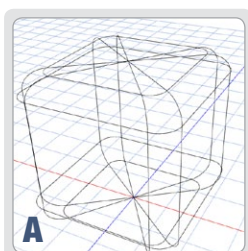


PRIMITIVES

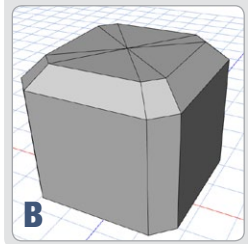


Click to play

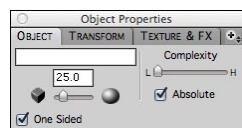
Primitive Resolution



A



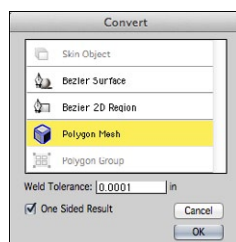
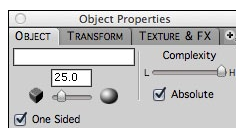
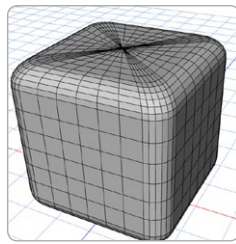
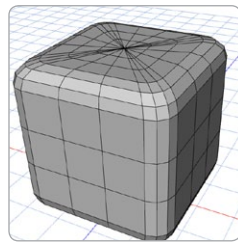
B



The two left images (A and B) are the same primitive whose 'complexity' is set to 'least'. However, the top image is displayed in Outline mode while the lower (B) is in Hidden Line mode.

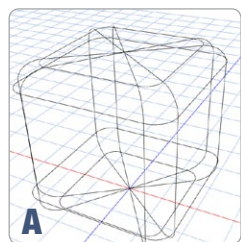
The 'Absolute' check box allows for finer increments in the resolution as the slider is increased.

The primitive's derived polygon mesh resolution can be adjusted, but it's still a primitive until explicitly converted to a polygon mesh based object.



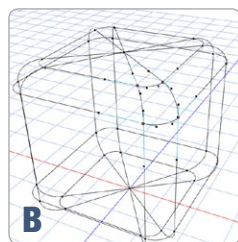
Click to play

Spline Conversion



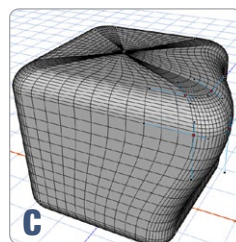
A

Rounded Corner primitive as shown in its default format while in Outline view mode.



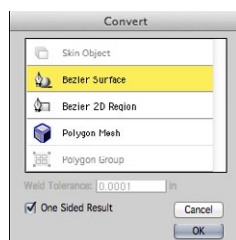
B

After conversion using the Convert function to a bezier surface object (shown in edit mode, note the bezier handles).



C

The view mode is switched to Hidden Line, but the object is still a bezier object. It can be adjusted much the same way bezier curves are adjusted in Adobe Illustrator, albeit in 3D.



3D PRIMITIVE CHARACTERISTICS

RESOLUTION INDEPENDENCE

In their default state, primitives are spline structures. This means when rendered they always have perfect curvature regardless of the size of a rendering. When viewed in Outline view mode, their spline nature is seen directly. But in other views a derived polygon mesh version is shown.

DERIVING POLYGONS

The 3 left images show the 3D primitive in Hidden line view. It displays the primitives in a polygon state. The primitive can be adjusted to create a higher, or lower, resolution polygon mesh. This is done using the Object Properties palette. The object is still a primitive until it is explicitly converted to a polygon mesh object.

CONVERSION TO POLYGON MESH

Once a desired resolution is achieved the Convert function (Modeling menu) can be used to change the primitive into a polygon mesh.

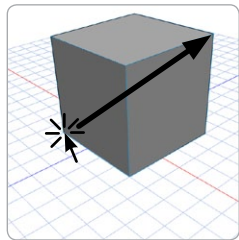
DERIVING SPLINE OBJECTS

Primitives can be converted to editable spline objects. While less flexible than polygon based objects, spline objects can nonetheless be very useful at times.

