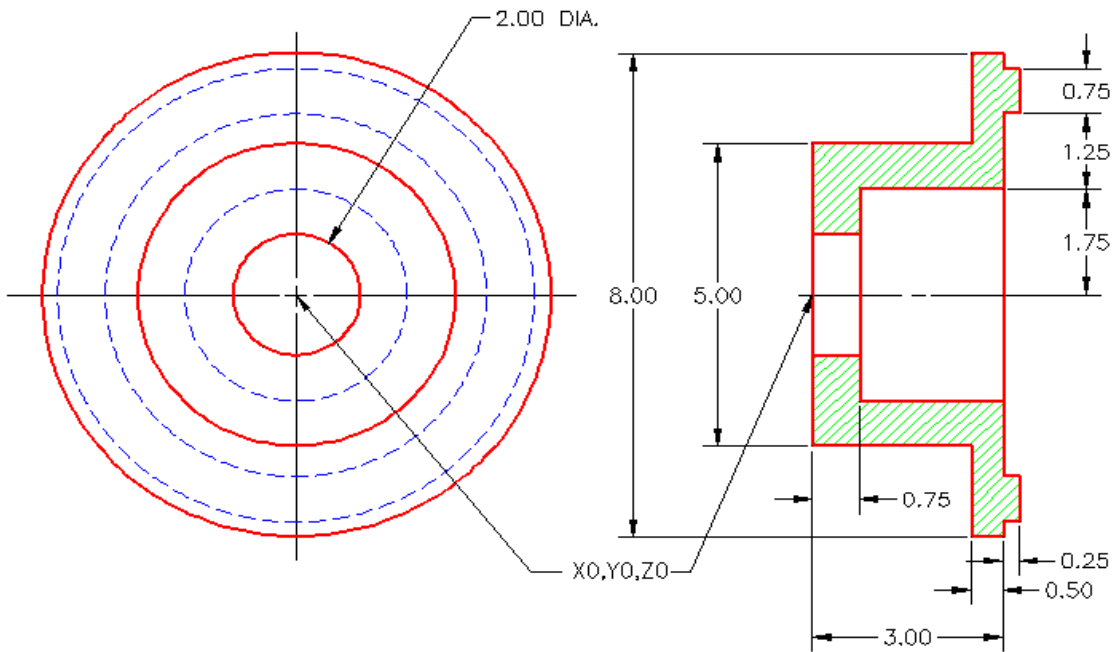
Step 1 Using the NEW command, start a new drawing using template Module Template 3D English.

Step 2 Save and name the drawing AutoCAD 3D Workalong 13-2.

Step 3 Create layers Construction, Model, Surface, and Surface Off as shown in Figure Step 3.

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
☐	Surface	☑	☑	☑	151	Continuous
☐	Surface Off	☑	☑	☑	71	Continuous

Figure Step 3



Multiview Drawing

Step 4 Change the view to SE Isometric and the UCS to Right as shown in Figure Step 4.

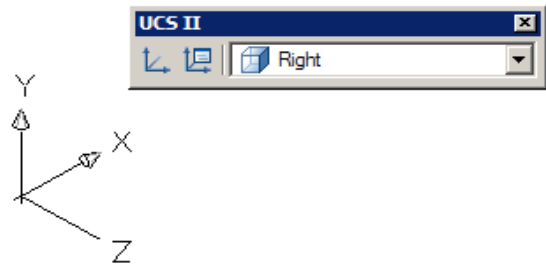


Figure Step 4

Step 5 Using the dimensions in the multiview drawing, draw the right side cross section of the solid part of the object as shown in Figure Step 5.

Author's Comments: You will be revolving this cross section to create a surface as it revolves. Therefore, only one-half of the section view must be drawn.

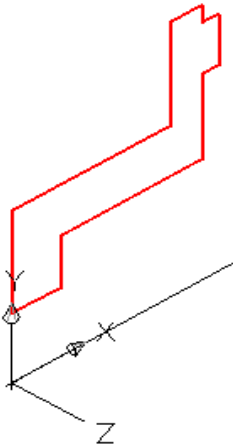


Figure Step 6

Step 6 On layer Construction, starting at 0,0,0, draw a line of any length along the X axis. If you use ortho mode, you can draw it quickly. This will be the axis for the revolution. See Figure Step 6.

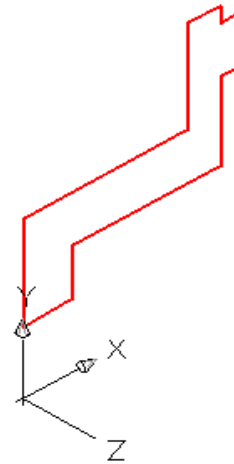


Figure Step 5

Author's Comments: To convert the model objects to a closed polyline using the PEDIT command, the drawing must be perfectly drawn with the endpoints joining exactly. There cannot be any overlapping or gaps. If you have problems using the PEDIT command to create closed polygons, see Module 27 in the AutoCAD 2D Modules.

