

# Drawing in three dimensions

Paper drawings typically represent two-dimensional views of three-dimensional objects. With BtoCAD, you can create three-dimensional models of three-dimensional objects.

This section explains how to:

- View entities in three dimensions.
- Create three-dimensional entities.
- Edit entities in three-dimensional space.
- Edit three-dimensional solids.
- Display hidden-line and shaded views of three-dimensional entities.

The tools and commands for many of the functions described in this section appear on the Draw 3D toolbar and the Insert menu, respectively, when you set the program to the Advanced experience level.

## ***Topics in this chapter***

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## Viewing entities in three dimensions

You can view a BtoCAD drawing from any position in three-dimensional space. From any selected viewing position, you can add new entities and modify existing entities. You can also generate hidden-line and shaded views from any viewing position.

### Setting the viewing direction

You view three-dimensional drawings by setting the viewing direction. The viewing direction establishes the viewing position, the Cartesian coordinate corresponding to the viewpoint looking back at the origin point, the 0,0,0 coordinate. When you view a drawing from the default viewpoint (0,0,1), you see a plan view of the drawing.

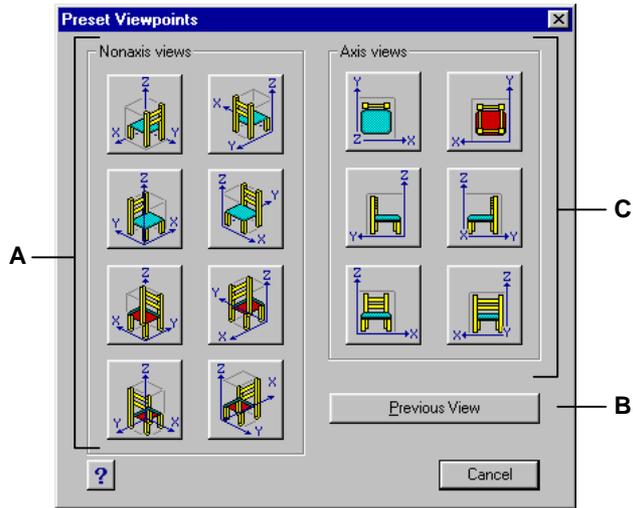
From the View menu, you can view a three-dimensional drawing using any of the following methods:

- Preset Viewpoints
- Dynamic View Control
- Plan View

You can change the viewing direction to look at the drawing from a different vantage point or to work on a three-dimensional model from a different orientation.

#### To set a new viewing direction

1. Do one of the following:
  - Choose View > Look From > Preset Viewpoints.
  - Type *setvpoint* and then press Enter.
2. Click the preset view you want to use.
  - A Click to select a non-axis viewpoint.
  - B Click to select the previous viewpoint.
  - C Click to select a viewpoint aligned with an axis.

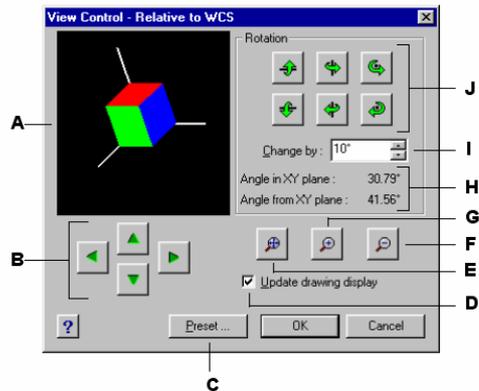


You can dynamically rotate the viewpoint within the xy plane and relative to the xy plane, and you can pan and zoom the drawing. As you change the viewpoint settings, the drawing display automatically updates.

**To dynamically set a view direction**

- 1 Do one of the following:
  - Choose View > Look From > Dynamic View Control.
  - Type *viewctl* and then press Enter.
- 2 Click the appropriate tools to dynamically change the viewpoint.
- 3 To complete the command, click OK.

- A Indicates the current viewpoint.
- B Click to pan the drawing.
- C Click to display the Preset Viewpoints dialog box.
- D Click to update the drawing display whenever you click a tool.
- E Click to zoom extents.
- F Click to zoom out.
- G Click to zoom in.
- H Shows the current viewpoint orientation.
- I Type or select the rotation angle increment.
- J Click to rotate the view about a predefined axis.



You can set the current viewing direction to the plan view of the current user coordinate system (UCS), a previously saved UCS, or the World Coordinate System (WCS).

### To display a plan view of the current drawing

- 1 Do one of the following:
  - Choose View > Look From > Plan View.
  - Type *plan* and then press Enter.
- 2 In the prompt box, choose one of the following:
  - Current displays the plan view of the current UCS.
  - UCS displays the plan view of a saved UCS. The program prompts you for the name of the UCS.
  - World displays the plan view of the WCS.

## Creating three-dimensional entities

BtoCAD supports the following types of three-dimensional models:

- Wire-frame models, which consist of lines and curves that define the edges of a three-dimensional entity. You can create a wire-frame model by drawing lines, arcs, polylines, and other two-dimensional entities anywhere in three-dimensional space. Wire-frame models have no surfaces; they always appear as outlines. Because you must individually draw and position each entity that makes up a wire-frame model, creating one can be exacting and time-consuming.
- Surface models, which consist of both edges and the surfaces between those edges. You can create a surface model by applying elevation and thickness to two-dimensional planar entities or by using specific three-dimensional entity-creation commands. Surface models consist of individual planes forming a faceted, polygonal mesh.

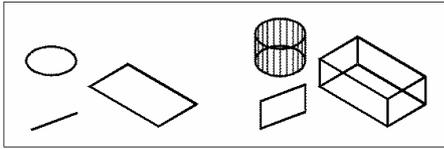
### Applying elevation and thickness

By default, the program creates new two-dimensional entities with a zero elevation and thickness. The easiest way to create a three-dimensional entity is to change the elevation or thickness property of an existing two-dimensional entity.

