Bonus Chapter 1: Working with Surfaces

In This Chapter

- **Creating primitive surface objects**
- **Creating complex surface objects from 2D objects**
- **Modifying surfaces**

In Book V, Chapter 5, I covered creating and modifying 3D solids. This chapter takes a similar look at creating and modifying surfaces, faces, and meshes. Many commands allow you to create primitives out of surfaces rather than a 3D solid. You can also create complex 3D surfaces by starting with 2D objects and performing extruding and revolving operations to create a new surface model. Surfaces, faces, and meshes take a little more planning to create and modify than 3D solids do, but they do have advantages, depending on what you are trying to model.

Creating Primitive Surfaces

AutoCAD offers a variety of commands that allow you to create primitives as surfaces, which are similar to the commands that allow you to create primitives as 3D solids. Just like the primitive 3D solids, surfaces help to form the foundation of 3D modeling in AutoCAD. Surfaces are not as easy to modify as 3D solids, but you can deform and change their shape much easier than you can a 3D solid. Most of the primitives that can be created as 3D solids can be created with surfaces through the use of the 3D command or a command designed to create a specific type of primitive object. You can also create faces and free-form meshes when creating a surface model. Table BC1-1 lists the commands that are used to create surfaces, faces, and meshes for surface models.

Table BC1-1 AutoCAD's Surface Modeling Commands

Icon	*Ribbon*	*Toolbar*	*Menu*	*Command Name (Alias)*	*Function*
	Home tab➪ 3D Modeling panel's title bar➪3D Face		Draw➪ Modeling➪ Meshes➪ 3D Face	3DFACE (3F)	Creates a three- or four-sided 3D face object

(continued)

Table BC1-1 *(continued)*

Icon	*Ribbon*	*Toolbar*	*Menu*	*Command Name (Alias)*	*Function*
	Home tab➪ 3D Modeling panel's title bar➪3D Mesh		Draw➪ Modeling➪ Meshes➪ 3D Mesh	3DMESH	Creates a multi-segmented 3D mesh object
	Home tab➪ 3D Modeling panel➪Planar Surface	Modeling, Planar Surface	Draw➪ Modeling ➪Planar Surface	PLANESURF	Creates a rectangular planar surface
				AI_BOX	Creates a cube or 3D rectangle surface primitive
				AI_WEDGE	Creates a cube or 3D rectangle surface primitive that has a height of 0 along one side
				AI_CONE	Creates a 3D surface primitive that has a circular base and a height with a top radius that is equal to 0 or greater
				AI_SPHERE	Creates a 3D surface primitive that has the same circumference in all directions
				AI_DISH	Creates a 3D surface primitive that is the lower half of a sphere
				AI_DOME	Creates a 3D surface primitive that is the upper half of a sphere
				AI_TORUS	Creates a circular 3D tubular surface primitive

Icon	Ribbon	Toolbar	Menu	Command Name (Alias)	Function
				AI_PYRAMID	Creates a 3D surface primitive that has a polygon-shaped base and a top radius of 0 or greater that is the same shape as the base unless the radius of the top is set to 0

3D face

A 3D face can be either three or four sided. Most of the commands in this chapter create meshes that are composed of multiple faces or surfaces to create a primitive. As you create a 3D face with the 3DFACE command, you can control which sides of the face are visible when the model is viewed as hidden, shaded, or rendered (see Figure BC1-1). To start the 3DFACE command, use one of the methods in Table 1-1. After specifying the first corner, you specify two more points and then press Enter to create a three-sided 3D face, or specify a fourth point to create a four-sided 3D face. You can continue to specify additional points to create additional 3D faces. As you specify points, you can toggle the visibility of the edge that is created.

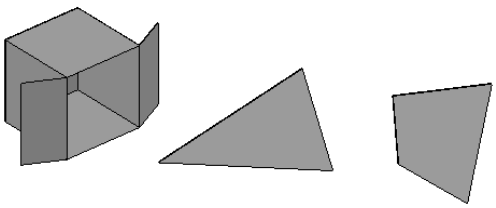

Figure BC1-1: An open box created with 3D faces, and a three- and four-sided 3D face.

