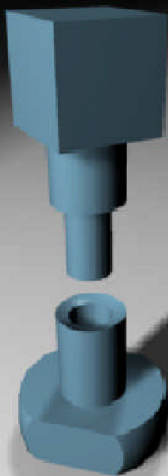


# 1

## Booleans

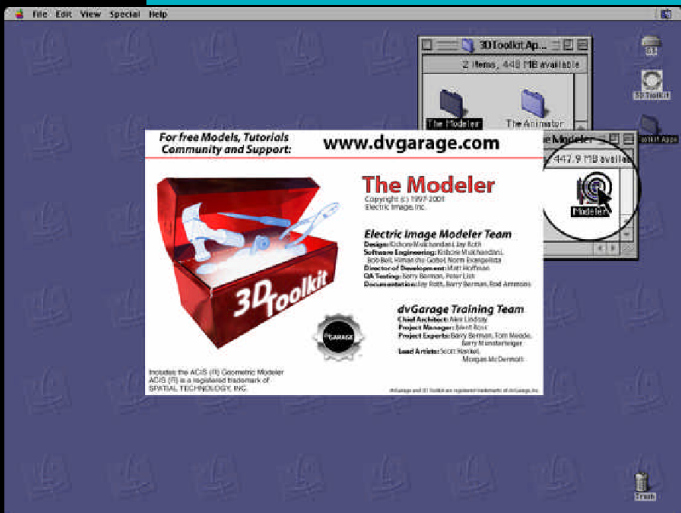


Complex objects are always a collection of simple shapes that are elegantly arranged to provide the necessary detail. Booleans are a key component of this process. Booleans use the overlap of two objects to create new objects. You can combine 2 objects, save just the intersection, subtract one from another, and more. When building mechanical objects you will use these tools many many times. As you start to get used to them, you will start to see the world around as a collection of simple shapes rather than a group of complex ones. We will be looking at four basic Boolean functions: union, subtraction, intersection and split. There are more Boolean methods, but for now we will look at these basic four.



### Overview

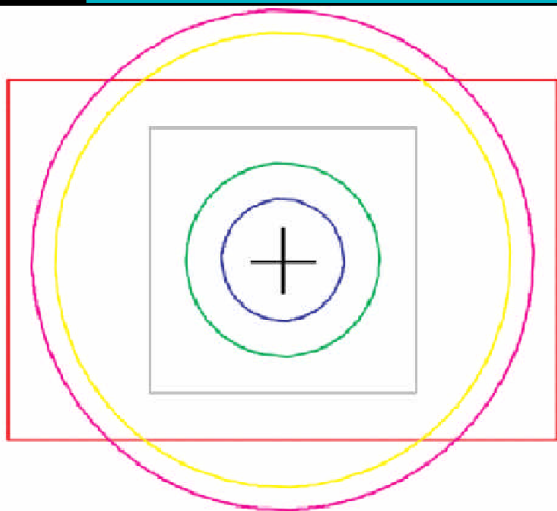




**[DBL+CLK]** the Universe Toolkit Modeler application program to launch the EI Modeler.

Note: Macintosh keyboard commands are indicated in **red**.  
PC keyboard commands are indicated in **blue**.



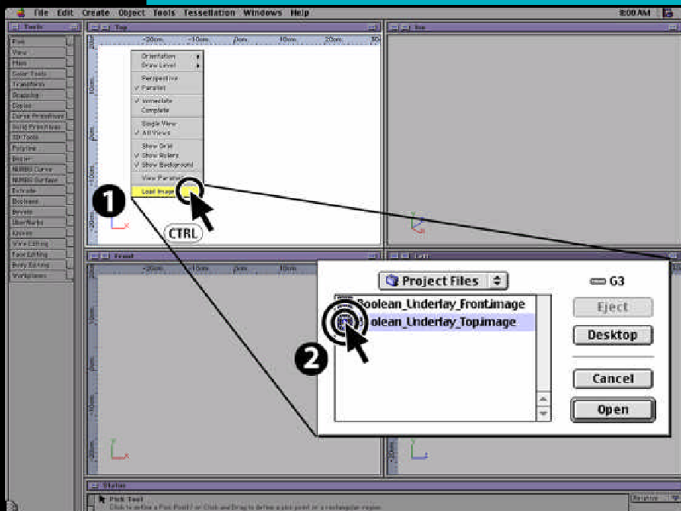


Before we begin, we will need to load our underlays as a guide for what we are about to create. You can load underlays into any or all the views to guide you along with your work. We will load underlays into the top and front views. While underlays may seem tedious, they save hours of work. Think of underlays as blueprints that guide you along. You will definitely use them of ten. The Modeler treats underlays as objects. So, to avoid any accidental movement of the underlay, we will lock them.



# 4

## Placing the Top Underlay



In the Top View window, [**CTRL/R+CLK**] and select Load Image Template.

[**DBL+CLK**] the Boolean\_Top\_Underlay.image file.

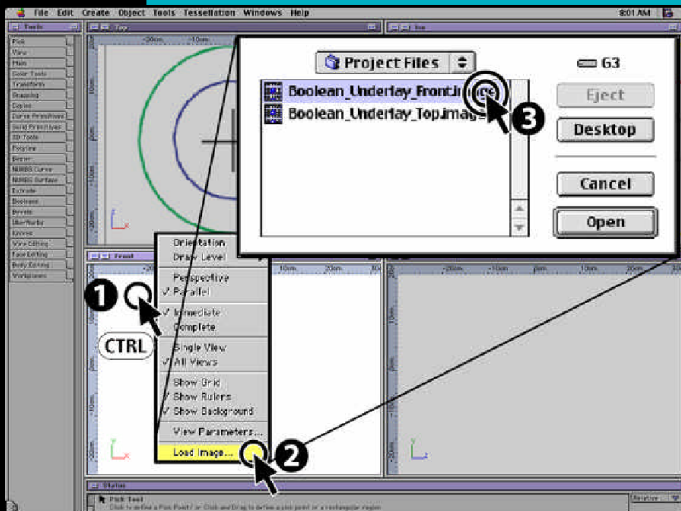
Note: 3D modeling can be complicated. Underlays allow you to have a reference that simplifies the process.



Underlays







In the Front View, [**CTRL/R+CLK**] and select Load Image Template.

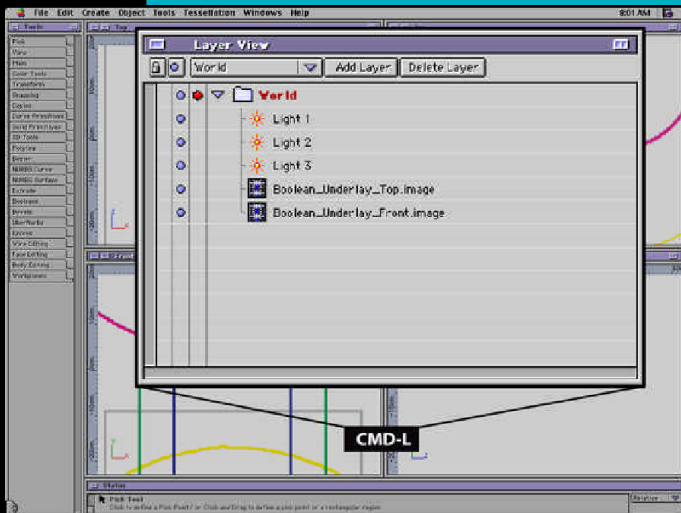
[**DBL+CLK**] the Booleans\_Front\_Underlay.image file.

Note: Using two to three underlays is common when modeling.



## 6

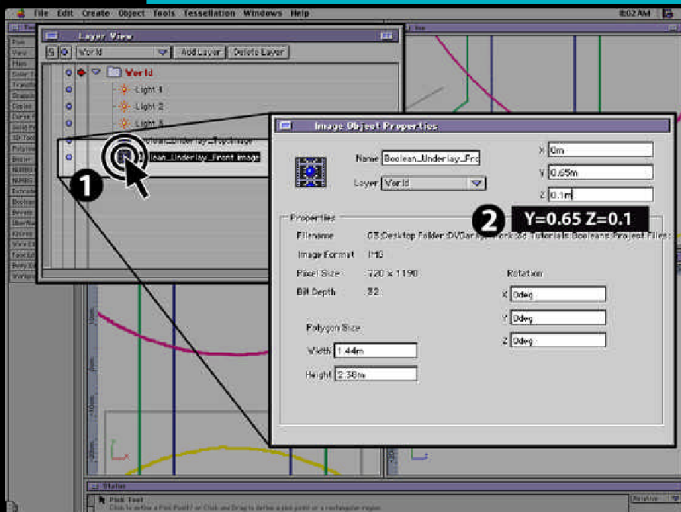
## Opening the Layer ViewWindow



Press [**CMD/CTRL+L**] to open up the Layer View window.

Note: You can use the layer window to get direct access to every object in a scene.



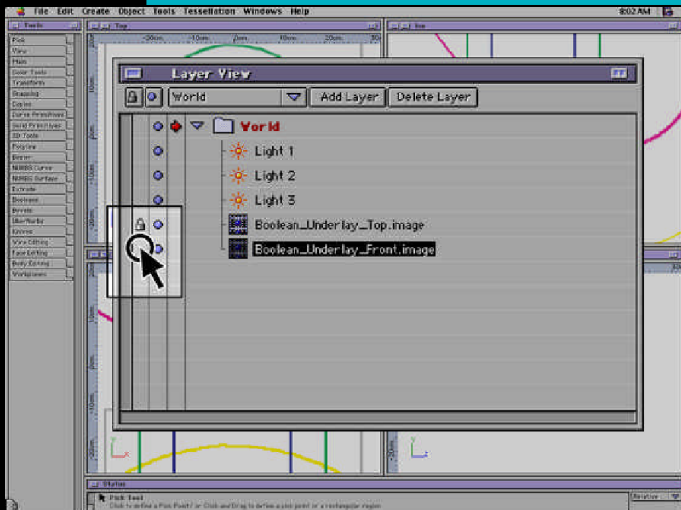


[DBL+CLK] the Boolean\_Front\_Underlay.image object to open up the Properties window.

For the position of the template, enter 0.65 for Y and 0.1 for Z.

Note: Carefully lining up underlays can really make the modeling process easier.

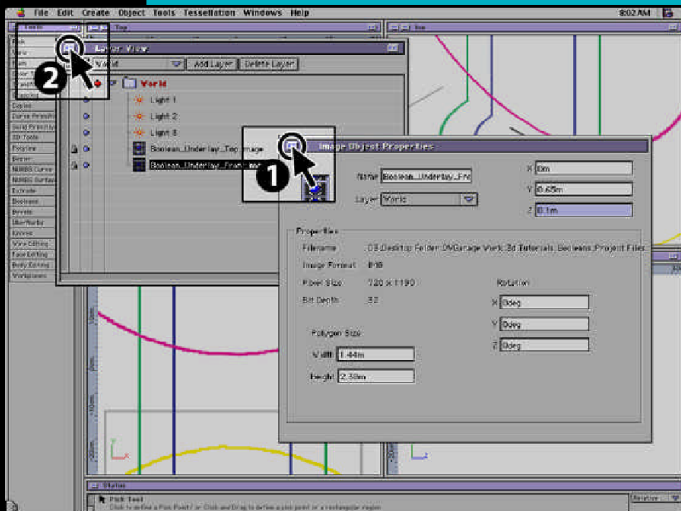




In the Layer View window, **[CLK]** in the lock column to lock both template images.

