Working with Basic Meshes

Now that we know how to move around in Blender, let’s start doing some basic building and shaping. In this chapter we will talk about creating basic shapes and using modifiers to form them. There are a lot of different types of things to draw in Blender. Right now we will only discuss Meshes.

Start a new drawing in Blender and save it in your “My Documents” directory. Call it Sculpture. Since there a variety of operating system and saving structures, you may need to set up folders as needed.

Placing Objects On Your Screen:

The 3D Cursor (bulls-eye) location is used to place new objects. Use the left mouse button to move the cursor in 3D space. When you have it in a good location, press Shift-"A" to bring up the insert menu. Select Add, then Mesh and select UV Sphere (my mesh menu may display more items than your menu due to selecting different Add-Ons in the preferences menu). You will then be asked how many segments and rings you want in the Tool Shelf (open this if closed with the “T” key). You can change these by dragging the mouse in the block or by clicking in the box to type. Your sphere will change to reflect your settings. You can also adjust some other settings there.

When you place an object in Blender, it comes into the scene in Object Mode. There are basically 2 states in Blender- Edit Mode and Object Mode. Edit mode is intended for modifying the shape of the object by selecting vertices on the object. Object mode affects the object as a whole. The Tab button toggles you between the two. You can also see and change your mode at the bottom of the viewport. After inserting an object into your scene, always make sure you’re in Object Mode. Otherwise, the next object you create will be joined to that mesh!
Chapter 3- Creating and Editing Objects

As mentioned on the previous page, another way to switch between Edit and Object mode besides using the Tab key is to use the Mode menu at the bottom of the 3D screen. Notice that there are a few more modes than just Edit and Object. Some of these will be discussed in later chapters.

Precise 3D Cursor Placement:

To precisely place the 3D cursor, use the “Shift-S” keys for options to move the cursor to objects, grid, and vice-versa.

Mesh Types

When pressing the space bar and choosing to add a mesh, you will notice several mesh types (often called primitives) available. More can be added through Add-Ons in the User Preferences menu. They are:

<table>
<thead>
<tr>
<th>Mesh Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plane</td>
<td>A simple two-dimensional shape. Can be subdivided and used with proportional vertex editing to make nice hilly terrain or shaped.</td>
</tr>
<tr>
<td>Cube</td>
<td>Basic 3D shape. Nice object to start with to shape into rectangles and other shapes.</td>
</tr>
<tr>
<td>Circle</td>
<td>Won’t display as a 3D object unless filled, but can be extruded and shaped.</td>
</tr>
<tr>
<td>UV Sphere</td>
<td>A sphere generated with rings and segments, like the latitude and longitude of the earth.</td>
</tr>
<tr>
<td>Icosphere</td>
<td>A sphere generated with triangular shapes. Like Epcot Center.</td>
</tr>
<tr>
<td>Cylinder</td>
<td>Like a can, with ends closed, but if you leave the ends off, it is a tube.</td>
</tr>
<tr>
<td>Cone</td>
<td>Basic closed cone shape.</td>
</tr>
<tr>
<td>Grid</td>
<td>Can be used and extruded like the plane.</td>
</tr>
<tr>
<td>Monkey</td>
<td>A fun shape that someone decided to include in the mesh list.</td>
</tr>
<tr>
<td>Empty Mesh</td>
<td>A mesh without any visible vertices, edges or faces.</td>
</tr>
<tr>
<td>Torus</td>
<td>A donut shape.</td>
</tr>
</tbody>
</table>

RoboDude Asks:

How do I set the quality of a mesh?
Remember that after selecting a mesh type, you will see the setting for that mesh at the bottom of the Tool Shelf. Also, don’t forget to be in Object Mode when making a new mesh- otherwise, your new mesh will be joined to another mesh.
Using Main Modifiers to Manipulate Meshes

Before we look at actually changing the shape of the meshes and turning them into other shapes, we should become comfortable with creating, moving, rotating and scaling basic meshes. The three main modifying commands used in Blender (in Object mode) are:

- **“G” key**- move or grab and object
- **“S” key**- sizing or scaling an object
- **“R” key**- rotating an object

If you would like to do any of these operations through an exact number (i.e. rotate 90 degrees on the X axis or size something to a specific number), type the "N" key to bring up the Transform bar on the right side of your screen (or click the small "+" at the top right corner). You can also lock numbers.