Step 7 Using the PEDIT command shown below, convert the lines of the model to a closed polyline.

```
Command: PE
Select polyline or [Multiple]:
  (Select one line of the model.)
Object selected is not a polyline
Do you want to turn it into one? <Y>
  (Press Enter to accept the default.)
Enter an option [Close/Join/Width/Edit vertex/Fit/Spline/Decurve/Ltype gen/Undo]: J
  (J for Join.)
Select objects: ALL
13 found
Select objects:
11 segments added to polyline
Enter an option [Open/Join/Width/Edit vertex/Fit/Spline/Decurve/Ltype gen/Undo]:
Command:
```

Step 8 To ensure that you have successfully created a closed polyline, open the Properties window and select the polyline as shown in Figure Step 8. The object type should read Polyline, all the objects should show as part of the polyline and the Closed property should be set to Yes.

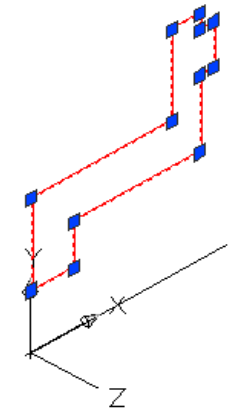
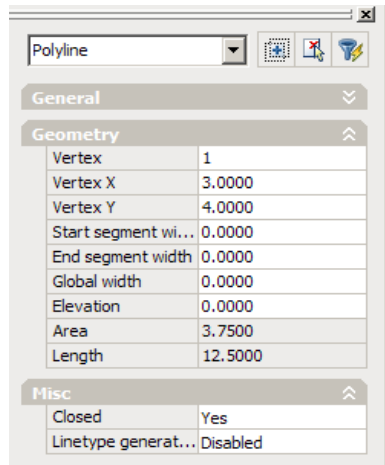


Figure Step 8

Step 9 Set the system variable SURFTAB1 to 64 and SURFTAB2 to 24 as shown below.

Command: **SURFTAB1**

Enter new value for SURFTAB1 <6>: **64**

Command: **SURFTAB2**

Enter new value for SURFTAB2 <6>: **24**

Command:

Step 10 Change the current layer to Surface and enter the REVSURF command as shown below. After you complete the command, your model should appear as shown in Figure Step 10.

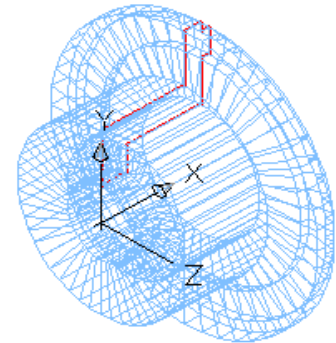


Figure Step 10

Command: **REVSURF**

Current wire frame density: SURFTAB1=64 SURFTAB2=24

Select object to revolve

(Select the closed polyline.)

Select object that defines the axis of revolution:

(Select the axis line.)

Specify start angle <0>:

(Accept the default of 0.)

Specify included angle (+=ccw, -=cw) <360>:

(Accept the default of 360.)

Command:

Step 11 Turn layers Construction and Model off and shade your model.

Step 12 Using the 3DORBIT command, rotate the model and look at all sides. See Figure 12A and 12B.

Step 13 Save and close the drawing.

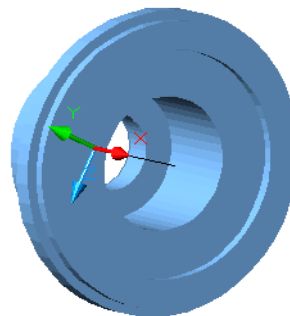


Figure Step 12A

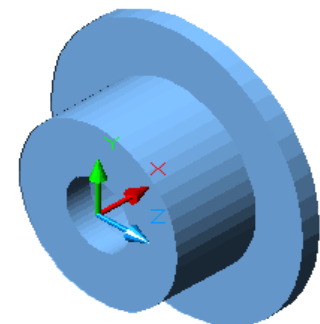


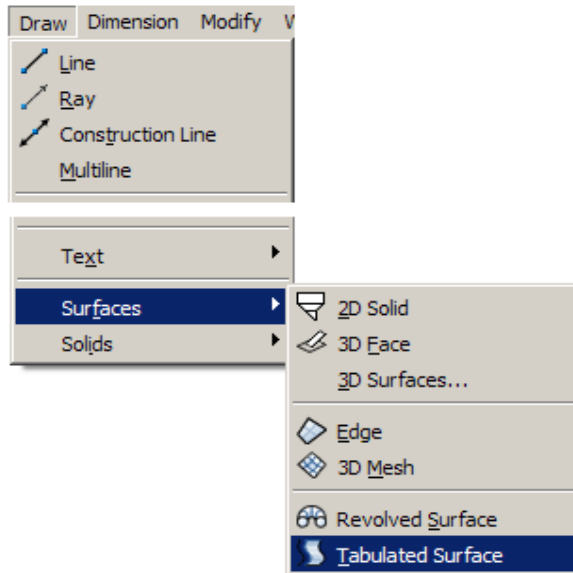
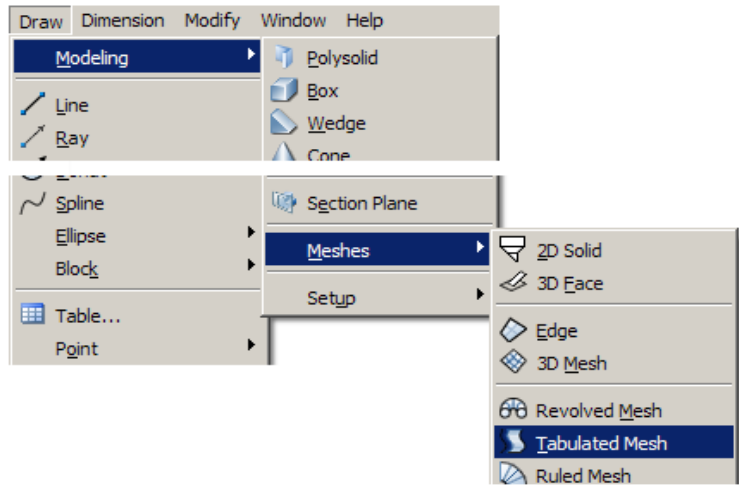
Figure Step 12B