The elevation of an entity is its z-coordinate position in relation to the xy plane in which the entity is drawn. An elevation of 0 indicates that the entity is drawn on the xy plane of the current UCS. Positive elevations are above this plane; negative elevations are below it.

The thickness of an entity is the distance it is extruded above or below its elevation. A positive thickness extrudes the entity upward in the positive z direction of the entity; a negative thickness extrudes it downward in the negative z direction. The thickness is applied uniformly to the entire entity. You can extrude any two-dimensional entity into a three-dimensional entity by changing the thickness of the entity to a nonzero value.

For example, a circle becomes a cylinder, a line becomes a three-dimensional plane, and a rectangle becomes a box.



Two-dimensional entities. Two-dimensional entities with thickness added.

You can create three-dimensional entities using any of the following methods:

- Draw two-dimensional entities in three-dimensional space.
- Convert two-dimensional planar entities into three-dimensional entities by applying elevation and thickness.
- Convert two-dimensional planar entities into three-dimensional entities by revolving or extruding.
- Create three-dimensional entities such as boxes, cylinders, cones, domes, spheres, and wedges.

You can change the default elevation and thickness values to create new entities with an elevation and thickness already applied.

#### To set the current elevation

1 Display the current elevation setting by doing one of the following:

- On the Settings toolbar, click the Thickness tool 
- Type *elev* and then press Enter.

2 Specify the New Current Value For Elevation, and then press Enter.

#### To set the current thickness

1 Display the current thickness setting by doing one of the following:

- On the Settings toolbar, click the Thickness tool 
- Type *thickness* and then press Enter.

2 Specify the New Current Value For Thickness, and then press Enter.

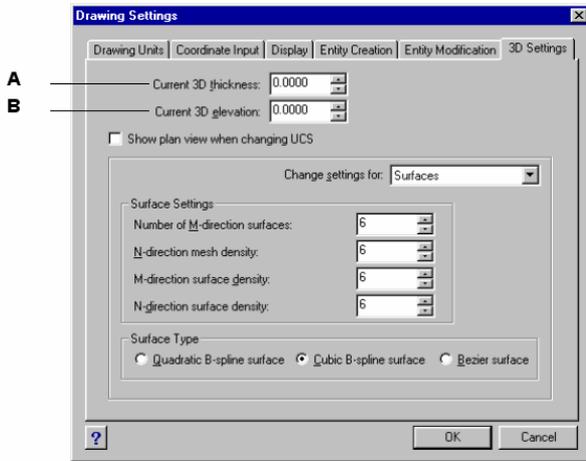
#### To set the current elevation and thickness using a dialog box

1 Display the Drawing Settings dialog box by doing one of the following:

- On the Settings toolbar, click the Drawing Settings tool 
- Type *settings* and then press Enter.

2 Click the 3D Settings tab.

- 3 In the Change Settings For list, click Surfaces.
- 4 To change the current thickness, in the Current 3D Thickness box, type a new thickness value or click the arrows to select a new thickness.
- 5 To change the current elevation, in the Current 3D Elevation box, type a new elevation value or click the arrows to select a new elevation.
- 6 Click OK.

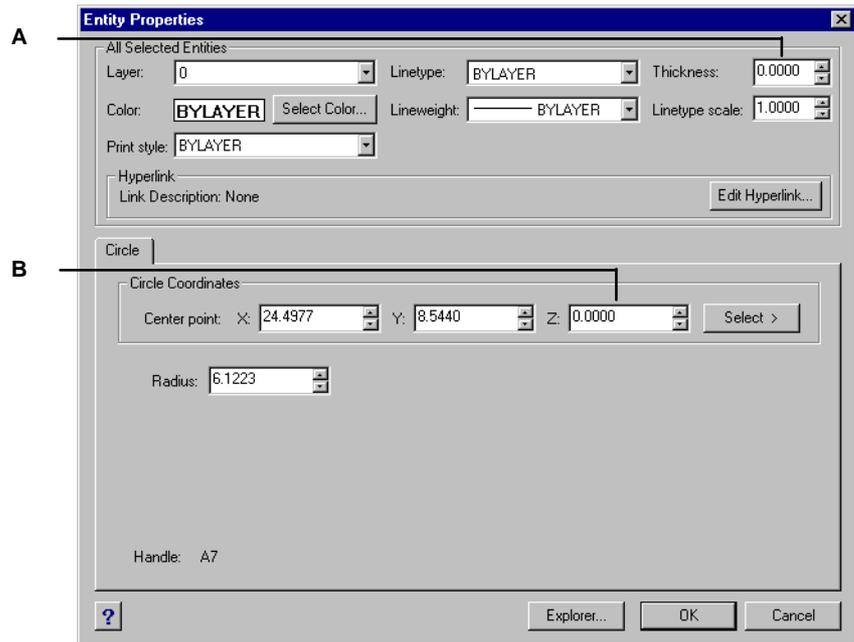


- A Type or select the current three-dimensional thickness.  
 B Type or select the current three-dimensional elevation.

### To change the thickness and elevation of an existing entity

- 1 Do one of the following:
  - Choose Modify > Properties.
  - Right-click on the entity, click the Properties tool
  - Type *entprop* and then press Enter.
- 2 Select the entity, and then press Enter. BtoCAD displays the Entity Properties dialog box. The exact appearance of the dialog box depends on the type of entity you select.
- 3 To change the thickness, in the Thickness box, type a new thickness value or click the arrows to select the new thickness.
- 4 To change the elevation, in the Z coordinate box, type a new elevation value or click the arrows to select the new elevation.
- 5 Click OK.