Note: Locking objects and templates keeps you from accidentally selecting or moving them later while modeling.

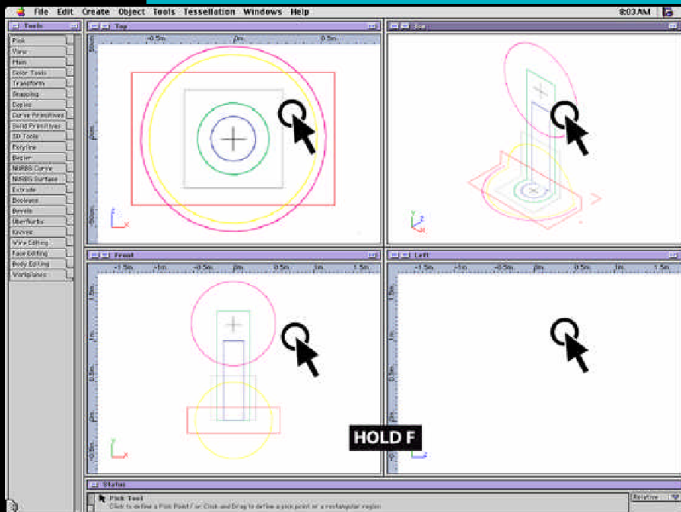




**[CLK]** the boxes in the upper left corners of the Image Object Properties and Layer View windows to close them.

Note: While you can use many image formats, it is best to use the image format when using either the Modeler or Animator.

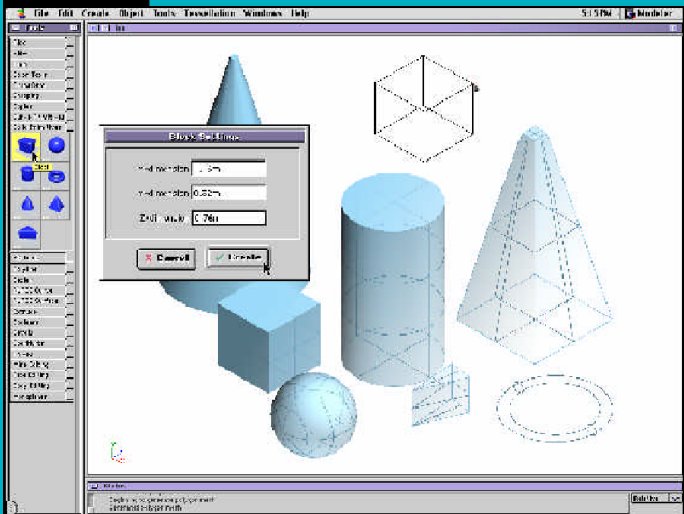




Press **[F]** and **[CLK]** in each of the four windows to fit the views. You may need to **[F+CLK]** more than once to fit everything to the window.

Note: Four windows often give you the needed perspective for creating objects in 3D space.



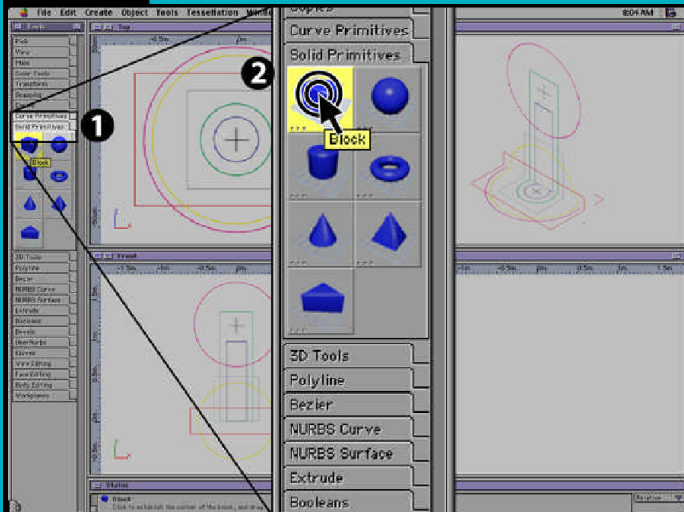


There are a number of ways to create our simple objects in 3D space. All of the objects we create in this tutorial will be created from the Solid Primitives palette. There are two ways to use the Solid primitives: interactive or numeric. In this tutorial, we will show you both.



## 12

## Creating a Block



**[CLK]** on the Solid Primitives palette.

**[DBL+CLK]** the Block tool.

NOTE: Primitives are basic objects often used as building blocks for more complex models.



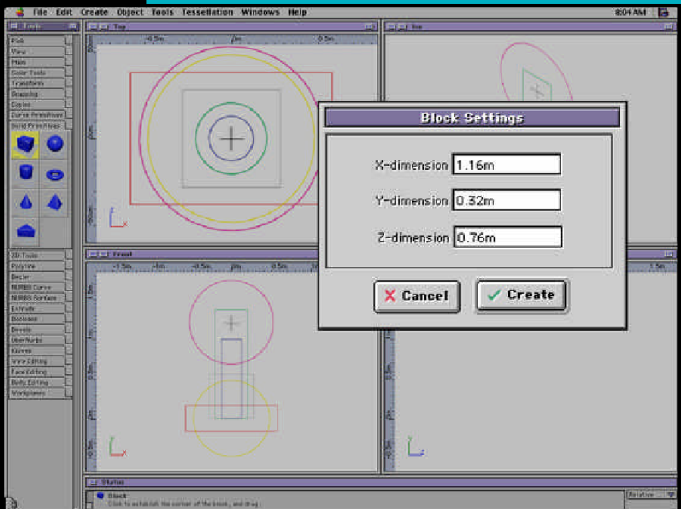
## Creating Shape One





# 13

## Entering Block Parameters



Enter the following values for the initial block:

X-dimension: 1.16

Y-dimension: 0.32

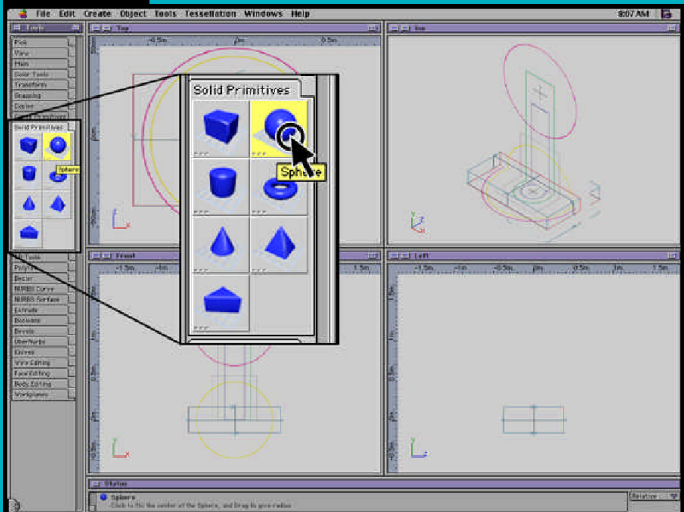
Z-dimension: 0.76

[CLK] the create button or hit [RTRN] on the keyboard.



### Creating Shape One



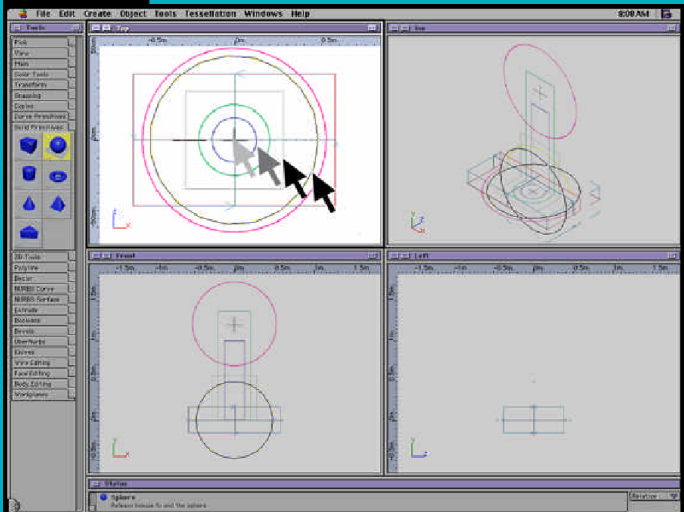


Open the Solid Primitives tool palette and select the Sphere tool.

Note: The Sphere is a parametric object, which is generated from an equation. Its surface is very accurate and smooth.



## Drawing the Sphere



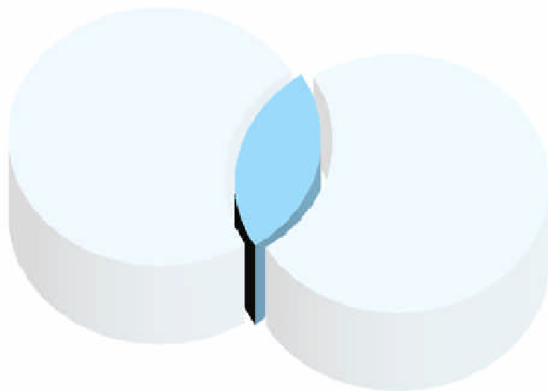
In the Top View window, position the cursor at the center of the crosshairs. **[CLK+DRG]** a sphere that closely approximates the yellow circle template.

Note: If you create and use precise underlays, your modeling usually will be much easier.



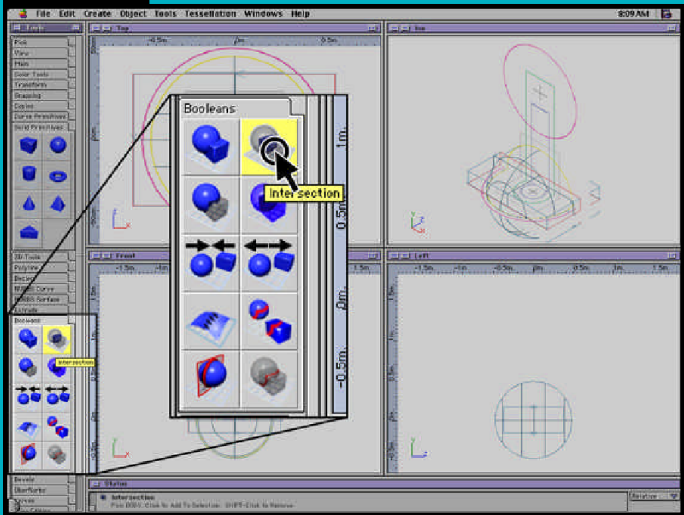
## Creating Shape One





The Intersection function will take two or more objects that intersect and create a new object where the objects had overlapped.