AutoCAD Command: **TABSURF**

The TABSURF command is used to create a surface mesh using a path curve along a direction vector.

Shortcut: none

SURFTAB1 = YES
SURFTAB2 = No Effect



2007-2010



2004-2006



2000-2002

2000-2006

**WORK
ALONG**

Using the TABSURF Command

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

Step 2 Save and name the drawing AutoCAD 3D Workalong 13-3.

Step 3 Create layers Construction, Model, Surface, and Surface Off as shown in Figure Step 3.

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
☐	Surface	☑	☑	☑	151	Continuous
☐	Surface Off	☑	☑	☑	71	Continuous

Figure Step 3

Step 4 Change the view to SE Isometric and the UCS to World as shown in Figure Step 4.

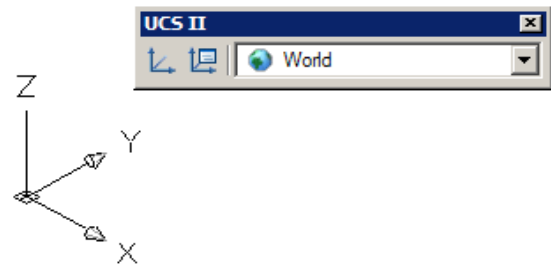


Figure Step 4

Step 5 Set layer Construction as the current layer and draw the model shown in Figure Step 5A. These are the construction lines and arcs to be used to construct the model. When complete, your model will appear as shown in Figure Step 5B. The length of the lines that appear dashed in Figure Step 5A is not important since they are axis lines only. You can draw them as continuous linetype.

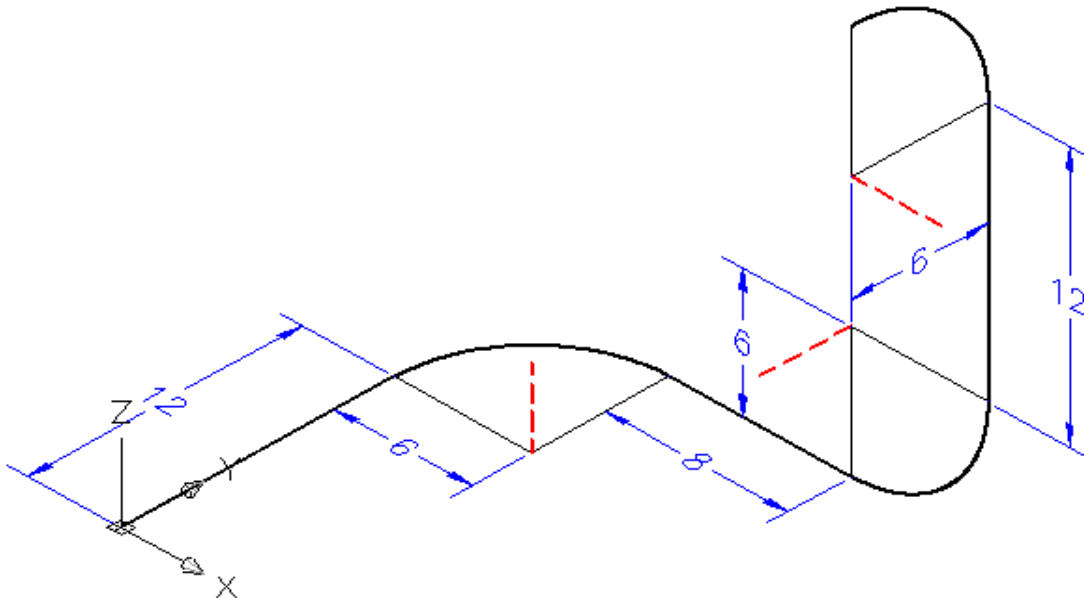


Figure Step 5A

Author's Comments

You will have to change the current UCS as you draw the construction lines to ensure you are drawing on the correct view.