3D mesh

A mesh is a group of vertices that form a particular pattern to create a group of surfaces based on the number of vertices specified (see Figure BC1-2). If a mesh is exploded, the result is a number of individual 3D faces created between the specified vertices. A mesh is commonly created as an open object, but it can be closed through the use of the PEDIT command. To start the 3DMESH command, use one of the methods listed in Table BC1-1. After you start the 3DMESH command, you are prompted to specify the size of the mesh in the M (or *x*) and N (or *y*) directions, which determines the number of vertices that

you are prompted for. After the M and N directions have been specified, you specify all the vertices to create the mesh.

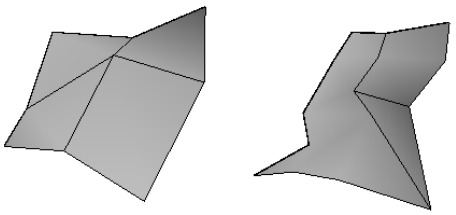

Figure BC1-2: A couple of meshes created with the 3DMESH command.

Planar surface

A planar surface is an object that you can create by specifying two corners to form a rectangular object, or by selecting objects that form a closed object just like the region command does (see Figure BC1-3). Unlike many of the commands that create surfaces and meshes in this chapter, exploding a planar surface results in the creation of a region. To start the PLANESURF command, use one of the methods in Table BC1-1. After you start the PLANESURF command, you are prompted to specify the first corner of the planar surface and then the opposite corner, which creates the planar surface on the *xy* plane. Alternatively, you are prompted to select a closed object.

The SURFU and SURFV system variables control the number of isolines that are displayed for the surface but do not affect the actual creation of the planar surface.

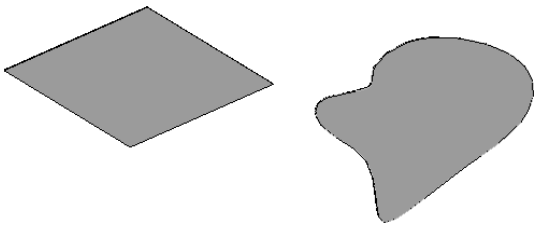

Figure BC1-3: Two planar surfaces: one created by picking two corners and the other created with a closed spline.

Box

You can create a box made of surfaces with the AI_BOX command that looks just like one created with the BOX command. The 3D solid that is created with the BOX command can be edited by using grips and retains the appearance of a box, but the surface version of the box can be easily deformed or stretched to fit into a specific shape, which can result in the final object not being a box (see Figure BC1-4). After the AI_BOX command is started, you specify the first corner of the box, its length and width, and finally its height. After the box is created, you have the option of rotating it along the *z* axis.

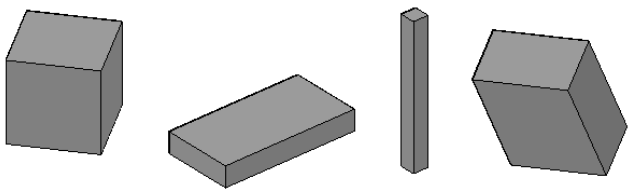

Figure BC1-4: Some of the boxes you can create with the AI_BOX command, and one (on the far right) modified with grips.

Wedge

You can create a wedge made of surfaces by using the AI_WEDGE command that looks just like one created with the WEDGE command (see Figure BC1-5), but you edit them in different ways. After the AI_WEDGE command is started, you specify the first corner of the wedge, its length and width, and finally its height. After the wedge is created, you have the option of rotating it along the *z* axis.

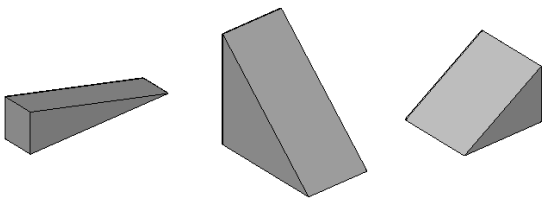

Figure BC1-5: Some of the wedges you can create with the AI_WEDGE command.