**NOTE** When you change the thickness of an entity, you do not change the entity type.



A Type or select the new thickness.

B Type or select the new elevation.

## Creating three-dimensional faces

You can create a three-dimensional face, which consists of a section of a plane in three-dimensional space. You define a three-dimensional face by specifying the x,y,z coordinates of three or more corners. After you specify the fourth point, the program continues to prompt you for additional faces by alternating prompts for the third point and fourth point to allow you to build a complex three-dimensional entity. Each three- or four-sided plane is created as a separate three-dimensional face entity.

### To create a three-dimensional face

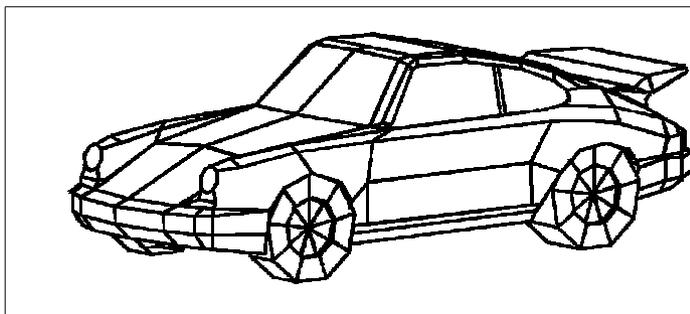
Advanced experience level

1 Do one of the following:

- Choose Draw > 3D Entities > Face.
- On the Surfaces toolbar, click the 3DFace tool 
- Type *face* and then press Enter.

- 2 Specify the first point of the three-dimensional face.
- 3 Specify the second, third, and fourth points.
- 4 Specify the third and fourth points for additional faces.
- 5 To complete the command, press Enter.

**TIP** Any or all edges of a three-dimensional face can be invisible to allow you to more accurately model entities with holes in them. As the program prompts you for the corner points, in the prompt box, choose *Invisible Edge* to make the next edge invisible.



An example of a three-dimensional model created using three-dimensional faces.

## Creating rectangular meshes

You can create a three-dimensional rectangular mesh consisting of four-sided polygons. You determine the size of the mesh by specifying the number of vertices along the primary (M-direction) and secondary (N-direction) mesh axes and then specifying the coordinates for each vertex.

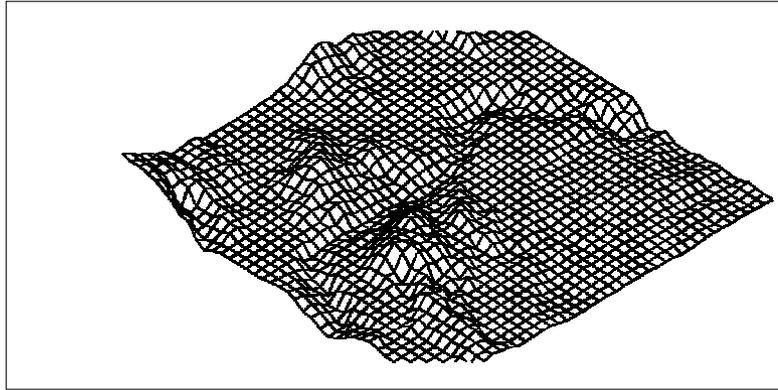
### To create a rectangular mesh

Advanced experience level

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Mesh.
  - On the Surfsces toolbar, click the Mesh tool 
  - Type *mesh* and then press Enter.
- 2 Specify the number of vertices along the primary mesh axis.
- 3 Specify the number of vertices along the secondary mesh axis.
- 4 Specify the coordinates for each vertex.

Specifying the coordinates for the last vertex completes the mesh and ends the command.

**TIP** Although creating rectangular meshes manually can be exacting, they are useful for representing complex surfaces such as three-dimensional terrain models. The Mesh tool is most useful when combined with scripts or LISP programs that mathematically calculate the coordinates of the vertices.



An example of a three-dimensional terrain model created using rectangular meshes.

## Creating polyface meshes

You can create a polygon mesh consisting of faces connecting three or more vertices. You first determine the coordinates of each vertex and then define each face by entering the vertex numbers for all the vertices of that face. As you create each face, you can control the visibility and color of each edge and assign each edge to specific layers.

### To create a polyface mesh

Advanced experience level

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Polyface Mesh.
  - On the Surfaces toolbar, click the Polyface Mesh tool 
  - Type *pface* and then press Enter.
- 2 Specify the coordinates of each vertex. After each vertex that you specify, the next vertex number is displayed, and you are prompted for the coordinates of the vertex. Specify the coordinates, and then press Enter. Continue to specify the coordinates for each numbered vertex.
- 3 To finish specifying vertex coordinates, press Enter.

- 4 Specify the vertex numbers that define the first face. You specify the face by entering the vertex numbers that were defined when you specified coordinates in step 2. Each face can be composed of three or more numbered vertices.
- 5 To finish defining the first face, press Enter.
- 6 Specify the next face by entering its vertex numbers.
- 7 To complete the command, press Enter.

**TIP** To make an edge invisible, type the vertex number as a negative value.

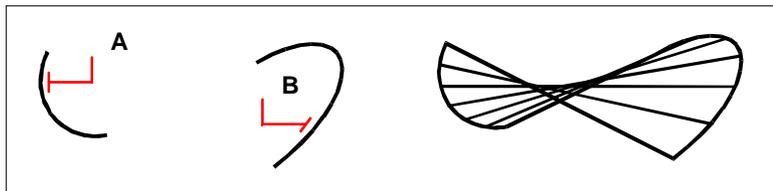
## Creating ruled surface meshes

You can create a ruled surface, which is a three-dimensional polygon mesh that approximates the surface between two existing entities. You select the two entities that define the ruled surface. These entities can be arcs, circles, lines, points, or polylines.