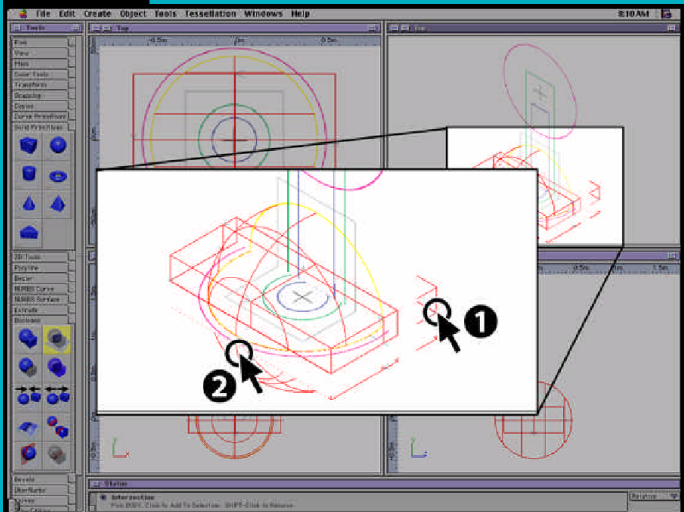




Open the Booleans palette and select the intersection tool.

Note: The Intersection tool saves only the volume where a group of objects overlap and deletes the rest.

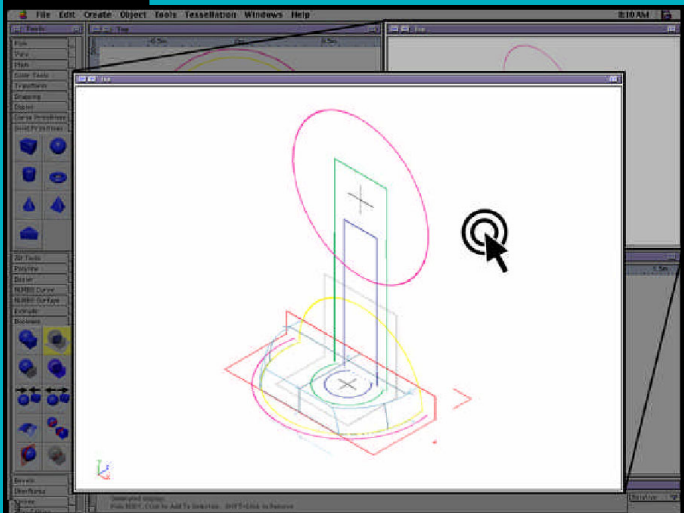




In the Iso View window, **[CLK]** once on the rectangle and once on the sphere. They will turn red when selected.

Note: You can include more than two objects in a Boolean function.

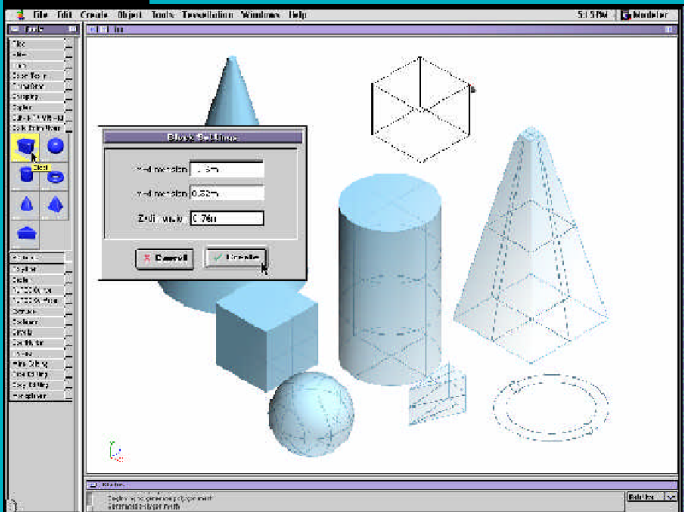




In the Iso View window, **[DBL+CLK]** in the empty space around the object to perform the intersection operation.

Note: Double clicking in the Modeler generally completes or commences a given function.

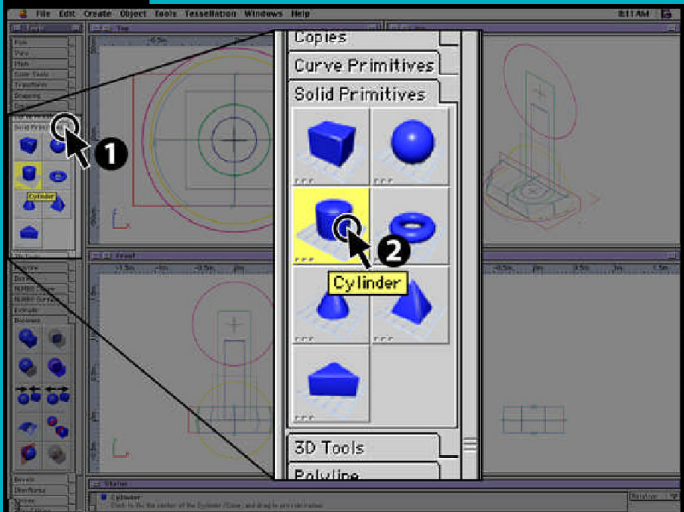




In this section we will be creating a cylinder that will be used as the receiver for our doohickey.



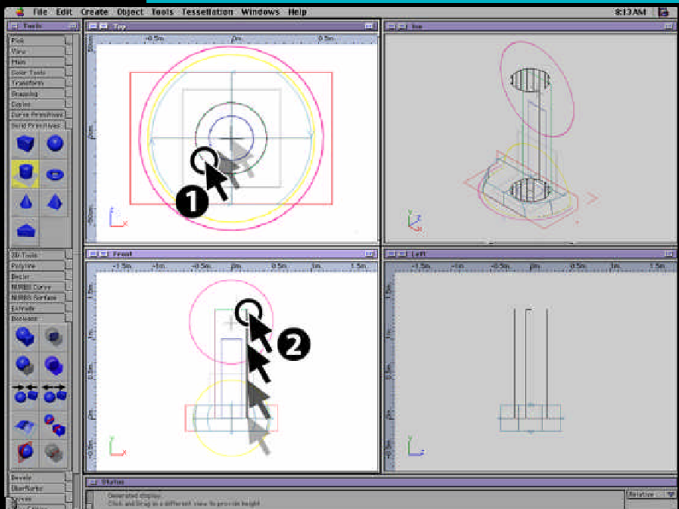




Open the Solid Primitives palette and select the Cylinder tool.

Note: Like the Sphere, the Cylinder is a parametric object.



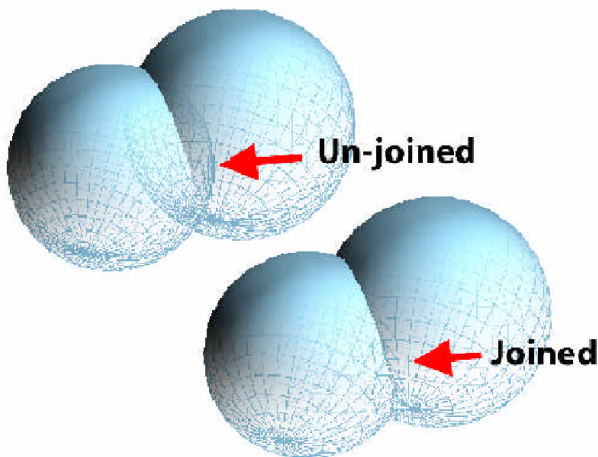


In the Top view window, start at the cross hairs and **[CLK+DRG]** a circle following the green circle template.

In the Front View window, **[DRG]** the mouse to match the height of the cylinder on the green rectangle template.

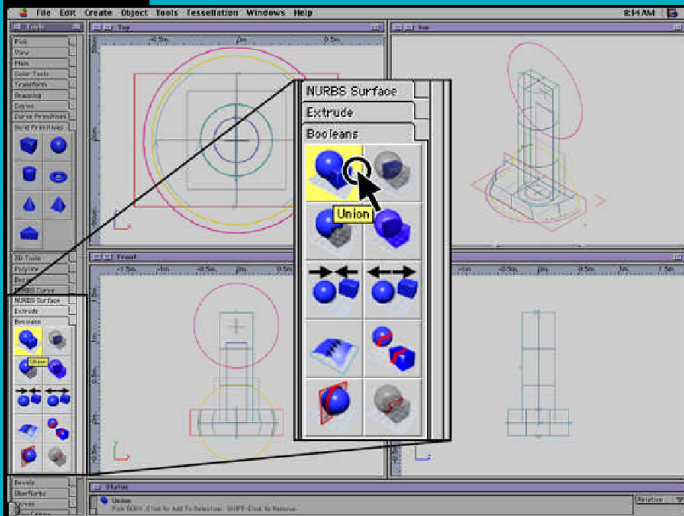
When the cylinder height matches the green rectangle template, **[CLK]** to set the height.





The Union function will take two or more intersecting objects and join them together to create a new object.

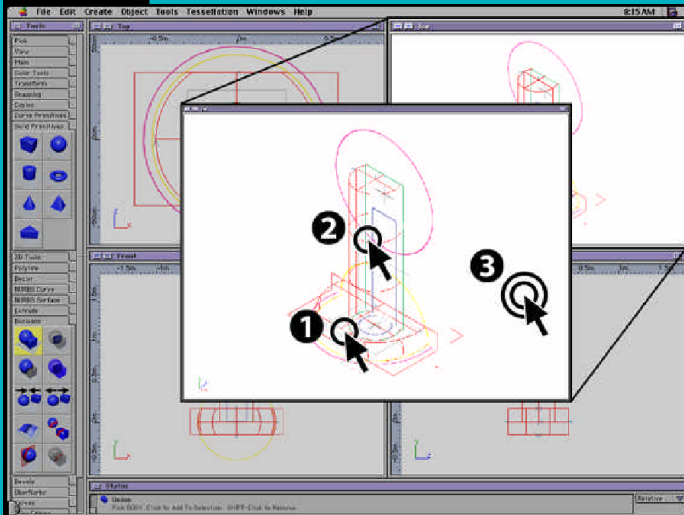




Open the Boolean palette and select the Union tool.

Note: A Union function deletes the area that a group of models share and fuses the remainder into one model.



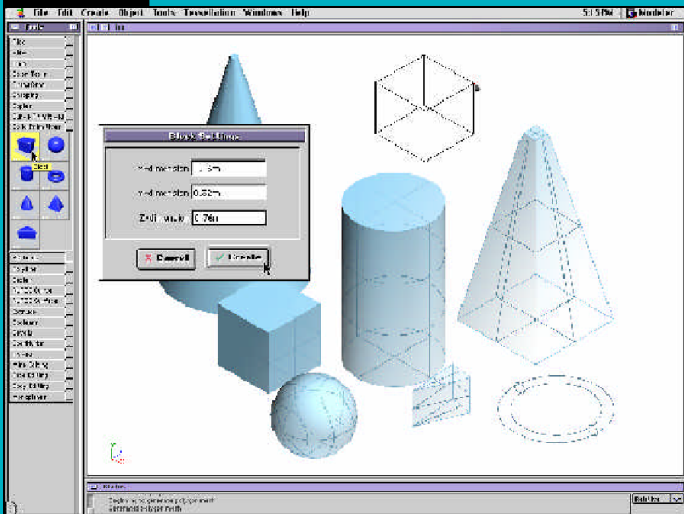


In the Iso View window, **[CLK]** on the cylinder and the sphere to select them.