Cone

You can create a cone made of surfaces by using the AI_CONE command that looks similar to the one that can be created with the CONE command (see Figure BC1-6), but both types of cones are edited in different ways. When the AI_CONE command is started, you specify the center point for the base, and then the radius or diameter of the base. After you have defined the base, you define the radius of the top of the cone. A radius of 0 creates a point, whereas a radius greater than 0 creates a flat top. After the base and the top of the cone have been defined, you specify the height of the cone. The last bit of input required is the number of segments that the cone should be created with: The higher the number, the smoother it appears. You should stay roughly around 16 segments when possible, but a larger number will result in a smoother cone. The highest value you can use is 32,767.

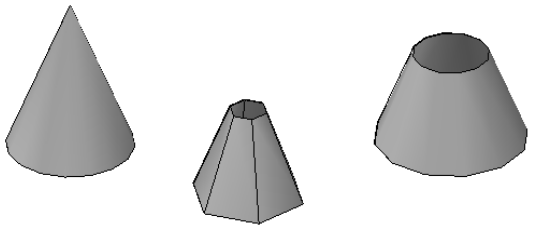

Figure BC1-6: Some of the cones you can create with the AI_CONE command.

Sphere

You can create a sphere from surfaces by using the AI_SPHERE command that can be made to look similar to one created with the SPHERE command (see Figure BC1-7), but they are edited in different ways. When the AI_SPHERE command is started, you specify the center of the sphere, and then its radius or diameter, and then the number of longitudinal and latitudinal segments. The greater the number of segments specified, the smoother the sphere appears.

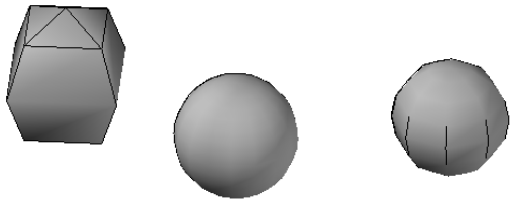

Figure BC1-7: Some of the spheres you can create with the AI_SPHERE command.

Dish and dome

A dish and a dome created by using the AI_DISH and AI_DOME commands create the lower or upper half of a sphere with surfaces. A dish is the lower half of a sphere if it was sliced in half horizontally, and a dome is the upper half (see Figure BC1-8). When the AI_DISH or AI_DOME commands are started, you specify the center of the dish or dome, and then its radius or diameter, and then the number of longitudinal and latitudinal segments. The greater the number of segments specified, the smoother the dish or dome appears. The number of latitudinal segments is half of what you use for a sphere created with the AI_SPHERE command.

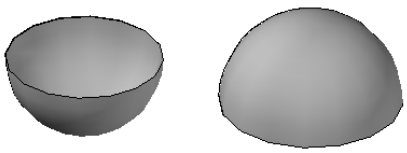

Figure BC1-8: A dish and a dome created with the AI_DISH and AI_DOME commands.

Torus

A torus created by using the AI_TORUS command is made up of surfaces and can be made to look similar to one created with the TORUS command (see Figure BC1-9), but they are edited differently. When the AI_TORUS command is started, you specify the center of the torus, its radius or diameter, and then the radius or diameter of the torus's tube. After you specify the overall size and tube size for the torus, you specify the number of segments for the torus and the tube. The greater the number of segments specified, the smoother the torus appears.

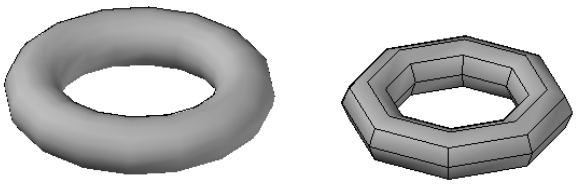

Figure BC1-9: Two of the toruses you can create with the AI_TORUS command.

Pyramid

You can create a pyramid defined by surfaces with the AI_PYRAMID command. It looks similar to a three- or four-sided pyramid that can be created with the PYRAMID command, but the AI_PYRAMID command offers a few variations that are not available with the PYRAMID command (see Figure BC1-10). The AI_PYRAMID command allows you to create a three-sided pyramid (tetrahedron) or a four-sided pyramid, which can have a point, a ridge, or a flat top. When the AI_PYRAMID command is started, you specify the first corner of the pyramid's base, and then up to four other corners based on whether you are creating a three-sided or four-sided pyramid. After the base is defined, you can specify the location and type of top for the pyramid: either a point (apex), a ridge, or a flat top. When you define the type of top for the pyramid, you are also defining its height.