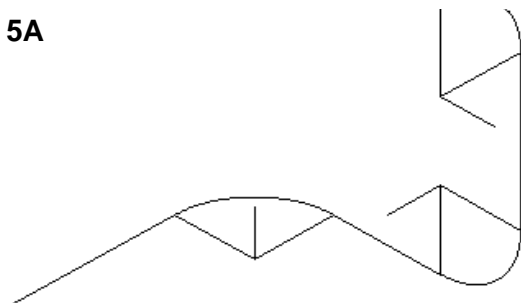


Figure Step 5B

Step 6 With the UCS set to Front, draw a model of the object shown in the multiview drawing Figure Step 6A. Your drawing should appear as shown in Figure Step 6B. Draw the model anywhere in model space. Its location is not important.

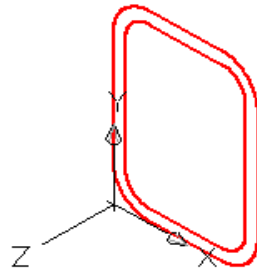


Figure Step 6B

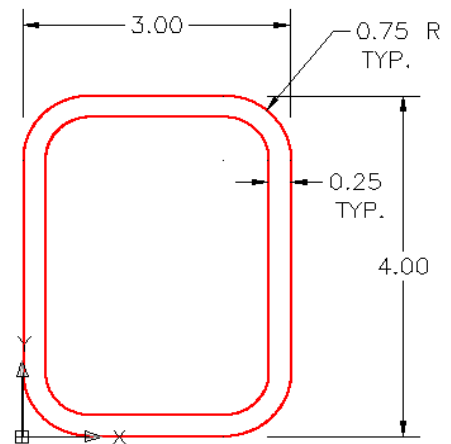


Figure Step 6A
Multiview Drawing - Front View

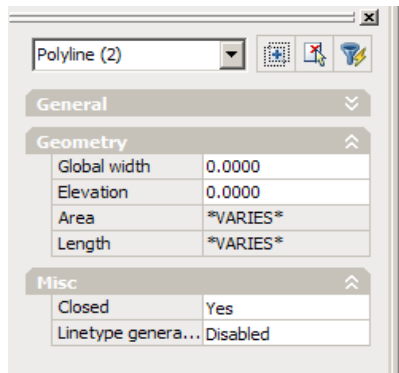
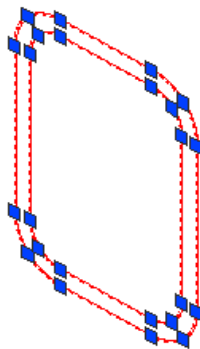


Figure Step 7



Step 7 Change the lines and arcs into two closed polylines using the PEDIT command. Check them using the Properties window as shown in Figure Step 7.

Step 8 On layer Construction, draw in two construction lines from midpoint of the lines to find the exact center of the object. See Figure Step 8

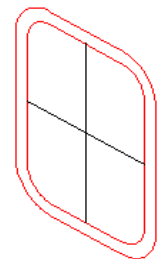


Figure Step 8

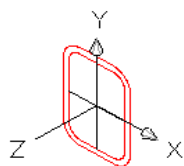
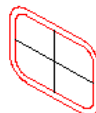


Figure Step 9A



Step 9 Make three additional copies of the model and rotate them to lay on different UCS views. See Figure Step 9A. Their location is not important. When complete, your drawing will appear similar to Figure Step 9B.

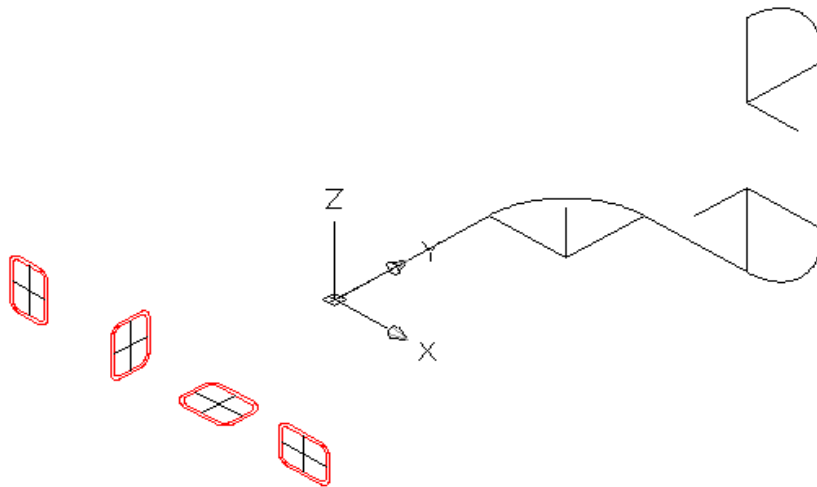


Figure Step 9B

Step 10 Copy the objects onto the construction lines. Ensure the midpoint of the object (the intersections of the lines) aligns to the endpoints of the lines and arcs as shown in Figure Step 10.