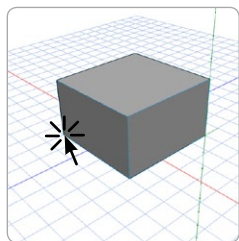
CONVERSION TO SPLINES

The resolution as set in the Object Properties palette does not affect the conversion from a primitive to a Bezier Surface Object.

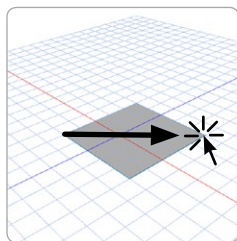
PRIMITIVES



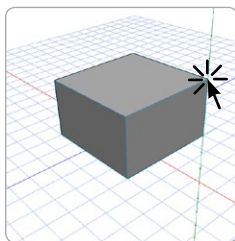
Click 1. Click, hold and drag to create the cube in one mouse movement. Simply release the mouse to finish.



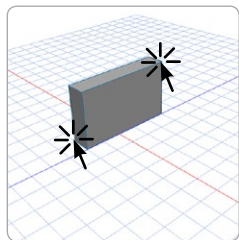
Click 1. Click, but don't hold the mouse, to define the start point.



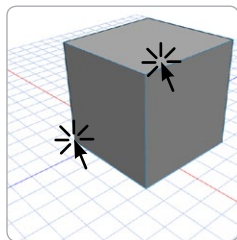
2. Drag to define profile size



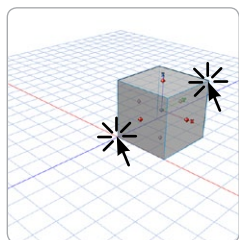
3. Click a second time, then pull up perpendicular to the grid to define the height. A final click will finish the creation.



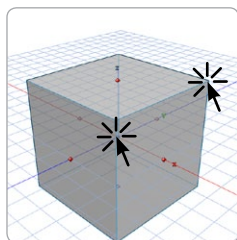
WITHOUT Shift held. The size of the primitive is not uniform but follows the click points of the mouse.



WITH Shift held. The primitive is created uniformly regardless of the mouse's position.



WITHOUT Option held. The primitive's lower corner starts at the first click point.



WITH Option held. The primitive's center is at the first click and is created outward.

CREATION METHOD

1 CLICK METHOD

A primitive can be created by clicking, holding and dragging the mouse. This creates a primitive in 3D using a single click.

3 CLICK METHOD

To first define the base profile size of a primitive, first click, then release the mouse and drag. Upon moving the mouse the object's 2d profile will be created. A second click will then create the 3D structure, moving it perpendicular to the active grid.

MODIFIERS

SHIFT

The Shift key creates a constrained primitive. This means it will be a uniform size in each axis.

OPTION

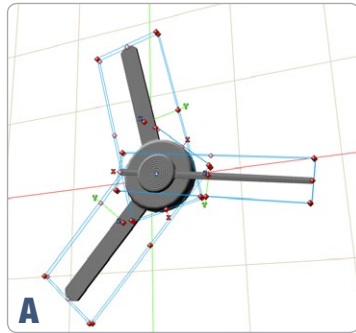
Holding the Option key creates the primitive from the center out. Instead of defining the lower corner, the first click will be the center of the primitive.

OPTION+SHIFT

Both modifiers can be held simultaneously in order to create the primitive from the center and with constrained proportions.