**[DBL+CLK]** away from the objects in any window to perform the operation.

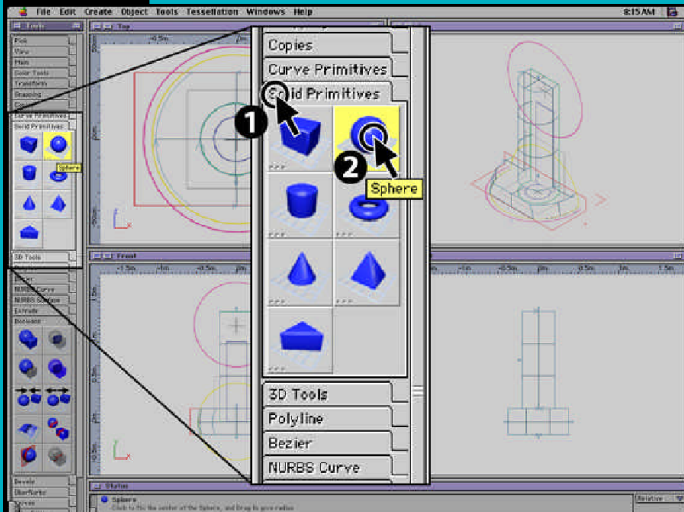
Note: The original objects are deleted when the Boolean function is performed.





In this section we will be creating a sphere to be used for a boolean split function.

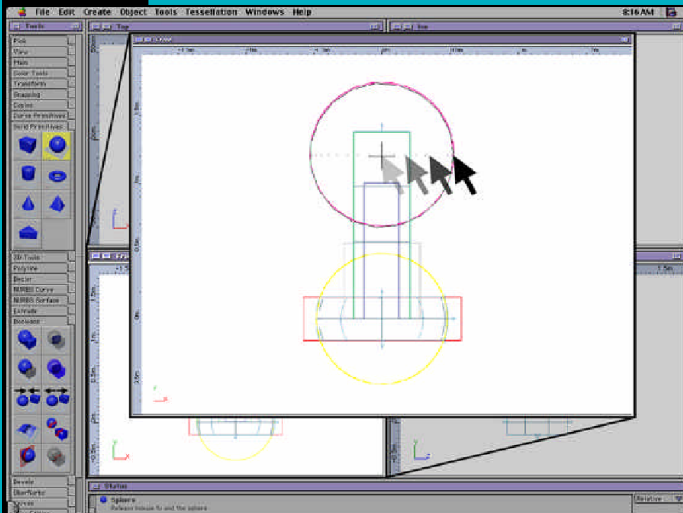




Open the Solid Primitives palette and select the Sphere tool.

Note: While they seem very simple, primitive objects can be cut and tailored into many different elements of complex models.



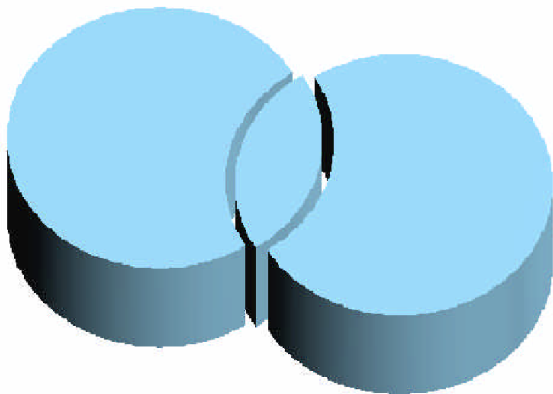


In the Front View window and starting in the center of the crosshairs, **[CLK+DRG]** out a sphere that closely approximates the pink circle in the template.

Note: You can numerically adjust object positions after creating them by double clicking on them in the Layer window.

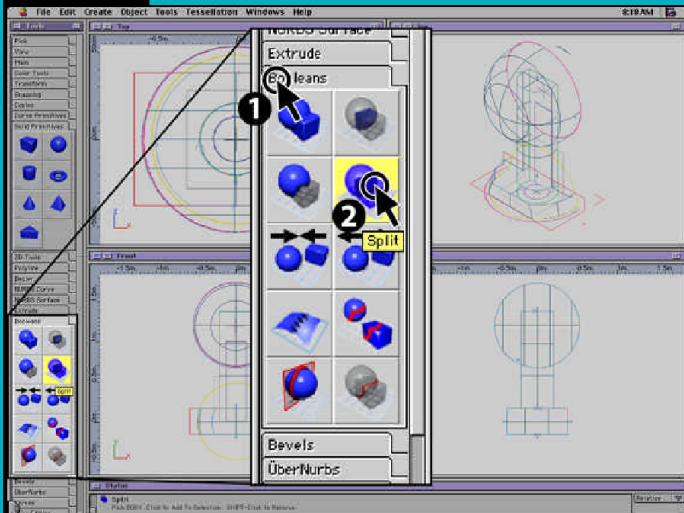




**Exaggerated View**

The Split function is similar to the Intersection function but works only with two objects. The result of the split leaves the original shapes but divided where they intersected.

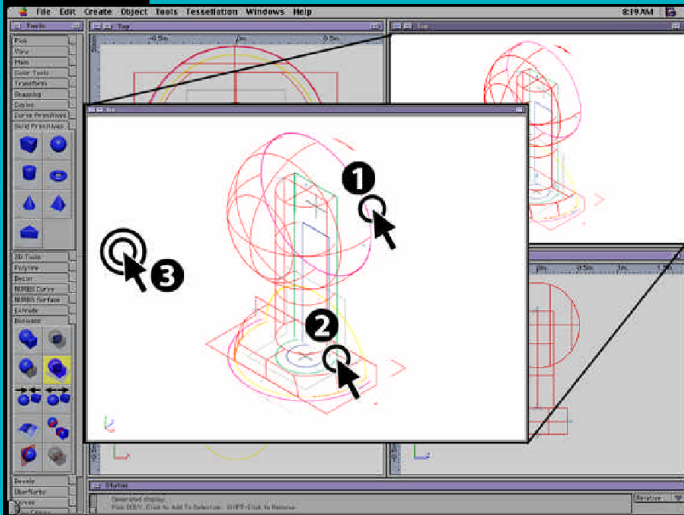




Open the Booleans palette and select the Split tool.

Note: The Split tool looks at the volume shared by two objects and splits each object at the points where they intersect with one another.

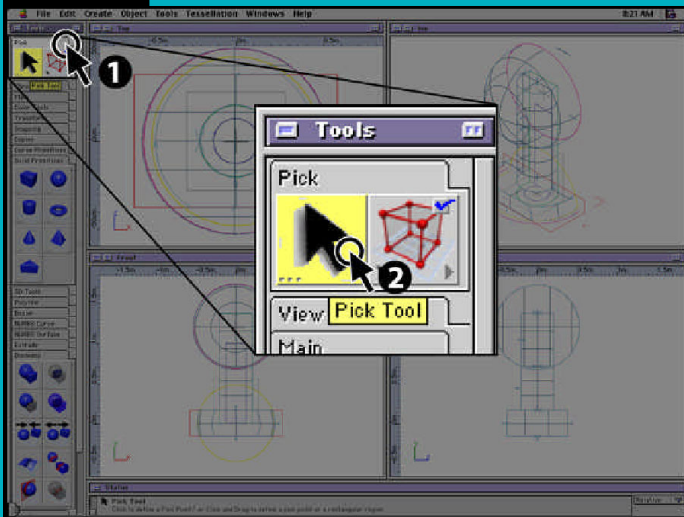




In the Iso view window, **[CLK]** the two objects to select them.  
**[DBL+CLK]** away from the objects in any window to perform the operation.

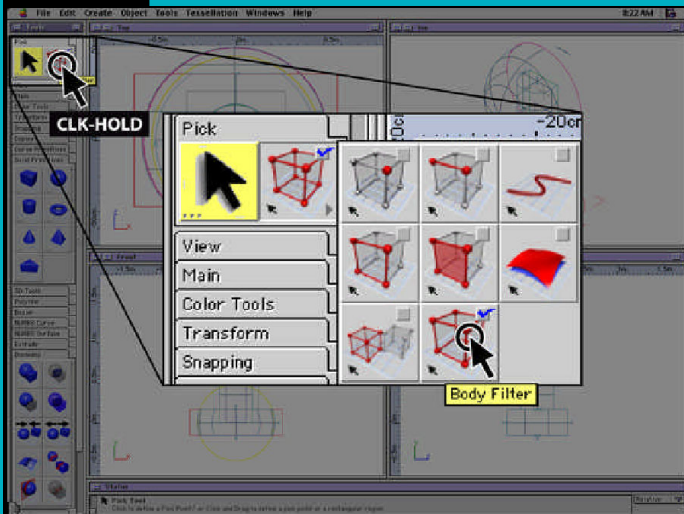
Note: The Split tool can be a powerful tool when building matching parts.





Open the Pick palette and select the Pick Tool.

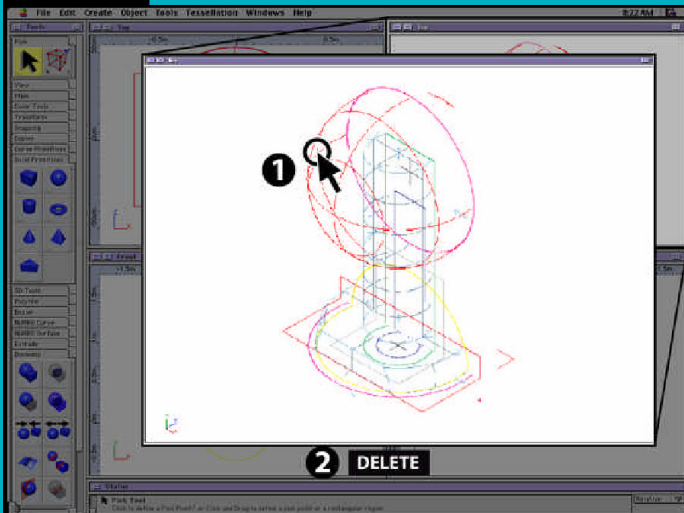




[CLK+HLD] the Filter Options and then select the Body Filter option.

Note: The Body Filter controls the types of geometry you can pick. You can set it to pick entire objects or single points and segments.



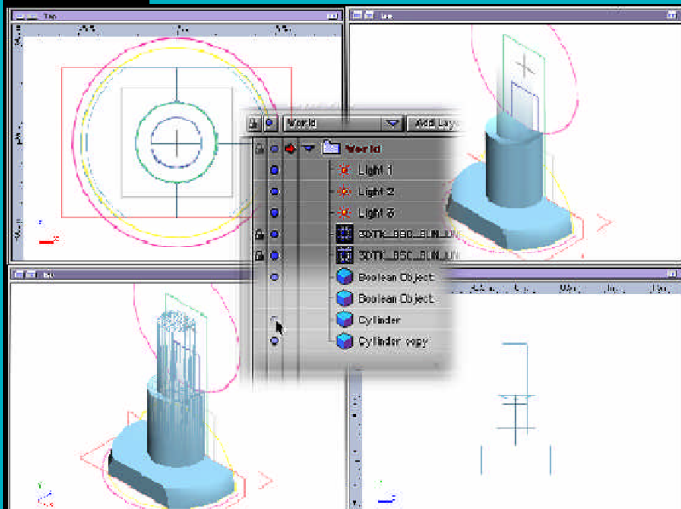


[CLK] the sphere in any of the view ports to select it.

Press [**DELETE**/**BACKSPACE**] to remove it.