You may be wondering- “What are these units of measurement?” By default, you are measuring in Blender Units. We will look at changing this to an actual metric or imperial system later.

**Using the Transform Widgets:**

Rather than typing R,S or G to manipulate an object, you can turn on the widget feature and simply grab the axis you wish to change. You can also change the motions to reflect Global (normal X,Y,Z planes), Normal or Local (X,Y,Z planes in relation to the object) movement.
Create a sculpture using at least 1 of every type of mesh found in the Add-Mesh menu (do not use grid or circle). Remember to make sure you are in Object Mode before creating a new mesh. Use a plane for the ground and scale it large. Divide your 3D window into two so you can have one working view and one camera view. Use the RMB to select objects on the screen. Experiment with sizing and rotating objects. New commands:

- **Size** ("S" key)- to change the size/scale of the object.
- **Rotate** ("R" key)- to rotate the object.
- **Move** ("G" key)- to change the location of objects.
- **Duplicate** (Shift-'D')- to make a copy of something on the screen.
- **Shaded** ("Z" key)- used to toggle the window from wireframe to solid view.
- **Tool Shelf** ("T" key)- shows editing commands and setting mesh detail.
- **Transform** ("N" key)- show the transform panel for exact placement of mesh.

Remember to make use of the number keys 1,3 and 7 to change your principle views!
Also play with the camera location and angle to get a nice view!
Save your work often!

**You do not have to make a monkey-this is just an example of using the meshes!**

**Call the instructor when finished**
Edit Mode - Mesh Editing

After you have created a mesh, you can go into Edit mode (Tab key or Mode option in window) and change its shape. In edit mode, you can work with the shape’s individual vertices (mesh intersections) to create the shape you want. You know you’re in edit mode when you see pink or yellow dots on the selected object. Pink dots are unselected vertices while yellow dots are selected vertices.

Selecting Verticies:
While in edit mode, to select a single vertex, RMB click on the vertex. To select multiple vertices, hold down the Shift key while RMB clicking on them. To drag a window around vertices, type “B” key and drag a window to select. Typing the “C” key will bring up a circular selection tool that can be sized by pressing the “+ or -” keys on the number pad. Scrolling the center mouse wheel will do the same as “+ and -” keys. To select vertices in circle select mode, hold down the LMB. To de-select vertices, hold down the mouse wheel. Pressing “Esc” will get you out of the circular selection tool. In order to select all verticies or deselect currently selected ones, hit the “A” key (for all) once or twice.

Viewing (Shading) Options:
In order to be able to see your objects better in object and edit modes, you can change the way your scene is displayed. The main options are Solid and Wireframe and changed with the “Z” key, but other views are available. All are available in the bottom of the 3D window by the drawing modes.

Edit Mode Selection Options:
By default, you are selecting verticies, but you can also select edges and faces. You can find these options at the bottom of the 3D window while in edit mode.

After selecting the vertices, you can use the same basic modifiers we talked about in the previous exercise (“G”- grab or move, “S”- scale, “R”- rotate).
Using the Shading Smooth-Flat Options and Auto Smooth:

As you add objects and view them in Flat shading, you will notice that circular objects are not being displayed smooth. In the Tool Shelf, you will see two buttons under Shading labeled Smooth and Flat. These 2 buttons not only effect the way things look on the screen, but how they will be rendered in a final image. **Be aware that the appearance of objects on the screen are not displayed at the same quality as a final rendered image.** Auto Smooth (found in the Object Data buttons) is used to smooth objects when faces meet at a certain degree or less while larger angles are kept sharp. This is a great feature when Smooth does not work properly alone. To use Auto Smooth, hit the Auto Smooth button. Adjust the degree angles as needed. To see a rendered picture of what the camera views, press F12. Smooth and Auto-Smooth are great for flat objects as well and help rendering.