GROUPS

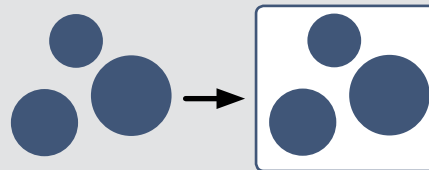
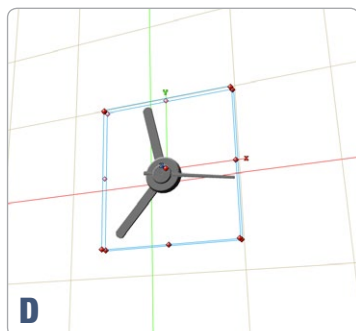
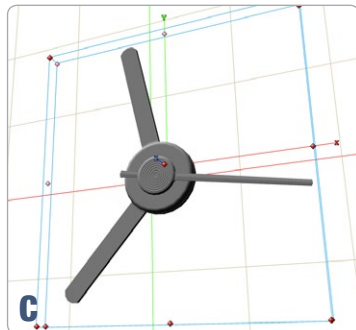
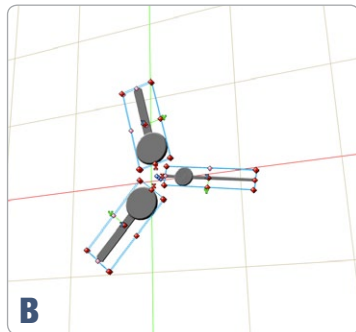
Groups are 'containers' which help to organize or temporarily manipulate either one or a collection of objects.



The top image (A) shows the original 3 objects.

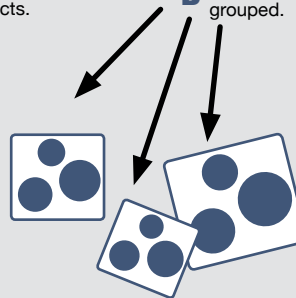
If a scaling factor is applied to all the items selected, each is scaled around its own center (B).

To scale around a single origin, the items are first grouped (C), then scaling is applied (D).



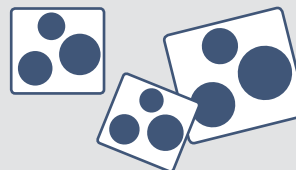
A 3 un-associated objects.

B These have been grouped.



C The group is duplicated 3 more times. Each is rotated and scaled. There are now 12 sphere objects in the scene, 3 in each group.

D Changes are made to the objects inside the original group.



E The groups that were duplicated are unaffected by the changes made to the items in the original group (B). This is because duplicating a group creates duplicates of the contents.

GROUP CHARACTERISTICS ORGANIZATION

A group is a way of putting a container around a series of objects. This allows all the contents of the container to be manipulated as a single object.

Double clicking a group opens a new window to reveal the contents. The included objects retain their original position, size, and scale, but now exist in a separate space.

Groups can also be nested, meaning a group can contain other groups (and instances).

TRANSFORMING A GROUP

The group can be moved, scaled and rotated as a single object. The group container has its own local coordinate system independent of its contents. Objects can be ungrouped and if rotated, scaled, or moved the contents take on these transformations.

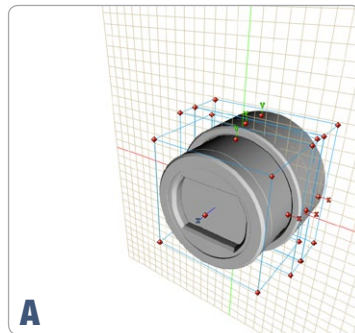
It's very common to temporarily transform a collection of items inside a group. As an example, a group could be used to rotate a series of objects around a common center point.

DUPLICATES

If a group is duplicated, the contents are duplicated, becoming new unlinked copies of the original data.

SHAPES / INSTANCES

Shapes are repositories of objects which help to organize the items in your scene. Multiple instances of this shape can populate the scene.