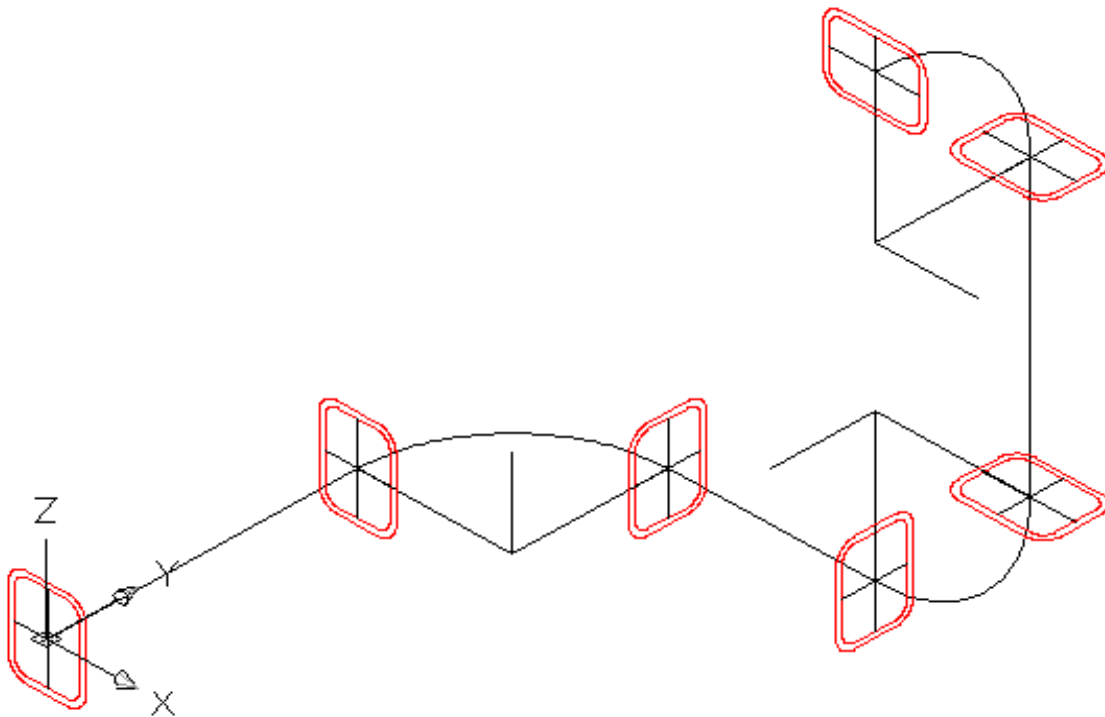


Figure Step 10

Step 11 With the UCS in Front, SURFTAB1 set to 48 and layer Surface as the current layer, enter the TABSURF command shown below to create the surface for the inside of the tube. See Figure Step 11.

Command: **TABSURF**

Current wire frame density: SURFTAB1=48

Select object for path curve:

(Select the inside polyline.)

Select object for direction vector:

(Select the construction axis line. Ensure you select it closer to the end where the object your are tabulating is located.)

Command:

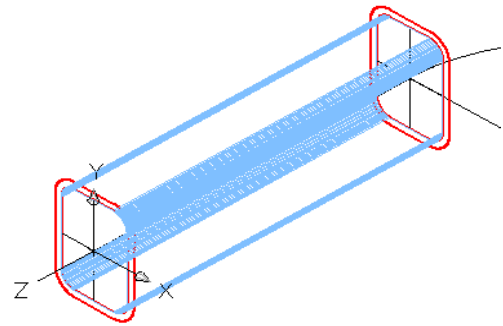


Figure Step 11

Step 12 Shaded, your model should appear as shown in Figure Step 12.

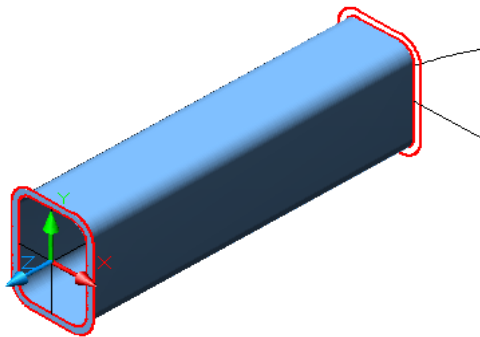


Figure Step 12

Step 13 Using the TABSURF command, create the surface for the outside of the tube as shown in Figure Step 13.

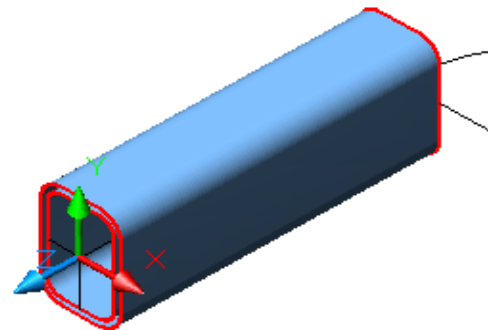


Figure Step 13

Step 14 Enter the REVSURF command shown below to construct the inside of the tube around the first corner. You will have to first change the layer of the straight tube surfaces you constructed in Steps 11 to 13 to Surface Off. See Figure Step 14.

Command: **REVSURF**

Current wire frame density: SURFTAB1=48 SURFTAB2=6

Select object to revolve:

(Select the inside polyline.)

Select object that defines the axis of revolution

(Select the axis line.)

Specify start angle <0>:

(Accept the default.)