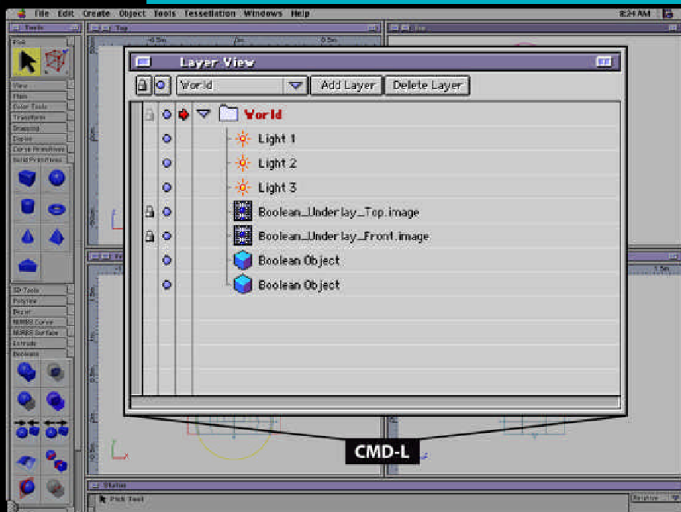
Note: We are deleting the sphere because we only needed it to split the cylinder.





It is sometimes necessary to hide objects. We do this so that they do not interfere in the creation of other objects. It also reduces screen clutter, which takes the guesswork out of which object you are working with.

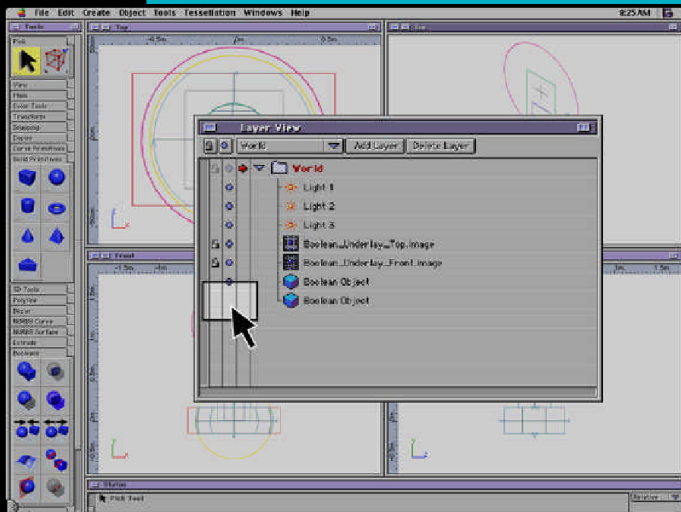




Press [**CMD/CTRL+L**] to open the Layer View window.



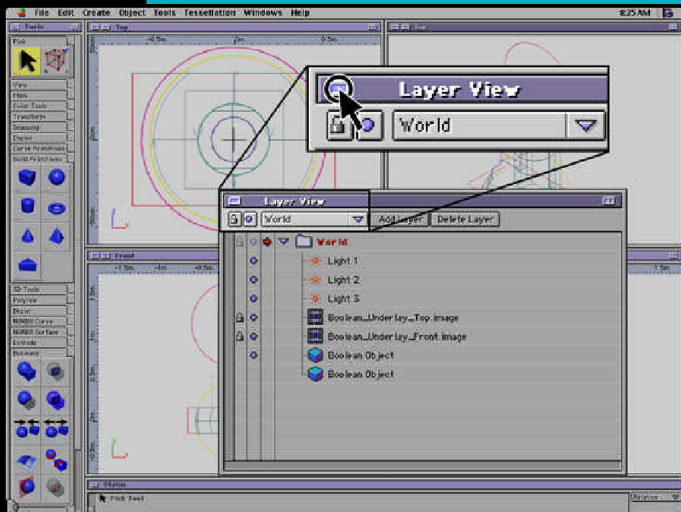




**[CLK]** the blue visibility dot next to the last Boolean Object at the bottom of the list.

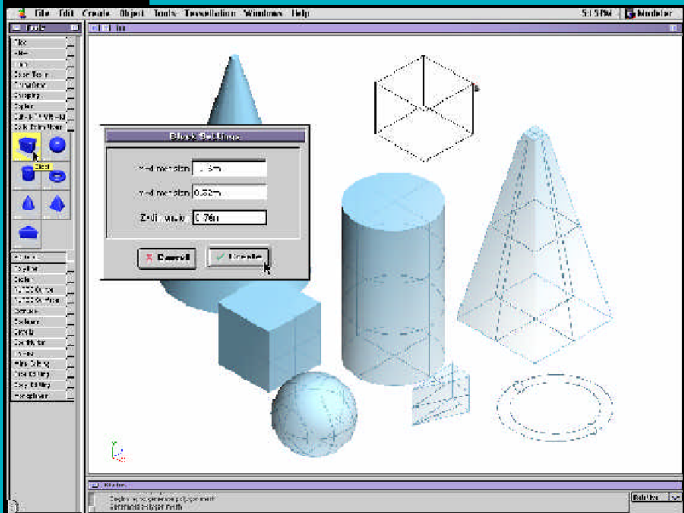
Note: It is often easier to turn off objects you don't need in your scene to simplify your workspace.





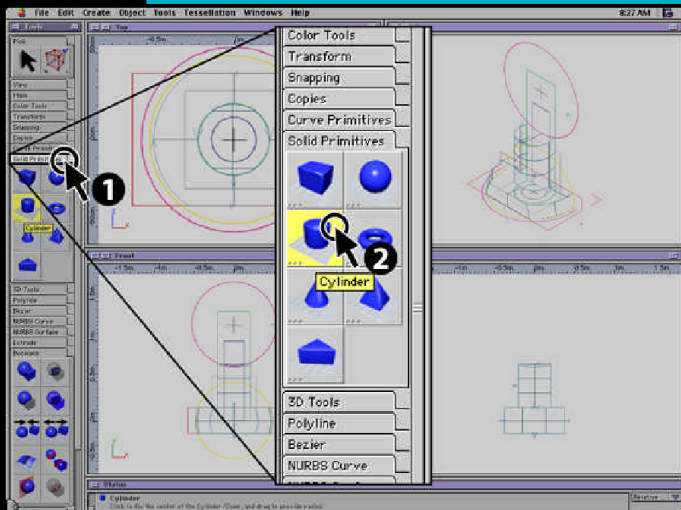
**[CLK]** the box in the upper left corner to close the Layer View window.





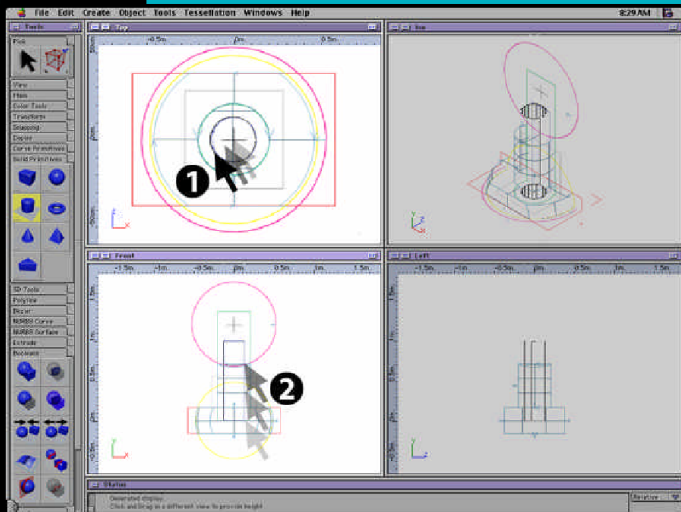
In this section, we will create a cylinder that will be used for two functions. We will move this cylinder into place, then duplicate and hide one of the cylinders. One of the cylinders will remain as the shaft of the doohickey that inserts into the base. The other cylinder will be used in a later section to remove a portion of the base object we built earlier.





Open the Solid Primitives palette and select the Cylinder tool.

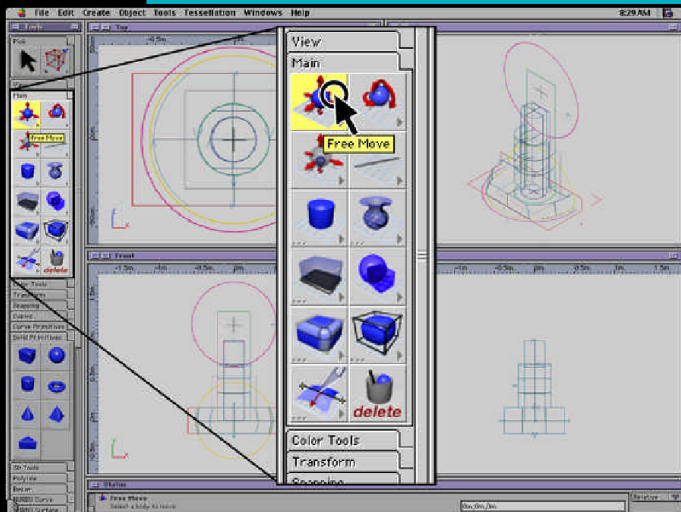




In the Top View window, **[CLK+DRG]** a circle starting at the cross hairs, and following the blue circle template.

In the Front View window, **[DRG]** the cylinder to its proper height on the blue rectangle template. **[CLK]** to set the height.

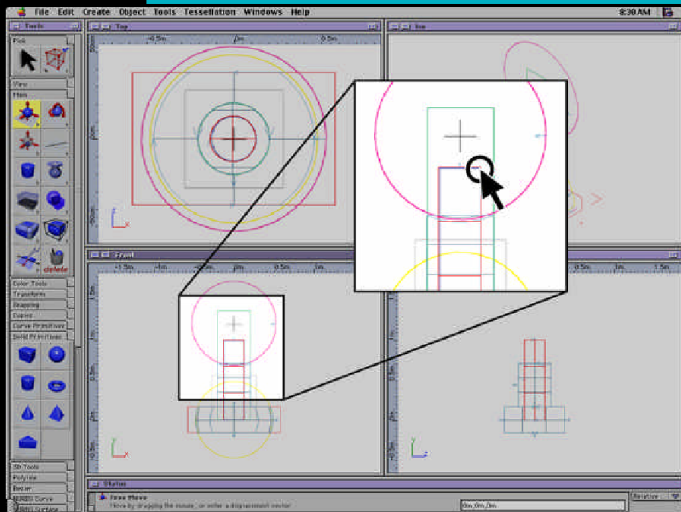




Open the Main palette and select the Free Move tool.

Note: The Main palette has a collection of some of the most used tools in the modeler.

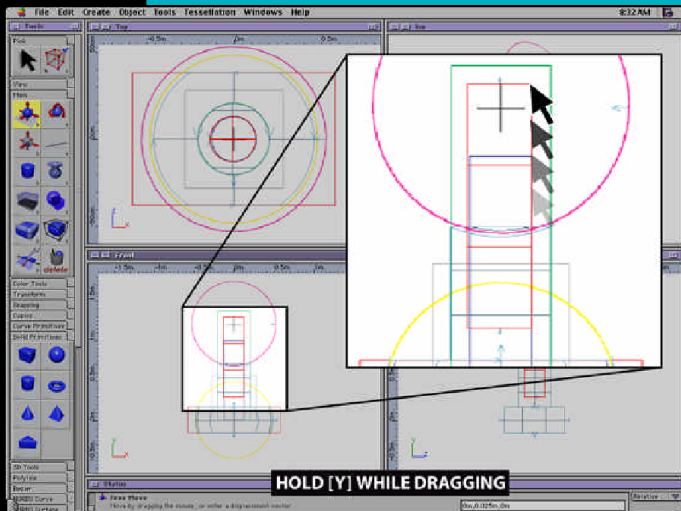




In the Front View window, **[CLK]** on the upper part of the cylinder to select it.