### To create a ruled surface mesh

Advanced experience level

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Ruled Surface.
  - On the Surfaces toolbar, click the Ruled Surface tool 
  - Type *rulesurf* and then press Enter.
- 2 Select the first defining entity.
- 3 Select the second defining entity.



Select the first (A) and second (B) defining entities.

The resulting ruled surface mesh.

**TIP** To control the density of the mesh, change the values for the Number of *-Direction Surfaces*. Choose Tools > Drawing Settings, and then click the 3D Settings tab. Under Change Settings For, select Surfaces. Under M Surface Settings, change the Number Of M-Direction Surfaces value. Or, on the Settings toolbar, use the Drawing Settings tool to display that dialog box.

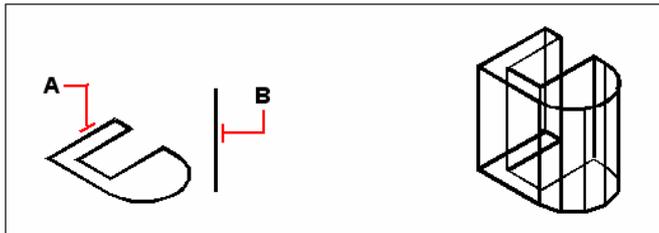
## Creating extruded surface meshes

You can create an extruded surface, which is a three-dimensional polygon mesh that approximates the surface generated by extruding a path curve along a direction vector. You select the two entities that define the path curve and direction vector. The length of the direction vector determines the distance the path curve is moved along the direction vector. The extruded entity can be an arc, circle, line, or polyline. You can choose a line or open polyline as the direction vector. The resulting mesh consists of a series of parallel polygonal planes running along the specified path.

### To create an extruded surface mesh

Advanced experience level

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Extruded Surface.
  - On the Surfaces toolbar, click the Extruded Surface tool 
  - Type *tabsurf* and then press Enter.
- 2 Select the entity to extrude.
- 3 Select the extrusion path.



Select the entity to extrude (A) and the extrusion path (B)

The resulting extruded solid.

**TIP** To control the density of the mesh, change the values for the *Number of -Direction Surfaces*. Choose Tools > Drawing Settings, and then click the 3D Settings tab. Under Change Settings For, select Surfaces. Under M Surface Settings, change the *Number Of M-Direction Surfaces* value. Or, on the Settings toolbar, use the Drawing Settings tool to display that dialog box.

## Creating revolved surface meshes

You can create a surface of revolution, which is a three-dimensional polygon mesh that approximates the surface generated by rotating a two-dimensional profile around an axis. You select the two entities that define

the profile and the axis. You also specify the starting angle and the number of degrees to revolve the profile.

Revolving the profile 360 degrees creates a closed three-dimensional mesh. The Number Of M-Direction Surfaces value determines the mesh density (the number of mesh segments) in the M-direction (around the axis of revolution). The N-Direction Mesh Density value determines the mesh density (the number of mesh segments) in the N-direction (along the axis of revolution).

**To create a revolved surface mesh**

Advanced experience level

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Revolved Surface.
  - On the Surfaces toolbar, click the Revolved Surface tool 
  - Type *revsurf* and then press Enter.
- 2 Select the entity to revolve.
- 3 Select the entity to be used as the axis of revolution.
- 4 Specify the starting angle.
- 5 Specify the number of degrees to revolve the entity.

**TIP** To control the density of the mesh, change the values for the Number of -Direction Surfaces. Choose Tools > Drawing Settings, and then click the 3D Settings tab. Under Change Settings For, select Surfaces. Under M Surface Settings, change the Number Of M-Direction Surfaces value. Or, on the Settings toolbar, use the Drawing Settings tool to display that dialog box.

**Creating edge-defined Coons surface patch meshes**

You can create a surface called a Coons surface patch, a mesh connecting four edges. You select the entities that define the edges. Edge entities can be arcs, lines, or polylines. The four edge entities must form a closed loop and share endpoints. A patch is a bicubic surface (one curve extends in the M-direction and the other in the N-direction) interpolated between the four adjoining edges. You can select the edges in any order. The first edge you select determines the M-direction of the mesh.

**To create an edge-defined Coons surface patch mesh**

Advanced experience level

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Coons Surface.
  - On the Surfaces toolbar, click the Coons Surface tool 
  - Type *edgesurf* and then press Enter.
- 2 Select the first edge.
- 3 Select the second, third, and fourth edges.

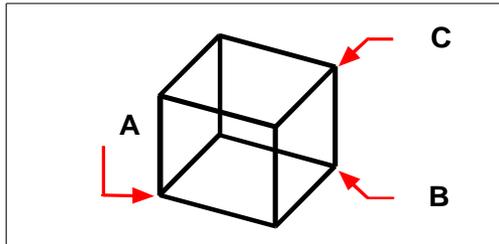
**TIP** To control the density of the mesh, change the values for the Number of -Direction Surfaces. Choose Tools > Drawing Settings, and then click the 3D Settings tab. Under Change Settings For, select Surfaces. Under M Surface Settings, change the Number Of M-Direction Surfaces value. Or, on the Settings toolbar, use the Drawing Settings tool to display that dialog box.

## Creating boxes

You can create rectangular boxes, or cubes. A box consists of six rectangular surface planes. The base of the box is always parallel with the xy plane of the current UCS. You position the box by specifying either a corner or the center of the box. You determine the size of the box by either specifying a second corner and the height; defining the box to be a cube and then providing its length; or specifying the length, width, and height.

### To create a box

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Box.
  - On the Solids toolbar, click the Box tool 
  - Type *box* and then press Enter.
- 2 Specify the first corner of the base.
- 3 Specify the opposite corner of the base.
- 4 Specify the height.