Specify included angle (+ = ccw, - = cw) <360>: **-90**

Command:

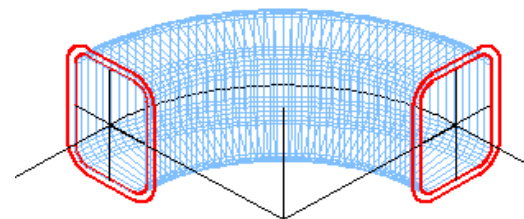


Figure Step 14

Step 15 Using what you just learned, construct the outside of the tube and change the layers of the surfaces until your model appear as shown in Figure Step 15.

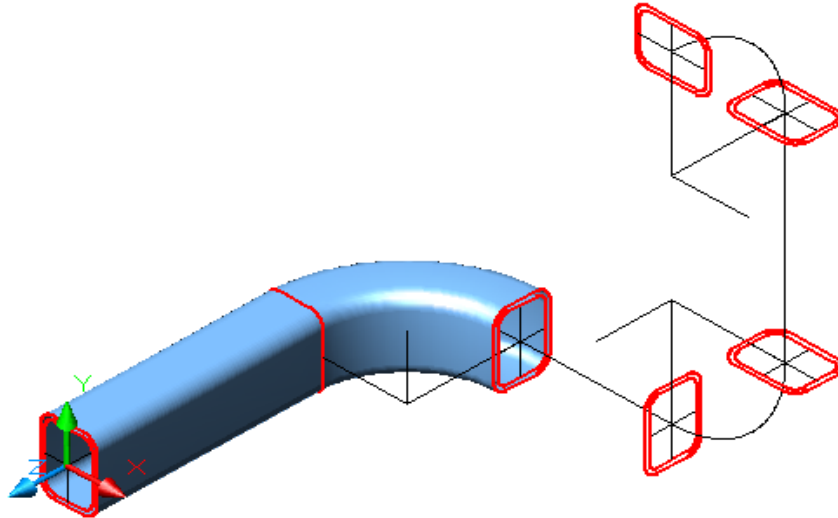


Figure Step 15

Step 16 Using what you just learned, complete the model as shown in Figure Step 16.

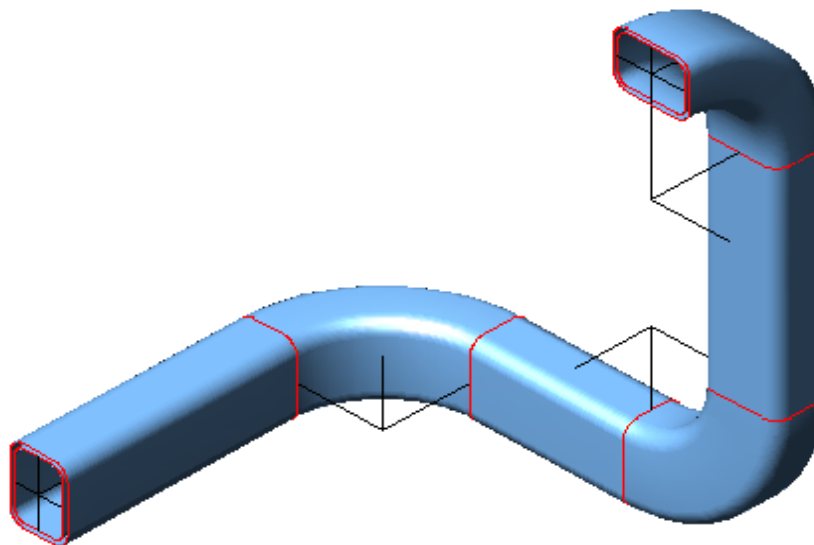
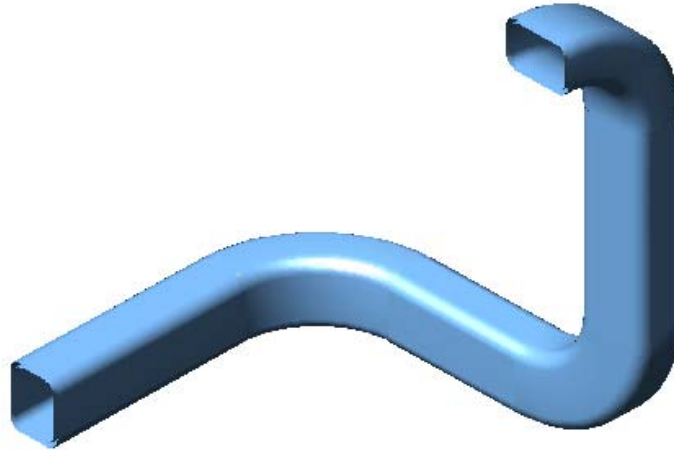


Figure Step 16

Step 17 Turn off layer Model and Construction and your completed model will appear as shown in Figure Step 17.



Step 18 Save and close the drawing.

**USER
TIP**

Although any possible surfacing command can be used to create the surfaces, the RULESURF command is the easiest and fastest to use for most surfaces. To shorten your modeling time, use it whenever you can.