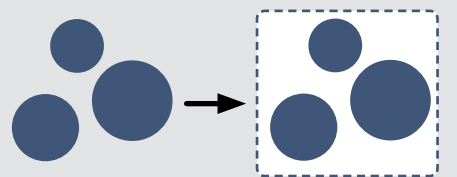
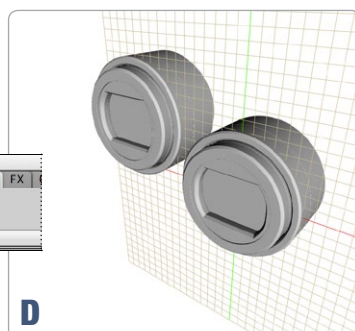
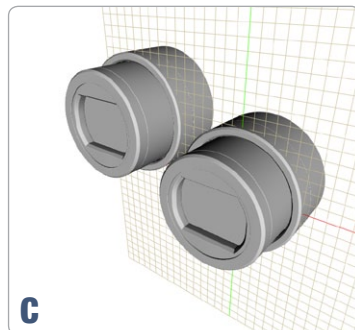
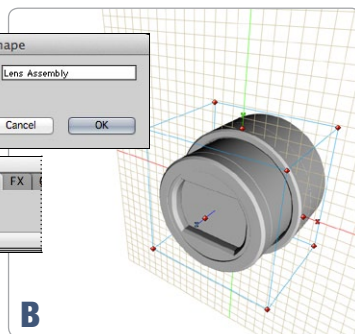


The top image (A) shows a collection of related items that are selected. Two are polygon meshes and one is a group of other objects.

A shape is made of those selected objects (Resource palette, Shapes tab) (B) and an instance now replaces the original items.

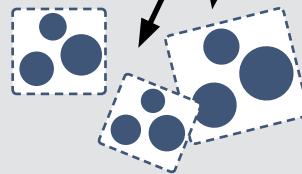
A duplicate of the original instance is made (C).

The lens group, inside the shape, is shifted back along the Z axis. Both instances reflect this change (D).



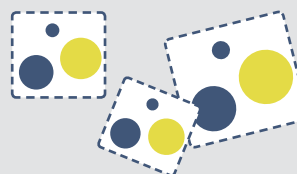
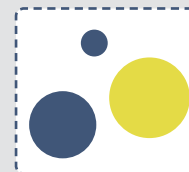
A 3 un-associated objects.

B A 'Shape' has been made. These objects are now contained inside it, and an 'instance' has been placed in the scene.



C The resulting instance is duplicated 3 more times. Each is rotated and scaled. There are now 4 instance objects in the scene.

D Changes are made to the objects inside the master shape (in the Resource palette).



E Each instance updates to reflect the changes made to the master data within the shape.

SHAPE CHARACTERISTICS ORGANIZATION

A **shape** is a storage mechanism used to manage items that will be used repeated times throughout a scene. Multiple 'instances' of the shape data can be used in the scene. This is much more efficient than simply duplicating the original item multiple times.

Shapes can also contain other instances of other shapes, groups, lights and spline or polygon meshes. This allows for simple or complex hierarchical scene organization.

INSTANCES

An instance is simple a reference object which links to the data inside the shape. The shape data resides in the Resource palette. Changes made to the contents of a shape update through every instance of this shape data used in the scene.

TRANSFORMING AN INSTANCE

Instances are very similar to groups regarding their behavior. They are containers around a collection of items. These items however refer back to the shape and aren't duplicates of the original data.

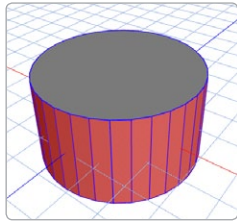
Each instance can be independently rotated, scale and positioned.

DUPLICATES

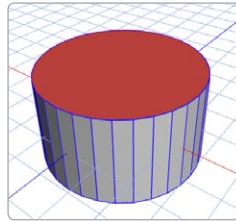
If an instance is duplicated, the contents are not duplicated, but are simply references back to the original shape data.

POLYGON MESHES

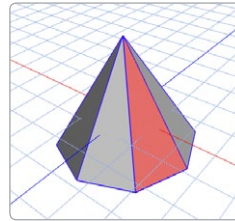
Polygon based objects make up the majority of common 3D geometry.