First corner of the base (A), the opposite corner of the base (B), and the height (C).

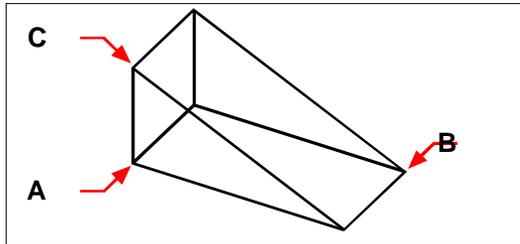
## Creating wedges

You can create three-dimensional wedges consisting of five surface planes. The base of the wedge is always parallel with the xy plane of the current UCS with the sloped face opposite the first corner. The height is always parallel with the z-axis. You position the wedge by specifying either a corner or the center of the wedge. You determine the size of the wedge by either specifying a second corner and the height; defining the wedge based on a cube having a given length; or specifying the length, width, and height.

### To create a wedge as a three-dimensional surface

- 1 Do one of the following:

- Choose Draw > 3D Entities > Wedge.
  - On the Surfaces toolbar, click the Wedge tool 
  - Type *wedge* and then press Enter.
- 2 Specify the first corner of the base.
  - 3 Specify the opposite corner of the base.
  - 4 Specify the height.



First corner of the base (A), the opposite corner of the base (B), and the height (C).

## Creating cones

You can create three-dimensional cones defined by a circular base and tapering to a point perpendicular to the base. The base of the cone is always parallel with the xy plane of the current UCS; the height of the cone is always parallel with the z-axis. You position the cone by specifying the center of the base. You determine the size of the cone by specifying either the radius or the diameter of the base and the height.

### To create a cone as a three-dimensional surface

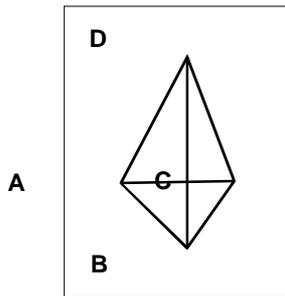
- 1 Do one of the following:
  - Choose Draw > 3D Entities > Cone.
  - On the Solids toolbar, click the Cone tool 
  - Type *cone* and then press Enter.
- 2 Specify the center of the base of the cone.
- 3 Specify the radius or diameter.
- 4 Specify the height.

## Creating pyramids

You can create tetrahedrons (three-sided pyramids) or four-sided pyramids. The sides of the resulting pyramid can meet at a point (the apex) or can form a three- or four- edged top. The sides of a four-sided pyramid can also meet along a ridge defined by two points. The base of the pyramid is always parallel with the xy plane of the current UCS. You position the pyramid by specifying a corner of the base. You determine the size of the pyramid by specifying the base points and either the apex, the corners of the top surface, or the endpoints of the ridge.

### To create a pyramid as a three-dimensional surface

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Pyramid.
  - On the Surfaces toolbar, click the Pyramid tool 
  - Type *pyramid* and then press Enter.
- 2 Specify the first point for the base of the pyramid.
- 3 Specify the second and third points.
- 4 In the prompt box, choose Tetrahedron.
- 5 Specify the apex of the tetrahedron.



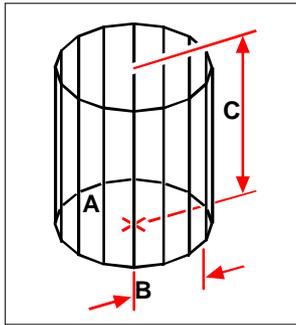
The first point (A), second point (B), and third point (C) of the base, and the apex (D).

## Creating cylinders

You can create cylinders defined by a circular base. The base of a cylinder is always parallel with the xy plane of the current UCS; the height of a cylinder is always parallel with the z-axis. You position a cylinder by specifying the center of the base. You determine the size of a cylinder by specifying either the radius or diameter of the base and the height.

**To create a cylinder as a three-dimensional surface**

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Cylinder.
  - On the Surfaces toolbar, click the Cylinder tool 
  - Type *cylinder* and then press Enter.
- 2 Specify the center of the base of the cylinder.
- 3 Specify the radius or diameter.
- 4 Specify the height.



Center of the base (**A**), radius of the base (**B**), and the height (**C**).

**Creating spheres**

You can create spheres. The latitude lines of a sphere are always parallel with the xy plane of the current UCS; the central axis is always parallel with the z-axis. You position a sphere by specifying its center point. You determine the size of a sphere by specifying either its radius or its diameter.

**To create a sphere**

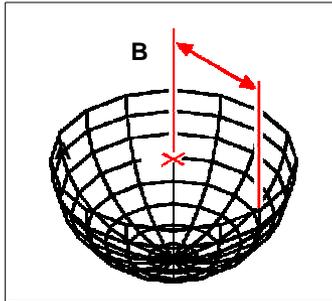
- 1 Do one of the following:
  - Choose Draw > 3D Entities > Sphere.
  - On the Surfaces toolbar, click the Sphere tool 
  - Type *sphere* and then press Enter.
- 2 Specify the center of the sphere.
- 3 Specify the radius or diameter.

## Creating dishes

You can create a three-dimensional dish. The latitude lines of a dish are always parallel with the xy plane of the current UCS; the central axis is always parallel with the z- axis. You position a dish by specifying its center point. You determine the size of a dish by specifying either its radius or its diameter.

### To create a dish as a three-dimensional surface

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Dish.
  - On the Surfaces toolbar, click the Dish tool 
  - Type *dish* and then press Enter.
- 2 Specify the center of the dish.
- 3 Specify the radius or diameter.



Center (A) and radius (B) of the dish.