Note: In the four views, you can usually find a given angle from which you can easily select a given object without accidentally selecting others.



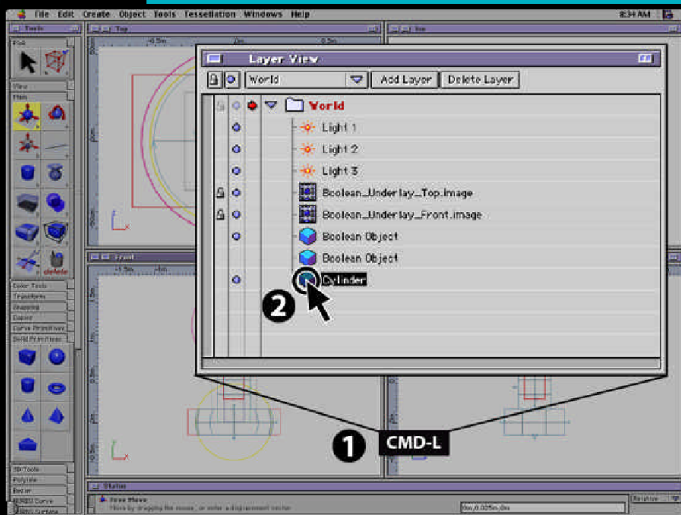


In the Front View window, hold down **[Y]** and **[DRG]** the cylinder so it is above the red rectangle and still inside the green rectangle on the template.

Note: Holding down either x, y or z will constrain the movement of an object along that axis.





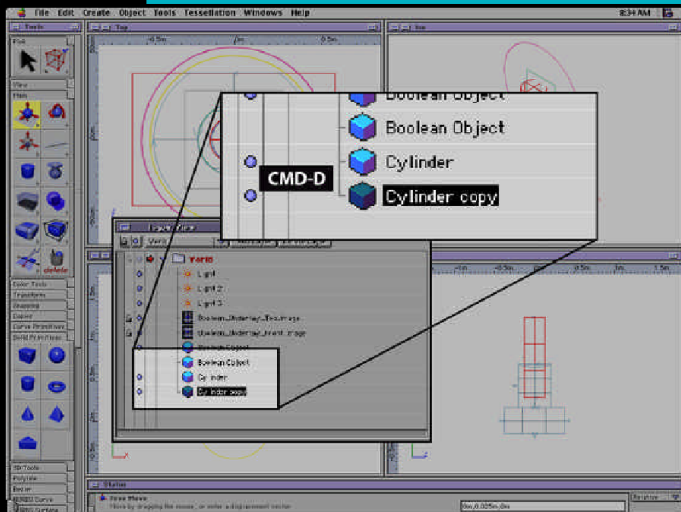


Press [**CMD/CTRL+L**] to open the Layer View window.

Select the cylinder model.

Note: Often times, it's easier to select a model in the layer window than in the view windows.

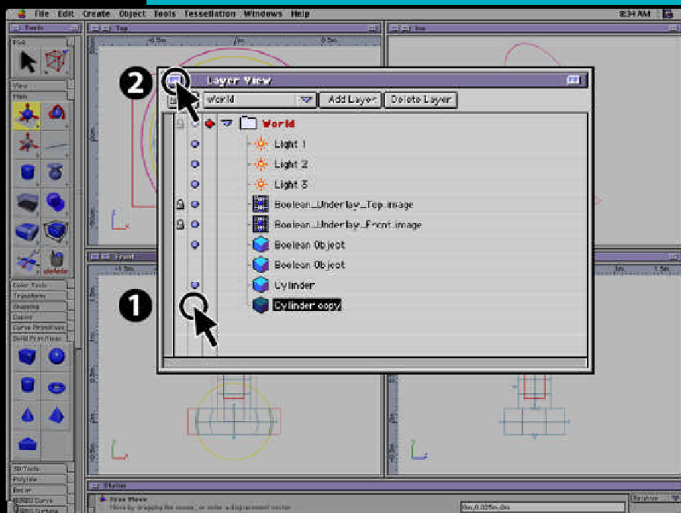




Press [**CMD/CTRL+D**] to duplicate the cylinder.

Note: We are duplicating the cylinder because we will be using it twice. The original object will be deleted both times.



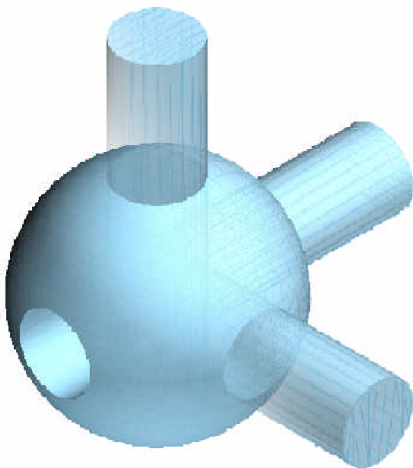


**[CLK]** on the blue visibility dot next to Cylinder copy.

Close the Layer View window.

Note: Turning off one of the cylinders makes it easier to do the next few operations cleanly.

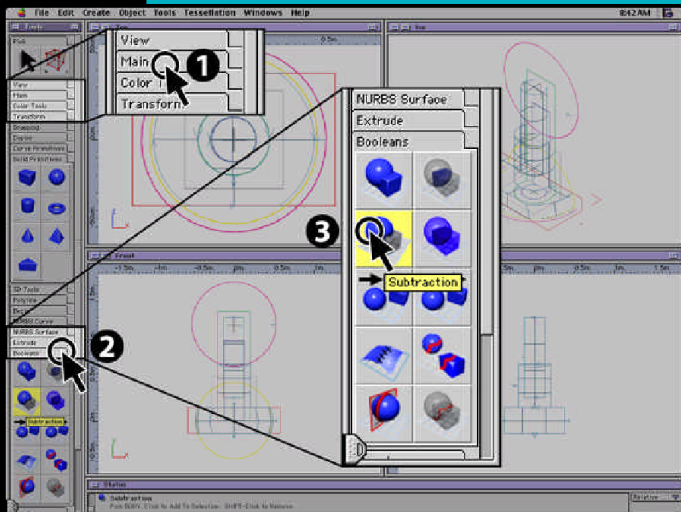




The Subtraction function allows you to use objects as cutting devices to remove portions from another object.

For this tool to work flawlessly, always **[CLK]** on the object you want to edit first, then **[CLK]** on the object(s) you want to use as your cutting device. Finally, **[DBL+CLK]** in empty space to commit the operation.



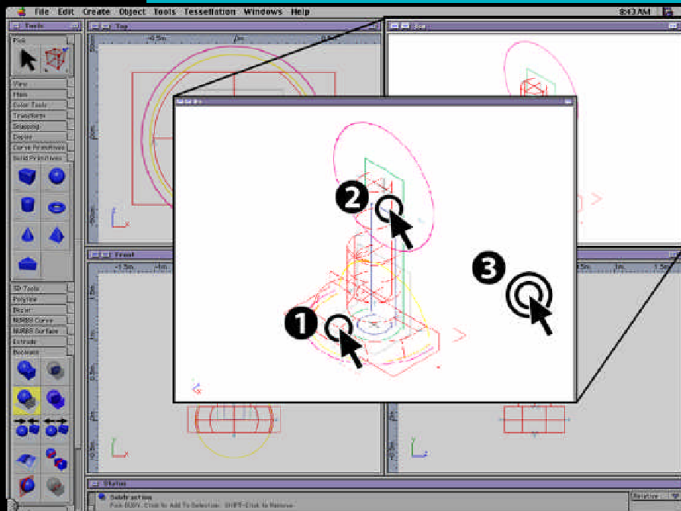


Close the Main Tool palette.

Open the Booleans palette and select the Subtraction tool.

**Note:** The Subtraction tool subtracts the volume of the second object from the first.





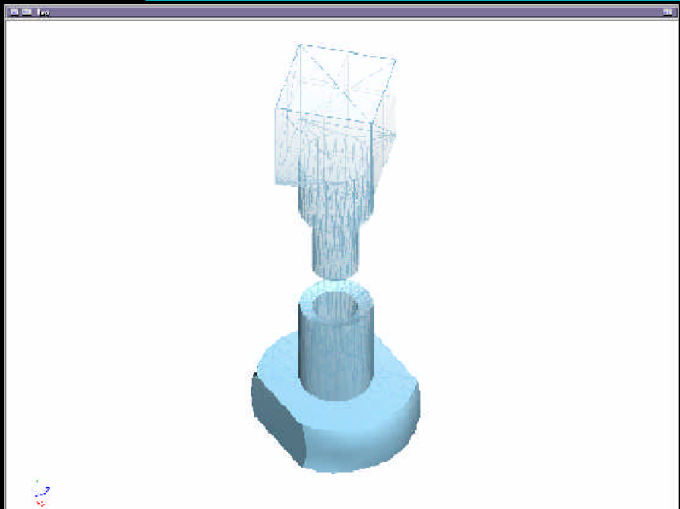
In the Iso View window, select the Boolean object that was created prior to the cylinder.

Next, select the cylinder.

**[DBL+CLK]** in empty space around the objects in any window.

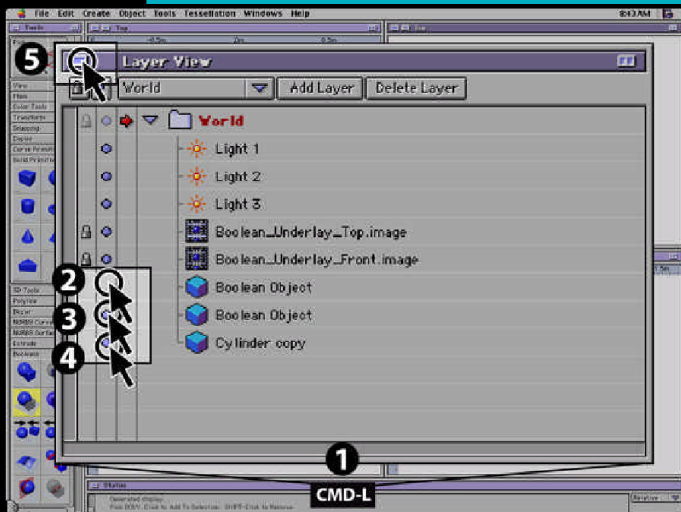
Note: The first cylinder was deleted in this step which is why we'll need the second one for the next operation.





In the following steps we will finish creating the doohickey by creating some more objects and combining them with what we have already created. We will also organize our objects in the Layer View window.





[**CMD/CTRL**+**L**] to open the Layer window.