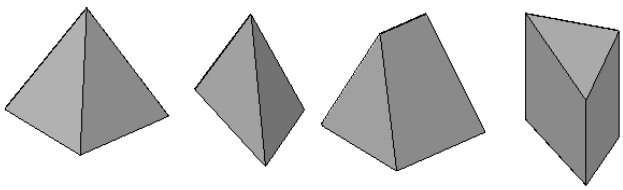

Figure BC1-10: Some of the pyramids you can create with the AI_PYRAMID command.

Creating Complex Surfaces

Creating complex surface models by using just primitive surfaces can take some time. AutoCAD allows you to create complex surfaces by first starting with one or more 2D objects. Four commands allow you to create complex surfaces from 2D objects: TABSURF, REVSURF, RULESURF, and EDGESURF. I explain each of the four commands in this section.

Tabulated Mesh

Tabulated Mesh allows you to create a mesh based on a profile (path curve) and a direction vector. Unlike some of the commands previously mentioned in this section, such as EXTRUDE and LOFT, a closed profile doesn't create a solid; instead it creates a mesh. You extrude the selected object (path curve) along a selected path (see Figure BC1-11). You start the TABSURF command on the menu browser or menu bar by clicking Draw menu➪Modeling➪Meshes➪Tabulated Mesh, or on the ribbon by clicking Home tab➪3D Modeling panel's title bar➪Tabulated Surface.

TABSURF uses the value of the SURFTAB1 system variable to control the number of segments that the mesh is created with. The higher the number, the smoother the mesh looks and the better it follows the selected object (path curve). By default, SURFTAB1 is set to a value of 6.

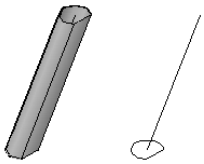

Figure BC1-11: The results of using TABSURF on a closed object.

Revolved Mesh

Revolved Mesh is similar to Revolve, except you can select only a single object, and a mesh is created even when a closed object is selected. After you select the object you want to revolve, you specify the axis by selecting an object, and then you specify the start and end point, and then include angles to revolve the object around the axis (see Figure BC1-12). You can start the REVSURF command on the menu browser or menu bar by clicking Draw menu➪Modeling➪Meshes➪Revolved Mesh, or on the ribbon by clicking Home tab➪3D Modeling panel's title bar➪Revolved Surface.

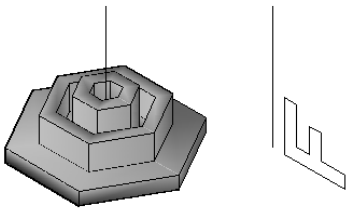

Figure BC1-12: The results of using REVSURF on a closed object.

REVSURF uses the values of the SURFTAB1 and SURFTAB2 system variables to control the number of segments with which the mesh is created. The higher the number, the smoother the mesh looks and the better it follows the selected object. By default, SURFTAB1 and SURFTAB2 are set to a value of 6.

Ruled Mesh

Ruled Mesh allows you to create a mesh between two selected objects. You can use both open and closed objects with the command, but if you use a closed object, the other object must also be a closed object. Ruled Mesh works similarly to the LOFT command because a new object is created based on the selection of two profiles (see Figure BC1-13). The different between RULESURF and the LOFT command is that RULESURF creates a mesh object and not a surface or solid. You can start the RULESURF command on the menu browser or menu bar by clicking Draw menu➪Modeling➪Meshes➪Ruled Mesh, or on the ribbon by clicking Home tab➪3D Modeling panel's title bar➪Ruled Surface.

RULESURF uses the value of the SURFTAB1 system variable to control the number of segments with which the mesh is created. The higher the number, the smoother the mesh looks and the better it follows the selected object. By default, SURFTAB1 is set to a value of 6.

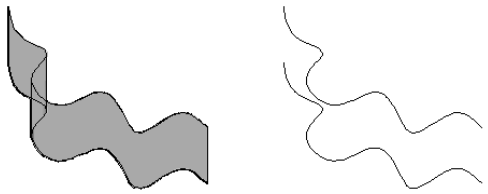

Figure BC1-13: The results of using RULESURF on two splines at different elevations.