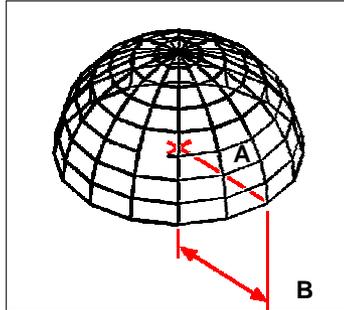
## Creating domes

You can create a three-dimensional dome. The latitude lines of a dome are always parallel with the xy plane of the current UCS; the central axis is always parallel with the z-axis. You position a dome by specifying its center point. You determine the size of a dome by specifying either its radius or its diameter.

### To create a dome as a three-dimensional surface

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Dome.
  - On the Surfaces toolbar, click the Dome tool 
  - Type *dome* and then press Enter.

- 2 Specify the center of the dome.
- 3 Specify the radius or diameter.



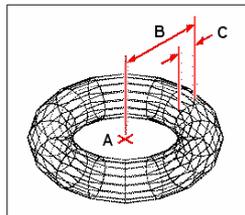
Center (A) and radius (B) of the dome.

## Creating torus

You can create a three-dimensional donut or ring-shaped entity known as a torus. The diameter of a ring is always parallel with the xy plane of the current UCS. A torus is constructed by revolving a circle about a line drawn in the plane of the circle and parallel with the z-axis of the current UCS. You position a torus by specifying its center point. You determine the size of a torus by specifying its overall diameter or radius and the diameter or radius of the tube (the circle being revolved).

### To create a torus as a three-dimensional surface

- 1 Do one of the following:
  - Choose Draw > 3D Entities > Torus.
  - On the Surfaces toolbar, click the Torus tool .
  - Type *torus* and then press Enter.
- 2 Specify the center of the whole torus.
- 3 Specify the radius or diameter of the whole torus.
- 4 Specify the radius or diameter of the body of the torus.



Center (**A**) and radius of the whole torus (**B**), and the radius of the body (**C**).

## Editing in three dimensions

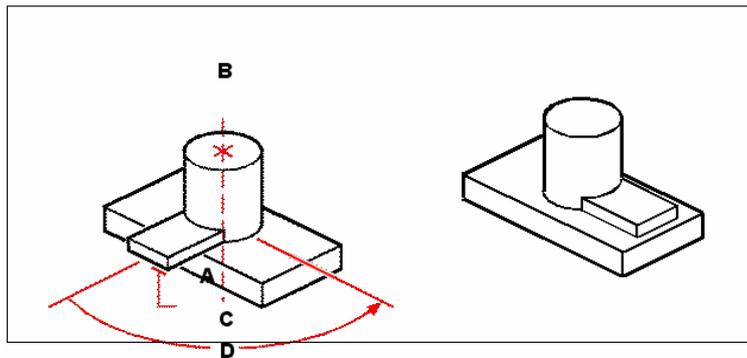
You can copy, move, rotate, array, mirror, and align two-dimensional and three-dimensional entities in both two-dimensional and three-dimensional space. You can also change and edit properties of three-dimensional entities much like you change and edit properties for two-dimensional entities. When you modify three-dimensional entities in two-dimensional space, you modify the entity in relation to the current UCS.

### Rotating in three dimensions

You can rotate selected entities about a specified axis in three-dimensional space. You select the entities to rotate and then define the axis of rotation either by specifying two points; selecting an existing entity; aligning the axis with the x-, y-, or z-axis of the current UCS; or aligning the axis with the current view.

#### To rotate an entity about an axis in three dimensions

- 1 Do one of the following:
  - Choose **Modify > 3D Operation > 3D Rotate**.
  - Type *rotate3D* and then press Enter.
- 2 Select the entities to rotate, and then press Enter.
- 3 Choose from one of the following options: **Entity**, **Last**, **View**, **Xaxis**, **Yaxis**, **Zaxis**.
- 4 Specify the rotation angle.
- 5 Specify the reference angle.



Select the entities to rotate (**A**), specify the endpoints of the axis of rotation (**B** and **C**), and then specify the rotation angle (**D**).

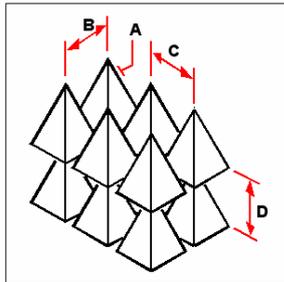
Result after rotating the entities.

## Arraying in three dimensions

You can copy selected entities and arrange them in a three-dimensional rectangular or polar (circular) pattern. For a rectangular array, you control the number of copies in the array by specifying the number of rows and columns and the number of levels. You also specify the distance between each. For a polar array, you specify the axis around which to array the entities, the number of copies of the entities to create, and the angle subtended by the resulting array.

### To create a three-dimensional rectangular array

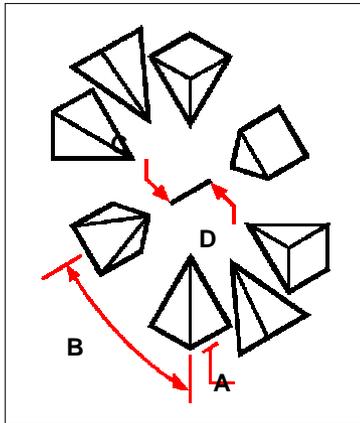
- 1 Do one of the following:
  - Choose **Modify > 3D Operation > 3D Array**.
  - Type *3Darray* and then press Enter.
- 2 Select the entities, and then press Enter.
- 3 In the prompt box, choose **Rectangular**.
- 4 Type the number of rows in the array.
- 5 Type the number of columns.
- 6 Type the number of levels.
- 7 Specify the vertical distance between the rows.
- 8 Specify the horizontal distance between the columns.
- 9 Specify the depth between the levels.



To create a three-dimensional rectangular array, select the entity to copy (**A**), type the number of rows, columns, and levels, and then specify the distance between each row (**B**), column (**C**), and level (**D**).