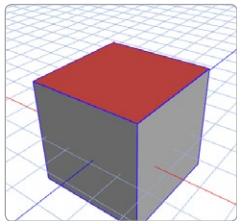
Quads selected



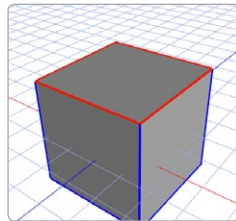
N-gon selected



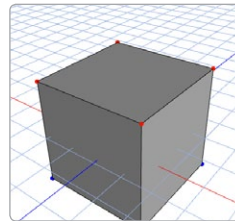
Triangles



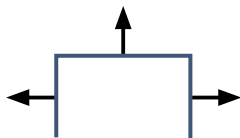
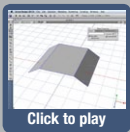
Polygon (face)



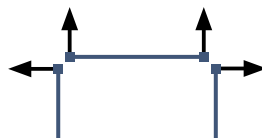
Edges



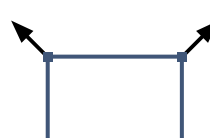
Vertices



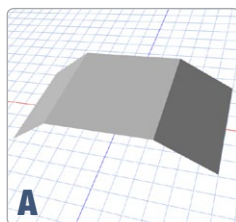
Face/Polygon normal
is perpendicular to the face.



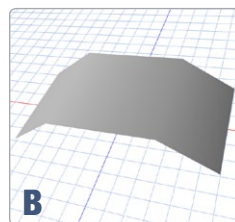
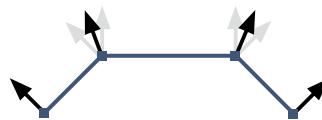
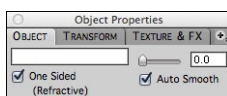
Vertex normal
of polygons which are
unconnected, they are
simply perpendicular to
the face.



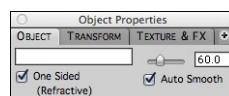
Vertex normal
of connected vertices.
Vertex normals on con-
nected (welded) vertices
are an average of sur-
rounding normals.



Vertex normals, not blended.
This creates flat shading.



Vertex normals, blended.
This creates smooth shading.



POLYGON TYPES TRIANGLES

The most basic polygon type is a triangle. A basic attribute of triangles is that they are always planar, each vertex is related to the other via their existence on a single plane.

QUADS

The most common (and desirable) polygon type is the quad. This is simply a polygon with 4 sides. Quads can be planar, meaning all 4 vertices lay on the same plane, or they can be non-planar.

N-GONS

A polygon can be composed of many sides. Polygons with more than 4 sides are called n-gons.

POLYGON COMPONENTS

Polygons meshes are composed of sub-components: edges, vertices, faces and non-visible elements called normals.

FACE, EDGE, VERTEX

The 'face' is the fill component of a polygon. The edge is the boundary between other polygons or open space; the vertex is the corner element.

Polygon meshes can be adjusted by directly manipulating each of these elements under different circumstances.

NORMALS

The 'normal' is, at its heart, a perpendicular relationship to each of the polygon sub-components.

For instance, a polygon 'face' has an imaginary line that runs perpendicular to this surface. This normal is used for surface shading in addition to modeling operations. For instance, a polygon can be moved along its 'normal' direction.

Some tools have a 'normal' tool variant. These are designed to operate by manipulating the elements relative to the normals. For instance the Rotate Normal Tool rotates a polygon around its normal.

NORMALS AND SHADING

Normals are also used for shading. A polygon is flat. To create the illusion of curvature across a surface composed of flat polygons, neighboring, connected vertex normals are blended together across the flat surface (B). This is called 'surface normal shading'.

Shading can be 'broken' either by angle, by manually unwelding geometry, or via a mechanism called 'hardness'. Hardness preserves vertex welding but prevents surface normal shading across an edge or vertex.

The polygon mesh shading is controlled globally via the Object Properties palette. The 'Auto-Smooth' function determines shading if the adjoining vertex normals are within a defined angle threshold.