Edge Mesh

Edge Mesh allows you to create a three-dimensional mesh that follows the edges of four objects. The objects must be open objects, but their end points meet end to end with each other. The edges must be selected in a specific order to properly generate the mesh (see Figure BC1-14). You can start the EDGESURF command on the menu browser or menu bar by clicking Draw menu➪Modeling➪Meshes➪Edge Mesh, or on the ribbon by clicking Home tab➪3D Modeling panel's title bar➪Edge Surface .

EDGESURF uses the values of the SURFTAB1 and SURFTAB2 system variables to control the number of segments with which the mesh is created. The higher the number, the smoother the mesh looks and the better it follows the selected objects. By default, SURFTAB1 and SURFTAB2 are set to a value of 6.

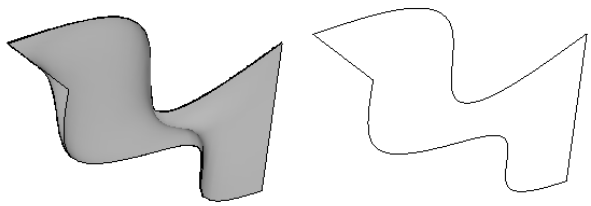

Figure BC1-14: The results of using EDGESURF on four objects.

Editing Surfaces

Editing surfaces is much different than editing 3D solids. 3D solids are tightly created objecst, whereas surfaces are loosely defined and can be altered radically through the use of grips. Not many commands and options are available for editing surfaces, but you should know and understand a few of the important ones.

Controlling the visibility of edges

The most important thing to remember when creating surfaces is that you must control which edges of the surfaces should be shown as you create a patchwork of surfaces to create holes and other features (see Figure BC1-15). The EDGE command allows you to control the display of an edge where two surfaces meet or, in some cases, don't meet. You usually want to hide edges where two surfaces that are parallel or nearly parallel to each other meet. You can't hide the edges of segments that are part of a mesh; the mesh must be exploded first into individual faces. You can start the EDGE command on the menu browser or menu bar by clicking Draw menu➪Modeling➪Meshes➪ Edge or on the ribbon by clicking Home tab➪3D Modeling panel's title bar➪ Edge. After the command is started, select the edge for which you want to toggle the visibility.

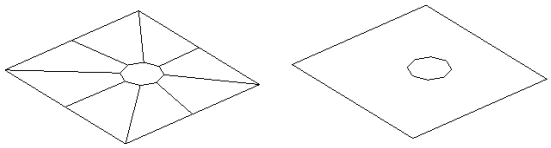

Figure BC1-15: A surface before and after the display of its edges has been toggled.

The SPLFRAME system variable controls the display of edges that have been set as invisible on a surface. Setting the variable to a value of 1 and doing a REGEN causes the edges that are invisible to be displayed on-screen. You can also use the Display option of the Edge command to make invisible edges appear temporarily in the drawing window.

Using grips to edit surfaces

You can use grip editing with surfaces, faces, and meshes, but the results are very different from using grips with 3D solids. When you select a surface, face, or mesh, a grip is displayed at each vertex. Activating the grip and using the stretch behavior of grip editing causes the surface, face, or mesh to become deformed, which can be an advantage when you need to blend surfaces, faces, or meshes together with 3D solids.

Working with convert to surface

AutoCAD allows you to take certain types of objects with specific property settings and convert them to surfaces: Some of these objects are 2D solids, regions, planar 3D faces, polylines that are open and have no width with thickness, and lines and arcs with a thickness. To convert these objects to surfaces, you use the CONVTOSURFACE command. After the command is started and the object is created, a new planar or extruded surface is created. The CONVTOSOLID command allows you to take some objects with specific property settings, such as a circle with a thickness or a polyline with a width, and create extruded 3D solids from them. For more information on these commands, refer to AutoCAD's online Help.

Thicken

The THICKEN command is similar to the EXTRUDE command, except it's limited to working on planar and extruded surfaces. You can start the THICKEN command on the menu browser or menu bar by clicking Modify menu➪3D Operations➪Thicken, or on the ribbon by clicking Home tab➪Solid Editing panel's title bar➪Edge. After the command is started, select the planar or extruded surface that you want to thicken and specify a value for the thickness.