Extruding Shapes:

Shapes can be lengthened by selecting a group of vertices, then by pressing the “E” key (or by selecting it in the Tool Shelf). You will make a duplicate of those vertices. They can then be “G” (moved), “S” (scaled), and “R” (rotated). When extruding a face, it will extrude in a locked direction, perpendicular to the face. When extruding connected vertices only, the extrusion will be free-moving. If you use the “Extrude Individual” command in the Tool Shelf, it will extrude only the vertices and no faces (it won’t be visible in 3D). Feel free to experiment with them. Below are example of a cube, extruded from the right side (only right 4 vertices were selected) several times using scale and rotate and a pawn extruded from a circle.
Chapter 3- Creating and Editing Objects

The Tool Shelf

If you’re familiar with older versions of Blender, this is a big change. In edit mode, you were able to access several edit commands with the “W” key (Specials Menu). You still can, but most of these options are now in the Tool Shelf as well. There are also commands that were once grouped in Editing buttons in the tool shelf. Here’s what you can find there and some descriptions of what we need:

### Tool Shelf- Object Mode:

<table>
<thead>
<tr>
<th>Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼ Object Tools</td>
</tr>
<tr>
<td>Transform: Rather than hitting G,R, or S, you can click these buttons.</td>
</tr>
<tr>
<td>Origin: Used to re-center your object’s geometry and center point.</td>
</tr>
<tr>
<td>Object: Copy, Delete or Join selected meshes</td>
</tr>
<tr>
<td>Shading: Changes a between flat shading and smooth shading (works best with Auto-Smooth in Object Data buttons)</td>
</tr>
<tr>
<td>Keyframes: Same as hitting “I” key for animation.</td>
</tr>
<tr>
<td>Repeat: Repeat your last operation or a list of past operations.</td>
</tr>
<tr>
<td>Grease Pencil: Used to make mark-up notes on your screen.</td>
</tr>
</tbody>
</table>

### Tool Shelf- Edit Mode:

<table>
<thead>
<tr>
<th>Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼ Mesh Tools</td>
</tr>
<tr>
<td>Transform: Same as Object Mode, but for selected vertices only.</td>
</tr>
<tr>
<td>Deform: Edge Slide- moves selected edges. Rip- opens mesh at a selected vertex. Smooth Vertex- smooths a selected area with clicks.</td>
</tr>
<tr>
<td>Remove: Deletion options, merging of vertices, and removal of double vertices.</td>
</tr>
<tr>
<td>Normals: Recalculate Flip Direction</td>
</tr>
<tr>
<td>UV Mapping: Unwrap Mark Seam Clear Seam</td>
</tr>
<tr>
<td>Shading: Smooth Flat</td>
</tr>
</tbody>
</table>

More About the Object’s Origin:
The object’s origin is the small dot for an object. By default, it is in the middle of the object, but can get moved if you move an object in edit mode (moving vertices only and not the entire object). To fix this, or to move it to a usable location (for example, a door needs it’s origin on the edge to act like a hinge), use the origin option in the tool shelf to move the object-to-center, the center-to-object, or center-to-cursor location. Remember that the cursor can be accurately placed using the Shift-“S” command.
Proportional Editing

Proportional Editing is used to create a flow in the shape when editing vertices. To turn proportional editing on, press the “O” key while in edit mode or by selecting the small circle button on the toolbar (enable). Proportional Editing now also works in Object Mode! By selecting the prop. editing command in object mode, objects around the selected object will move proportionally with it. You have several options for effecting vertices in proportional editing. We usually use Sharp or Smooth falloff, but feel free free to experiment with the other options. The examples below are with one vertex selected.

Knife/Cut Tools:
The Knife Tool allows you to split edges differently than the subdivide command. To use the knife tool, select the vertices you wish to cut, hold the “K” key while dragging a line across the surface you wish to split. You can also select the “Loop Cut and Slide” option in the Tool Shelf to cut around an object.

Using Subdivide and Proportional Editing to Create Ground Contour:
You can use proportional editing to create flowing landscape easily. The first thing you need to do is create a plane in the top view (7 key). While in edit mode, make sure all vertices are selected (vertices are yellow). You can use the “A” key to select them all. In the Tool Shelf, select “Subdivide”. Do this a few times. Select a single vertex somewhere near center. Next, switch to a front view (“1” key) and enter Proportional Editing. Select Smooth Falloff. Type “G” to grab (move) the vertex. Use the “+ -” keys on number pad or scroll mouse wheel to change the size of the selection. Select other vertices and fallofs for more hills and shapes. To see your final work in a smooth display, exit edit mode (“Tab” key) and ,with the object selected, Select Smooth from the Tool Shelf. This will smooth the mesh in display and final output. Finally, hit the “Z” key to shade your view.
Over the next several chapters, we will be developing a nice landscape scene in an effort to build your Blender skills while you become more comfortable with the program. Below is an example of what we will be completing:

This is the basic scene, but as you work through the chapters, you will be encouraged to add more elements and details to your lighthouse and landscape to make it your own. We will eventually add rain to our “stormy night at sea” scene and animate the water, light and camera.