The Key Principles in Module 13

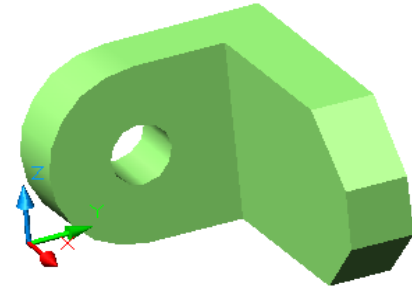
1. Geometrically defined surface meshes use existing geometry that must be created before the surfaces. In almost all cases, you will use the wireframe of the model as the existing geometry.
2. Although any surfacing command can be used to create a surface, the RULESURF command is the easiest and fastest to use for most surfaces.
3. When using the RULESURF command, ensure that you select the objects closest to matching ends. If opposite ends are selected, the mesh will twist.
4. The mesh density represented by the lines, circles or arcs that make the rows and columns of the surface mesh are controlled with the system variables SURFTAB1 and SURFTAB2.

Lab Exercise 13-1**Time Allowed: 45 Min.**

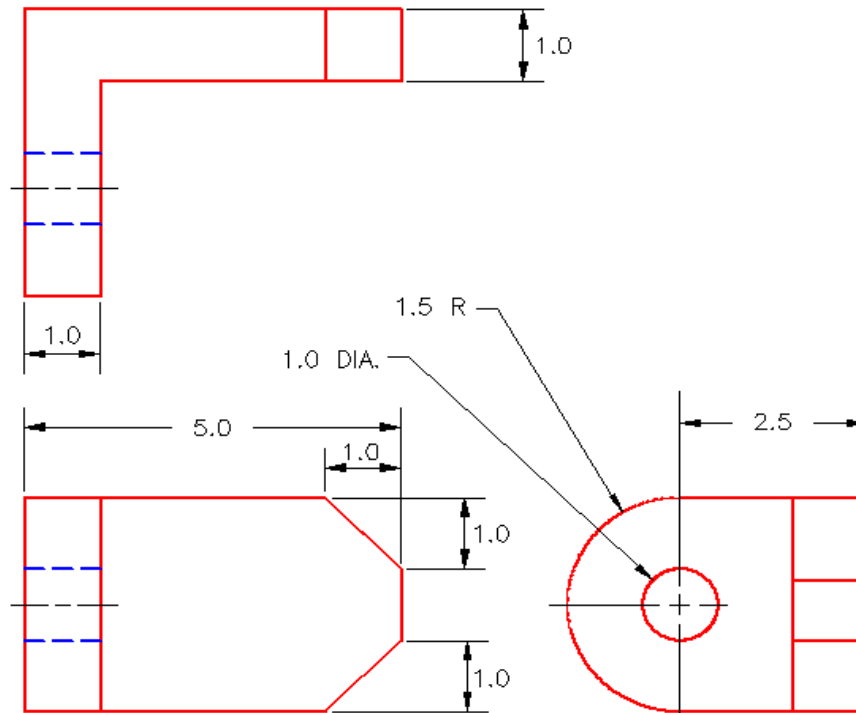
Name	Template	Units
AutoCAD 3D Lab 13-1	3D Layout English	Inches

Instructions:

- Step 1** Draw a wireframe of the object shown below.
Step 2 On layer Surface, create surface meshes on all surfaces including back and bottom.
Step 3 Pick appropriate mesh densities.
Step 4 Freeze layer Construction and Model.
Step 5 Shade the model when complete.
Step 6 Using 3DORBIT, check the model.



Completed Model



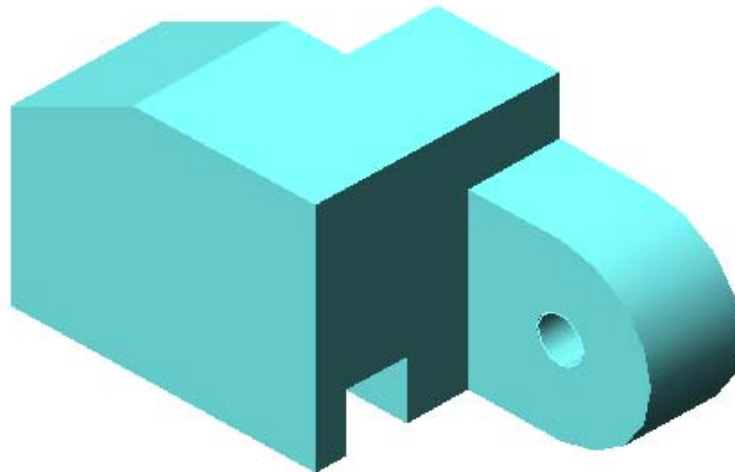
Multiview Drawing

Lab Exercise 13-2**Time Allowed: 45 Min.**

Name	Template	Units
AutoCAD 3D Lab 13-2	N/A	Inches

Instructions:

- Step 1** Open the drawing AutoCAD 3D Lab 04-1.
- Step 2** Save the drawing with the name AutoCAD 3D Lab 13-2.
- Step 3** On layer Surface, create surface meshes on all surfaces including back and bottom.
- Step 4** Freeze layer Construction and Model.
- Step 5** Shade the model when complete.
- Step 6** Using 3DORBIT, check the model for completeness.