**To create a three-dimensional polar array**

- 1 Do one of the following:
  - Choose **Modify > 3D Operation > 3D Array**.
  - Type *3Darray* and then press Enter.
- 2 Select the entities, and then press Enter.
- 3 In the prompt box, choose **Polar**.
- 4 Type the number of copies to make, including the original selection set.
- 5 Specify the angle the array is to fill, from 0 to 360 degrees. The default setting for the angle is 360 degrees. Positive values create the array in a counterclockwise direction; negative values create the array in a clockwise direction.
- 6 In the prompt box, choose one of the following:
  - **Yes-Rotate Entities** to rotate entities as they are arrayed.
  - **No-Do Not Rotate** to retain the original orientation of each copy as it is arrayed.
- 7 Specify the center point of the array.
- 8 Specify a second point along the central axis of the array.



To create a three-dimensional polar array, select the entity to copy (A), type the number of copies to make, specify the angle the array is to fill (B), and then specify the center point of the array (C) and a second point along the central axis of the array (D).

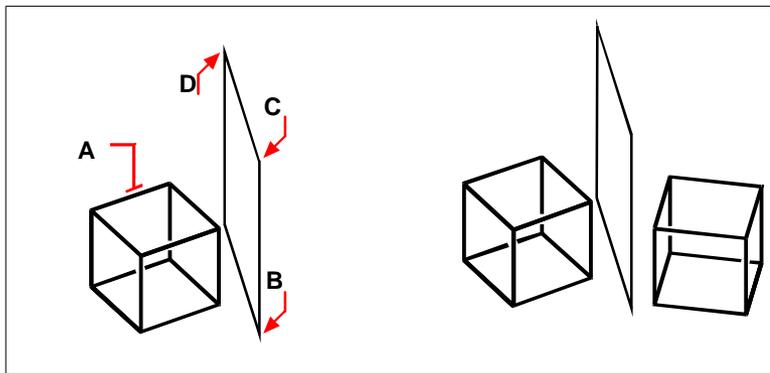
**Mirroring in three dimensions**

You can create a mirror image of selected entities in three-dimensional space. You mirror the entities about a mirror plane that you define by either specifying three points; selecting an existing two-dimensional planar entity; aligning the plane parallel with the xy, yz, or xz plane of the current UCS; or aligning the plane with the

current view. You can delete or retain the original entities.

### To mirror an entity about a three-dimensional plane

- 1 Do one of the following:
  - Choose **Modify > 3D Operation > 3D Mirror**.
  - Type *mirror3D* and then press Enter.
- 2 Select the entities, and then press Enter.
- 3 In the prompt box, choose **3 Points**, or press Enter to select the default.
- 4 Specify the first point on the mirror plane.
- 5 Specify the second and third points on the plane.
- 6 In the prompt box, choose one of the following:
  - **Yes-Delete Entities** to delete the original entities.
  - **No-Keep Entities** to retain the original entities.



Select the entity to mirror (A), and then specify the first point (B), second point (C), and third point (D) defining the mirror plane. The resulting mirrored entity.

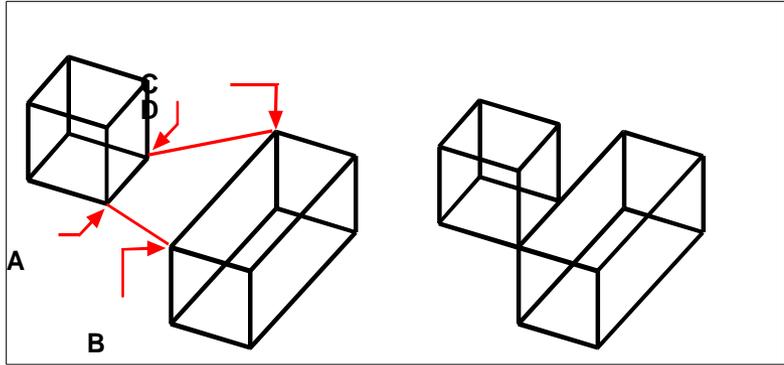
## Aligning in three dimensions

You can align selected entities with other entities in three-dimensional space. You select the entities you want to align, and specify one, two or three pairs of points to align the selected entities.

### To align an entity an entity with another

- 1 Do one of the following:
  - Choose **Modify > 3D Operation > Align**.
  - Type *align* and then press Enter.

- 2 Select the entities, and then press Enter.
- 3 Specify the first source point.
- 4 Specify the first destination point
- 5 Specify additional source and destination points if desired (up to three pairs).



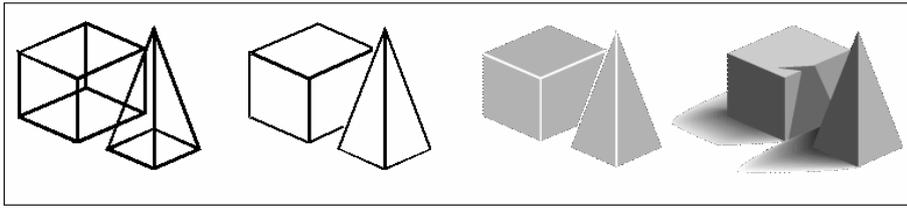
Select the entities to align, and then specify the first source point (A), the first destination point (B), the second destination point (C), and the second destination point (D). You can specify up to three pairs of source/destination points. The resulting mirrored entity.

## Hiding, shading, and rendering

As you create three-dimensional entities, the program displays both wire-frame and surface models in wire-frame view, which makes it difficult to visualize your three-dimensional models. To better visualize the model, you can remove all the lines that are hidden behind other entities or surfaces when seen from the current viewpoint.