The first thing we need to do is create a new Blender scene and save it as “Landscape Scene”. Again, we will be using this file for the next several chapters, so keep it safe and save often! Split the workspace into 2 viewports as shown on the next page. We will use the left viewport for working in and the right one for camera and 3D views.

While in the top orthographic view (number pad 7 and 5 - note the label in the top, left corner) erase the initial cube from the scene, then add a plane from the mesh menu (Shift “A”- add- mesh- plane). For now, you may want to turn off the 3D widgets and minimize the Tool Shelf and Transform Panel on the right view.
Your scene and viewports should look something like this. To maximize workspace, you can close and open the Tool Shelf and Transform panels at any time. To re-open them, click on the small “+” or type “T” for Tool Shelf and “N” for Transform Panel.

In order to see all your buttons, Hold down your mouse wheel and scroll here.

This plane will be used for our ground. Our next step is to scale it up a bit. To do this precisely, we will use the Transform Panel. With the plane selected and in Object Mode, press “N” to bring up the Transform Panel. Change the Scale X, Y, and Z to 10.000. Close the Transform Panel. You may need to zoom out to see the entire plane.

Next, go into Edit Mode (tab) and make sure all vertices are selected (“A” key). In the Tool Shelf, click Subdivide 6 times. Your plane should be well subdivided.

Deselect all vertices using “A” and press “C” for the circular selection tool. While holding down the LMB, select half the vertices as shown. Keep the edge random similar to what is shown so it looks like a rough shoreline. If you select too many vertices, remember that by holding down the mouse wheel, you can deselect vertices.
Now switch to the front view (number pad 1). Your plane will now just look like a line. Type “G” to grab and move the selected vertices. Move them up about 2 Blender grid blocks. You may want to type “Z” to keep the move locked to the vertical axis. Use your right side viewport to spin around and get a nice look at the landscape.

Now it’s time to make some fine adjustments to the mesh to make the cliff edge a bit more random. Turn on the proportional editing button (small bull’s eye button) and experiment with the types of falloff. Select single verticies, “G” to grab and scroll the mouse wheel to change the affected areas while moving. While in the move command, type “Z” to lock to z-axis.

Randomly pull the edges of the cliff up and down to different levels. You may even want to do some of this with proportional editing off. Try selecting a few verticies back on the high flat land and create some hills. Leave a flat area close to the cliff to place the lighthouse later.

The scene’s looking better, but a bit angular. Exit edit mode (tab) and find the “Smooth” button in the Tool Shelf. Press it and you should see a much better looking landscape (you must be in object mode to see the smoothing).

Now it’s time to set up the camera. We will start by adding an Empty object in the top view (7 number pad key). An Empty is basically used for targeting purposes and does not render as a visible object. Press Shift “A” - Add- Empty.

Now, RMB click on the camera to select it. We will add a Tracking constraint to the camera to always point toward the Empty. With the camera selected first, hold down the Shift key and RMB click on the Empty. Both objects will be highlighted. Press Ctrl-T and add a “TrackTo Constraint”. A dashed line indicates the link. With the camera selected only, move it around- it always points to the Empty. If the link appears to work backwards, it means you had the Empty selected first. Use the UNDO command to back up and try again.
It's time to place the Camera and Empty at good rendering locations. You will need to use the move command ("G" key) and place the Empty and Camera using your principle views of Top (#7), Front (#1), and Side (#3). Try to get the camera low so it looks as though you are viewing the shore line from a boat. Place the Empty on the cliff line. Use the picture below to frame up your view. You do not want to see any edges on your rendering. Use the “F12” key to render out a picture.

Here is the final render. We’re still missing water, textures and a few other things, but it’s a good start. Feel free to develop and refine the landscape contour any way you wish. The more time you spend with it, the quicker you will become comfortable with the program and the more realistic it will become.

Save the scene and start a new Blender file (I hope you’ve been saving every few minutes anyways). We are finished with the landscape for now and will now begin developing the lighthouse as a separate scene that we’ll add to the landscape at a later time. Save this new Blender file as “Lighthouse”.