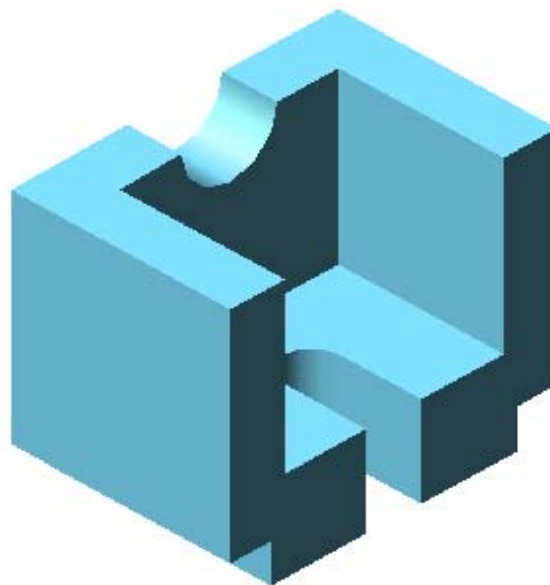
Completed Model

Lab Exercise 13-3**Time Allowed: 45 Min.**

Name	Template	Units
AutoCAD 3D Lab 13-3	3D Layout English	Inches

Instructions:

- Step 1** Open the drawing AutoCAD 3D Lab 08-1.
- Step 2** Save the drawing with the name AutoCAD 3D Lab 13-3.
- Step 3** On layer Surface, create surfaces on each side including back and bottom.
- Step 4** Freeze layer Construction and Model.
- Step 5** Shade the model when complete.
- Step 6** Using 3DORBIT, check the model for completeness.

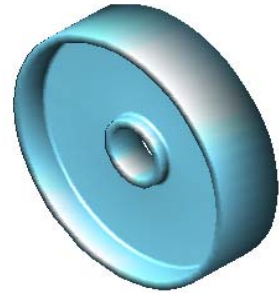


Completed Model

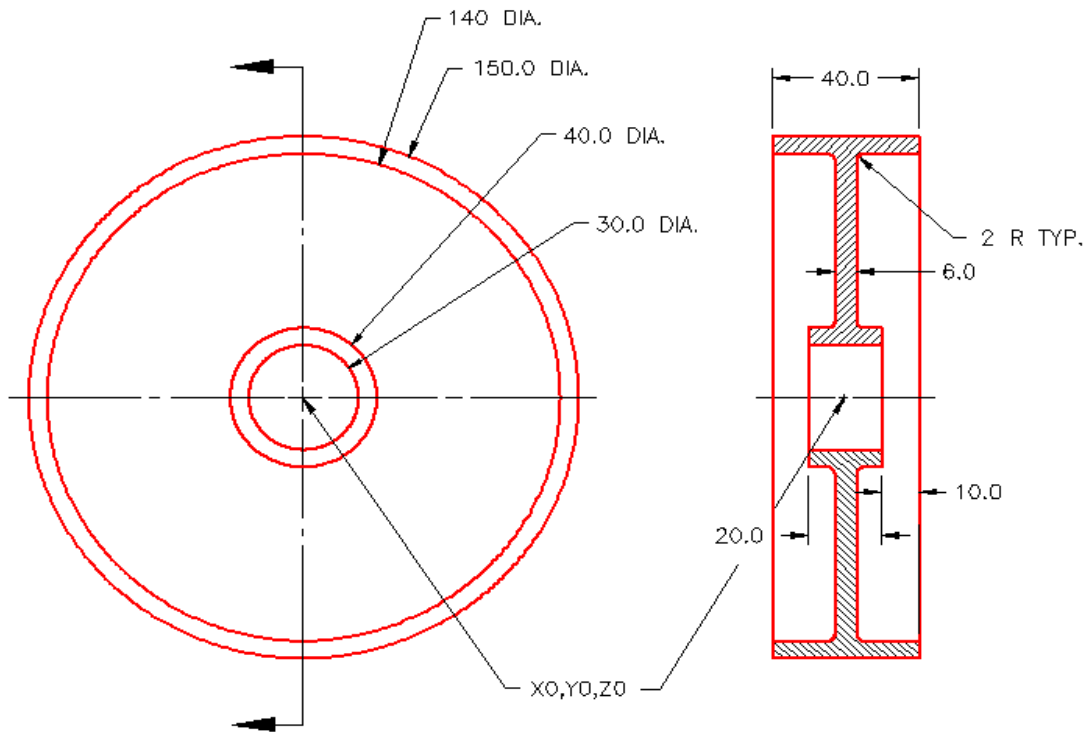
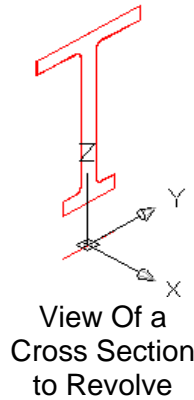
Lab Exercise 13-4		Time Allowed: 45 Min.
Name	Template	Units
AutoCAD 3D Lab 13-4	3D Layout Metric	Millimeters

Instructions:

- Step 1** On layer Surface create the surface model shown below.
- Step 2** Freeze layer Construction and Model.
- Step 3** Shade the model when complete.
- Step 4** Using 3DORBIT, check the model for completeness.



Complete Model



Multiview Drawing