Shading goes a step further by removing hidden lines and then assigning flat colors to the visible surfaces, making them appear solid. Shaded images are useful when you want to quickly visualize your model as a solid entity, though they lack depth and definition.

Rendering provides an even more realistic image of your model, complete with light sources, shadows, surface material properties, and reflections, giving your model a photo-realistic look. As shown in the following illustrations, when you render a model, the program removes hidden lines and then shades the surfaces as though they were illuminated from imaginary light sources.



Wire-frame model.

Hidden-line image.

Shaded image.

Rendered image.

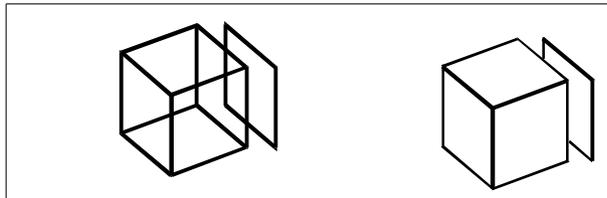
## Creating hidden-line images

Creating a hidden-line view of your drawing removes all the lines that are hidden behind other surfaces when seen from your vantage point. When you remove hidden lines or shade a model, the program treats the entities differently, depending on how you created them. Wire-frame models always appear transparent, because they have no surfaces. Surface models appear filled, with surfaces applied to all visible sides.

### To create a hidden-line image

Do one of the following:

- Choose View > Rendering > Hide.
- On the Rendering toolbar, click the Hide tool 
- Type *hide* and then press Enter.



Before creating a hidden-line image.

After removing hidden lines.

## Creating shaded images

Creating a shaded image of your drawing removes hidden lines and then applies shading to the visible surfaces based on their entity color. Because they are intended to provide a quick visualization, shaded images do not have a light source and use continuous colors across surfaces, causing them to appear flat and unrealistic.

### To create a shaded image

Do one of the following:

- Choose View > Rendering > Shade.
- On the Rendering toolbar, click the Shade tool 
- Type *shade* and then press Enter.

To control the appearance of the shaded image, choose Tools > Drawing Settings, and then click the 3D Settings tab and select the options you want. You can shade the surfaces and edges of the model in four ways:

- Faces shaded; edges not highlighted.
- Faces shaded; edges highlighted in the background color.
- Faces filled in the background color; edges drawn using the entity color (similar to a hidden-line view).
- Faces filled using the entity color; edges highlighted in the background color.

## Creating rendered images

Creating a rendered image of your drawing removes hidden lines and then shades the surface as though it were illuminated from multiple light sources.

Full rendering creates a photo-realistic image of your model, complete with light sources, shadows, surface material properties, and reflections. You can illuminate your image with spotlights, distant lighting to simulate sunshine, and ambient light. If you choose not to customize the light sources, the program generates default light sources for you.

Rays from these imaginary light sources are traced as they reflect off and refract through the surfaces of the model, a process called *ray tracing*. Ray tracing determines where shadows fall and how reflections on shiny materials such as metal and glass appear. You can modify the reflective properties of the materials that make up your model to control how the light rays reflect off its surfaces.

Full rendering automatically creates a base on which your model is displayed, if you don't already have one, so it does not appear suspended in space. A background is also automatically added to the image. A background such as a cloudy sky or an imported raster graphic such as a stone wall can also be added behind the image, making it even more realistic.

### To create a quickly rendered image

Do one of the following:

- Choose View > Rendering > Render.
- On the Rendering toolbar, click the Render tool 
- Type *render* and then press Enter.

### To create a fully rendered image

Do one of the following:

- Choose View > Rendering > Full Render.  
Type *fullrender* and then press Enter.

## Creating custom rendered images

BtoCAD allows you to create custom rendered images by applying materials, backgrounds, and lighting (including shadows) to your drawing:

- **Materials** Specify materials for different surfaces and define how the materials map to those surfaces. Predefined materials are available in the materials library, which can be customized further using the built-in editor. You can choose to use procedural or bitmap materials.
- **Backgrounds** Specify the background or backdrop for a rendered image. Several predefined backgrounds are available. By default, no background is used and it appears black. The background is an infinite, planar surface and reflects off of any reflective surfaces in your model. The background is not affected by lighting however, so no shadows or highlights are seen on the background.
- **Lighting** Specify the placement of lights, light color, and light intensity to determine how your drawing or scene is lit, including shadows and reflections in the scene. Lights can be placed either outside the field of view or inside to illuminate different areas of the scene. Several predefined lighting controls are available, including ambient lighting, diffuse lighting, specular reflections, specular highlights, and transparency.

### To apply materials, backgrounds, and lighting

- 1 Do one of the following:
  - Choose View > Rendering, and then choose Materials, Backgrounds, or Lighting.
  - On the Rendering toolbar, click the Materials tool () , Backgrounds () , or Lighting tool () .
  - Type *materials*, *backgrounds*, or *lighting* and then press Enter.
- 2 Make your selections.

**NOTE** You can specify additional options by choosing View > Rendering > Render Settings. For more information about creating custom rendered images, click Help in any of the Render dialog boxes.

## Printing a rendered image

You cannot print a rendered image directly to a printer. Instead, you must first save the drawing to a different format — either a bitmap (.bmp), JPEG (.jpg), TIFF (.tif), TrueVision TGA (.tga), or Portable Network Graphic (.png). After you save a rendered image, you can print it from another graphics program.

### To save a rendered image of your drawing

- 1 Create a rendered image of the drawing.
- 2 Do one of the following:
  - Choose View > Rendering > Render Settings.
  - On the Rendering toolbar, click the Render Settings tool 
  - Type *setrender* and then press Enter.
- 3 On the Rendering tab, click Save Last Image.
- 4 Enter a file name and path.
- 5 In Save As Type, choose the file format.
- 6 Click Save