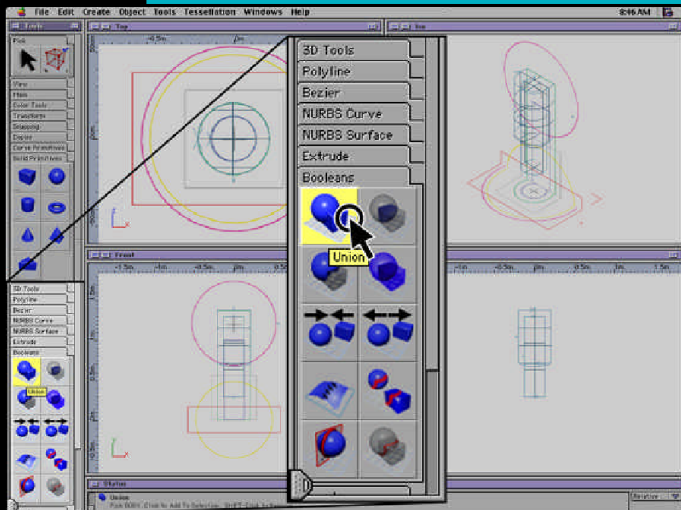
[**CLK**] on the blue visibility dot next to the top Boolean Object.

[**CLK**] in the visibility column next to the second Boolean Object and the Cylinder Copy.

Close the Layer View window.

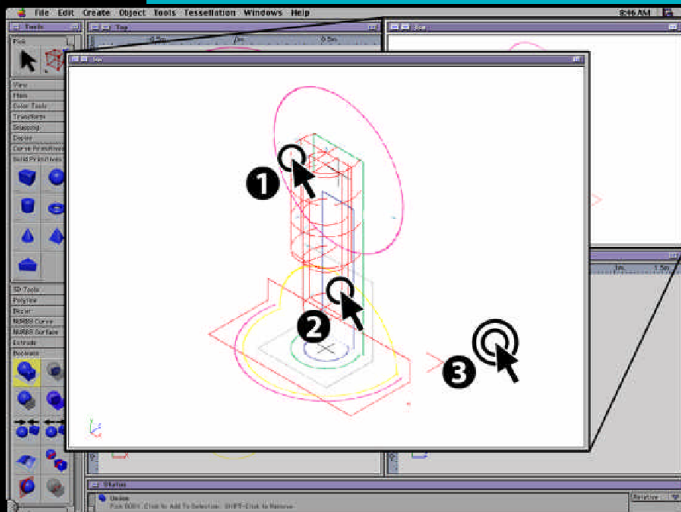






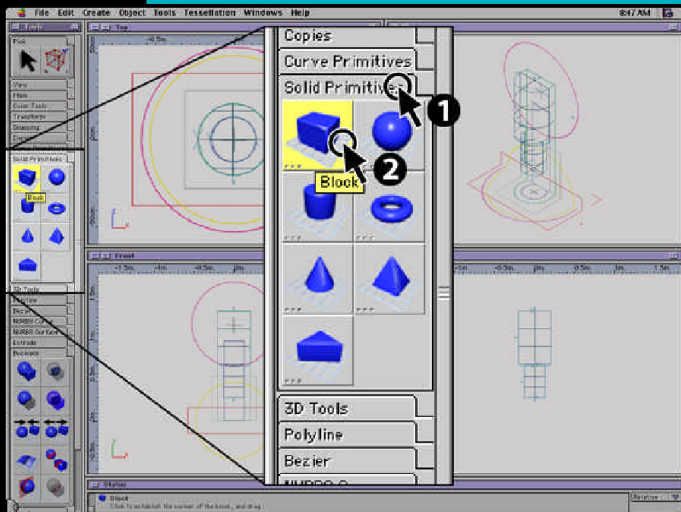
Open the Booleans palette and select the Union tool.





In the Iso View window, **[CLK]** on both objects. **[DBL+CLK]** in empty space to perform the operation.

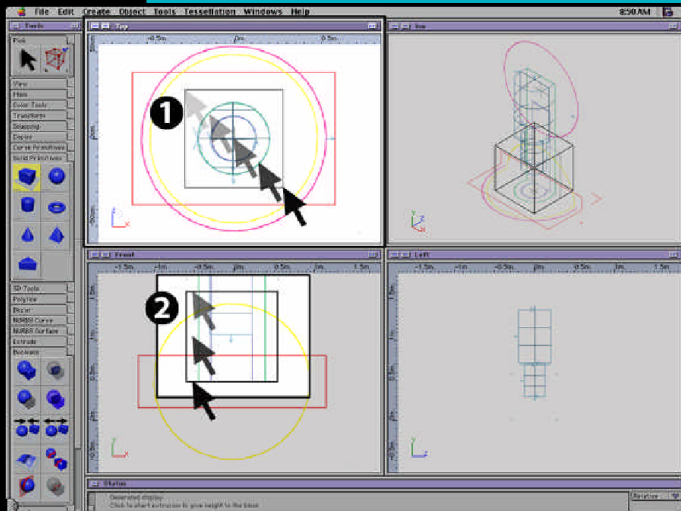




Open the Solid Primitives palette and select the Block tool.

Note: If you **[DBL+CLK]** the Block tool, you can enter the dimensions numerically.

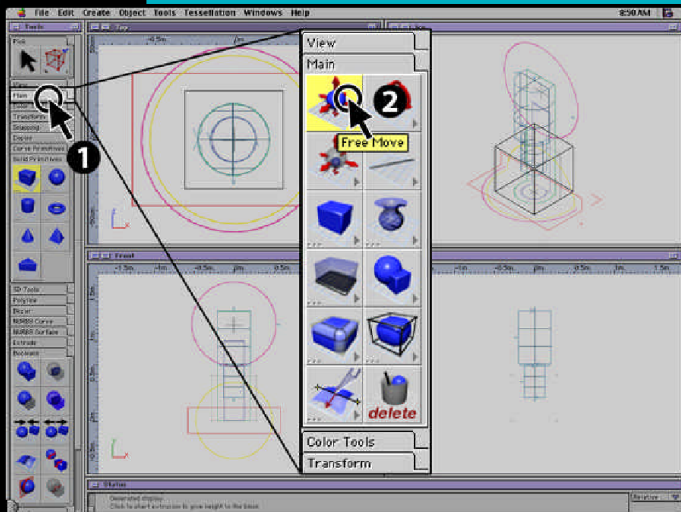




In the Top View window, start at one of the corners and **[CLK+DRG]** a square to match the gray square in the template.

In the Front View window, **[DRG]** to match the gray rectangle, and **[CLK]** to set the block height.

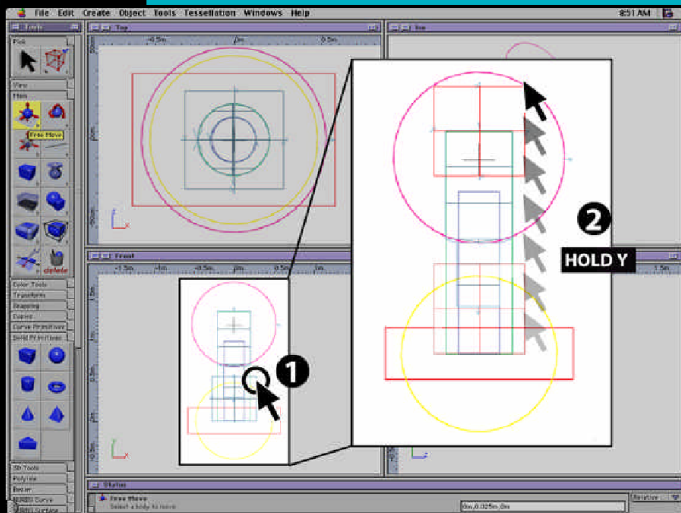




Open the Main palette and select the Free Move tool.

Note: If you hold the **[CLK]** for a moment, you will see other move options. It is easier to just use the keyboard shortcuts.



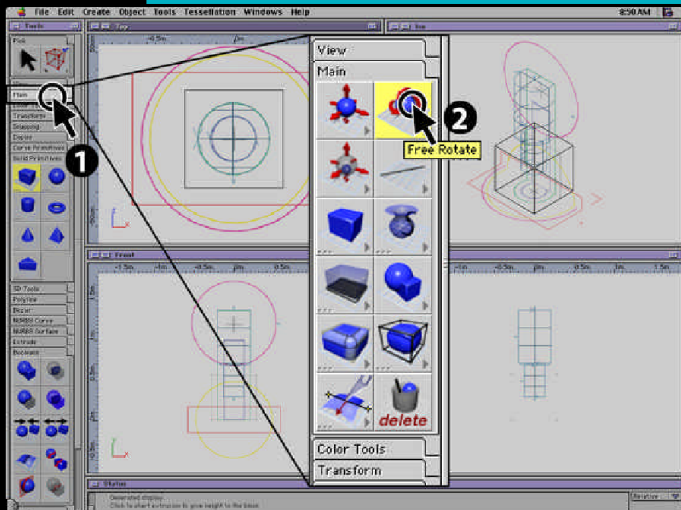


In the Front View window, **[CLK]** the block to select it.

Hold down **[Y]**, then **[CLK+DRG]** the block up until the upper corners touch the upper edge of the magenta circle.

Note: Pre-planning the model saves you time.

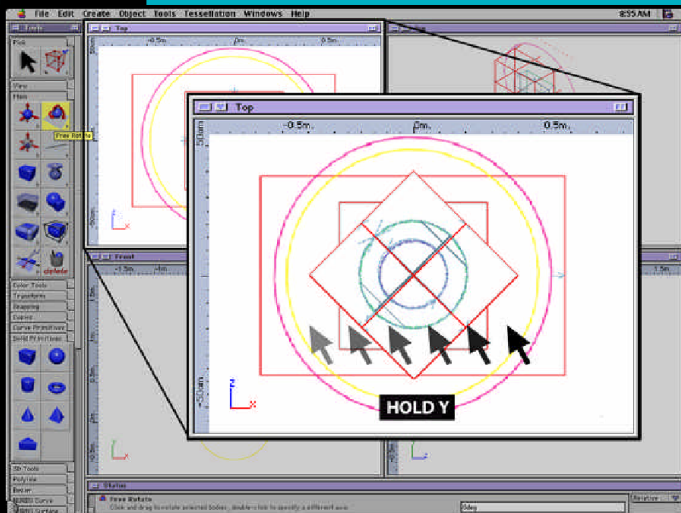




Open the Main Tool palette and select the Free Rotate tool.

Note: Similar to the Move tool, there are many rotation options to choose from. Free Rotate is usually the place to start.



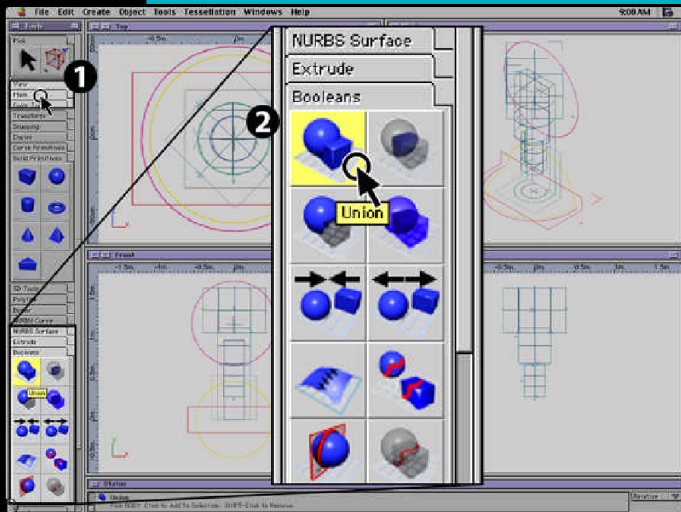


In any window, hold down **[Y]** and **[CLK+DRG]** to rotate the block approximately 45 degrees.

Note: Constraining rotation along an axis makes it easier to make adjustments more quickly and accurately.





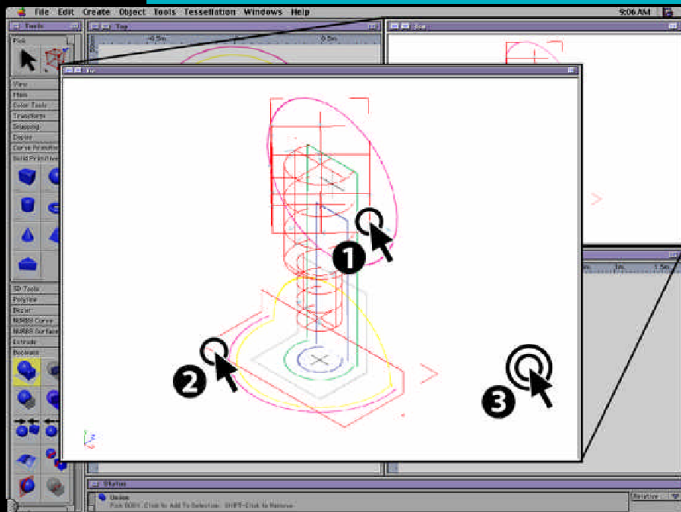


Close the Main Tool palette.

Open the Booleans palette and select the Union tool.

Note: Booleans remove overlapping geometry that can cause rendering errors later.

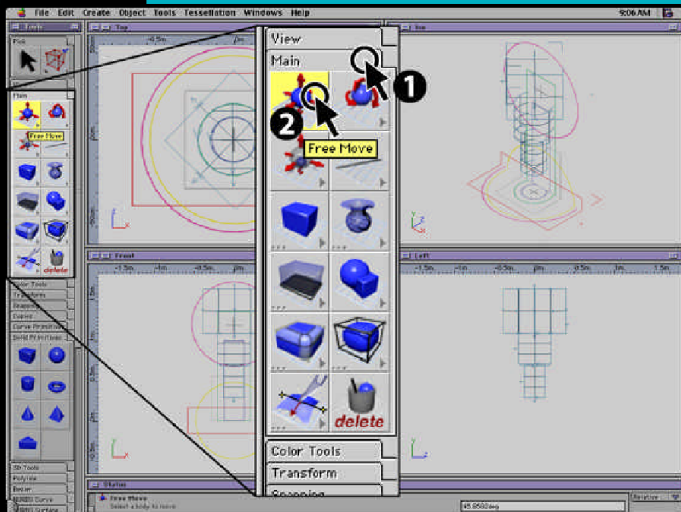




In the Iso View window, **[CLK]** both objects.

In any window, **[DBL+CLK]** to perform the operation.

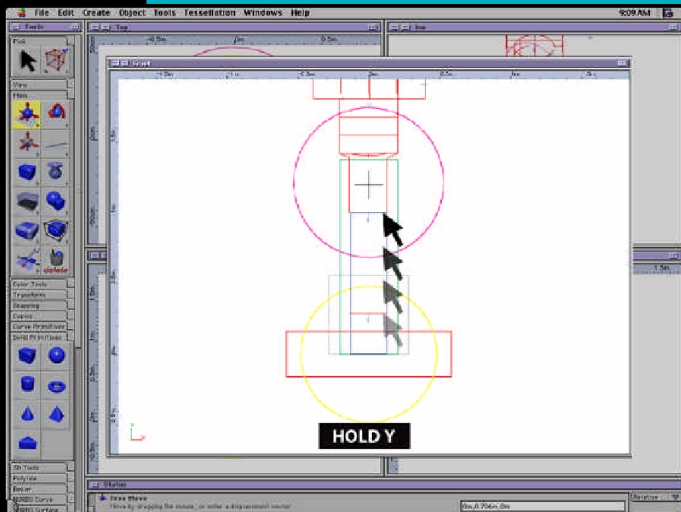




Open the Main Tool palette and select Free Move tool.

Note: It's often a good idea to move groups of objects in a scene to their initial positions for animation to ease the update process.



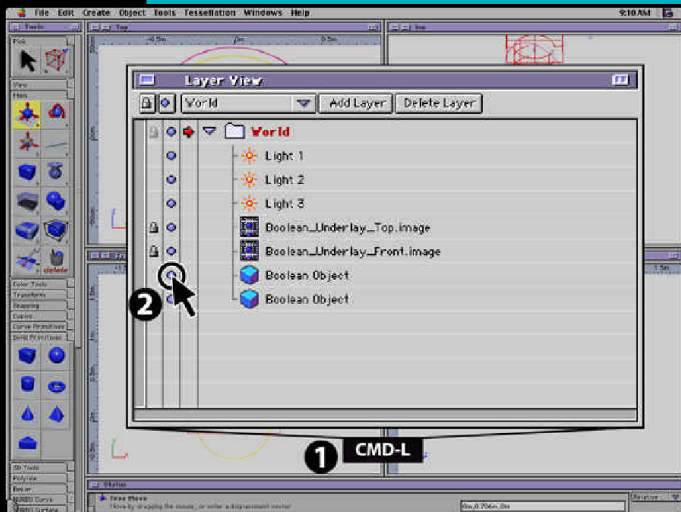


Hold down [Y].

In the Front View, **[CLK+DRG]** the object up until the bottom edge lines up with the top of the blue rectangle in the template.

Note: You can also nudge objects with the arrow keys.



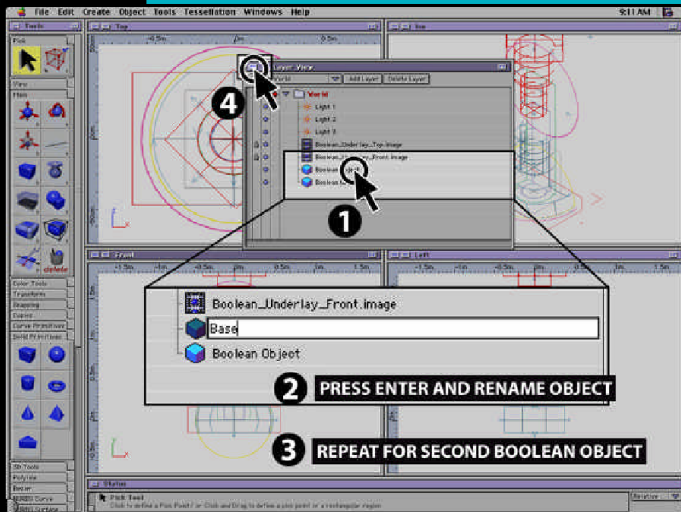


[**CMD/CTRL**+**L**] to open the Layer window.

[**CLK**] the visibility box near the first Boolean Object.

Note: You can also build folders to manage large numbers of objects in the layer window.





[CLK] the first object in the Layer View.

Press [ENTER] to rename it.

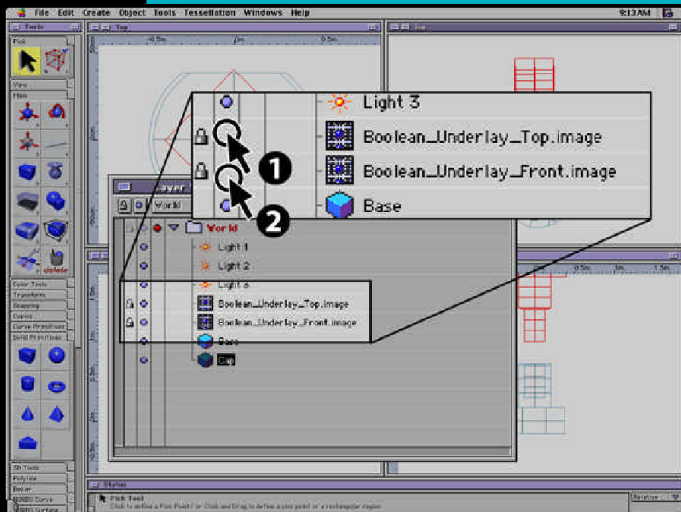
Type "Base" as its name and press [ENTER].

[CLK] the second object and press [ENTER].

Type "Cap" as its name and press [ENTER].

Close the Layer View window.

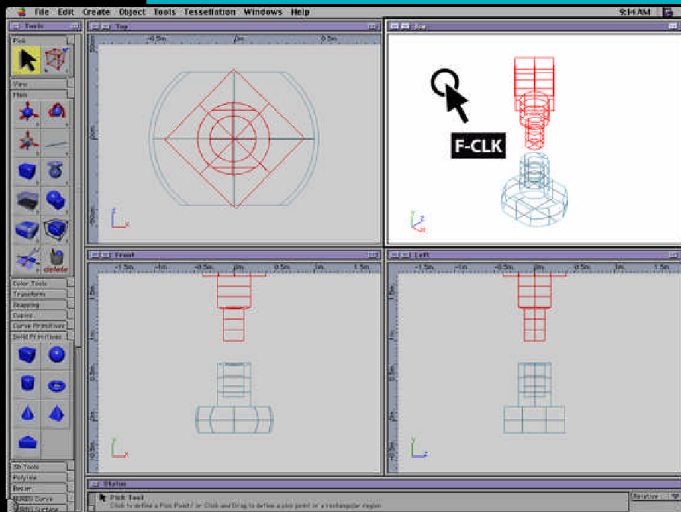




**[CLK]** the blue visibility dots in the Layer View to hide the underlay templates.

Note: Saving many versions of projects can make going back much easier when mistakes are made.



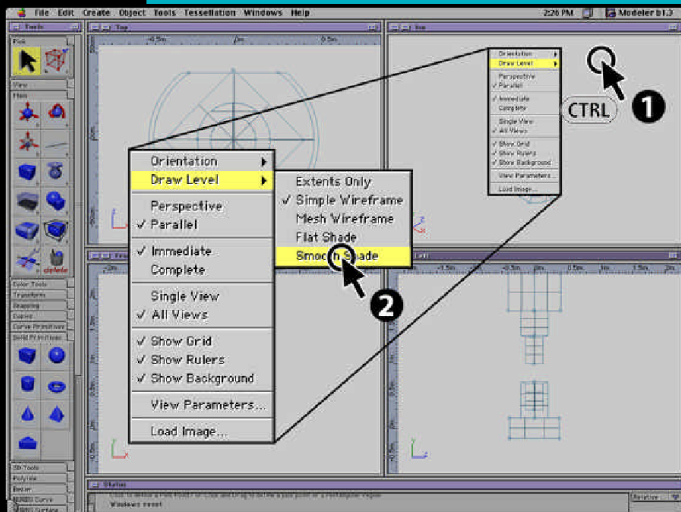


Hold down the **[F]** key and **[CLK]** in the Isometric view window to fit the view.

Note: To quickly get to another area of a model, it's often best to fit the model to a window and then zoom into a new area of interest.







In the Iso View window, [**CTRL/R+CLK**].

Select Draw Level.

Select Smooth Shade from the pop-up list.

Note: Smooth shading will often show small surface problems you don't see in other drawing levels.