Basic Editing - Landscape and Lighthouse
Now it's time to start shaping a lighthouse using the **Extrude** and **Scale** commands. Begin by deleting the default cube and add a **Circle** (Shift “A”- Add- Mesh-Circle) in the **Top Ortho View** (#7, 5). Use the default setting of 32 vertices, radius of 1, and Fill checked, (found at bottom of the Tool Shelf). These setting will be fine for what we are making. Depending on what you are making and what it will be used for, you may require more or less verticies.

You will now need to switch to the **Front View** (#1) so the circle appears as a line. Enter **Edit Mode** and make sure all verticies are selected (yellow) and press “E” to **Extrude**. If you forgot to check the “Fill” button when making the circle, you will need to press the “Z” key as you extrude to lock on the Z axis. If you filled the circle, it will extrude on the Z axis automatically. Extrude the lighthouse about 3 Blender grid blocks high and LMB click to place them. Hit “S” to **Scale** them in slightly. This is your lighthouse- feel free to adjust sizes as desired. Remember to stay in the front view throughout this process! Rotated views can cause a distorted lighthouse.

It is now time to make the small walkway around the top. Press “E” to extrude again and right mouse button (RMB) click. This will place the new extruded verticies right on top of the old ones. Then “S” to scale. Pull your mouse away from the lighthouse and scale the walkway outward as desired. LMB click when you have a good size. Remember, you can always UNDO (Ctrl-Z) if it doesn’t seem right. Extrude again to give the walkway some height. You will then Extrude, RMB and Scale again to reduce the size back inward.

Continue extruding and shaping to get the light area and the roof. The point of the roof will actually have 32 verticies which you could scale very small so that it appears to be a single point, but we will use a Tool Shelf command to correct this. Select the “Merge” option and “At Center”. You will see that 31 verticies are being removed leaving only one at the center.
Exit Edit Mode for the lighthouse then select and move your Camera to a location that displays the lighthouse well and press "F12" to render an image. The lighthouse looks good, but angular. It will take more than Smooth Shading to make it look good. Some edges actually need to stay sharp. This is where Auto Smooth becomes important.

Select the lighthouse again. In the Tool Shelf, select the “Smooth” button under shading. Ignore how the lighthouse look on the screen. Render a picture with “F12” to see the results. Some things are smooth that should remain sharp (and some other strange edge effects). Go to the Object Data buttons and find the “Auto Smooth” button. You will notice a degree angle below the Auto Smooth button. Leaving it a the default of 30 degrees should work well, but feel free to experiment with other setting. Basically, this setting determines which faces are smoothed and which ones are kept sharp.

Finally, press “F12” to render a picture and check your results. If you haven’t saved your file, do so now and remember to save often. We are finished with our lighthouse for now. If you have the time, feel free to modify the lighthouse, change the style, add more features, etc.

** Call the instructor when finished **
Joining/Separating Meshes and Boolean Operations

Now that you have some experience with basic editing, here’s a few more options:

Joining Meshes:

To join 2 or more meshes together, hold down the “Shift” key to select them, then press “Ctrl” and “J” to join them. They will retain any materials you have placed on them, but will be one object. Also available in the Tool Shelf.

Separating Meshes:

In order to break up a mesh, you need to be in edit mode (Tab Key) and select the vertices you wish to separate from the rest of the mesh. With vertices selected, type the “P” key (I like to think of it as partition) and select your option. You also an option to separate all loose parts.

Deleting Vertices, Edges, and Faces:

If you want to make a hole in a mesh, select the vertices, edges, or faces you wish to remove, then hit the “Delete” key. Select the option of what you wish to delete.

Adding Faces:

Sometimes, you need to fill in holes in a mesh by creating your own faces. To do this, go into edit mode and select the vertices you wish to face together (you are limited to 4 vertices in a group). With vertices selected, hit the “F” key. A face will be formed. Here is an example of 2 cubes joined together with a space that needs filled between them. In edit mode, select the 4 vertices (hold down shift key and right click on them), then type F. A face will be created. Ctrl- F will give a Face Specials menu of options that will allow a larger set of closed vertices to be faced with additional options.

RoboDude Says: Adding and deleting faces and vertices are the basics in any model construction. It is important to become comfortable with these operations while knowing how to accurately work within your viewports.
Verticies and Faces - Logo Design

For this exercise, you will be creating a 3D logo for a favorite team, company, or school. You will be using many of the techniques discussed on the previous page. Your first step is to go to the internet and search for an image you wish to use as a background image to model. I will be using a Blender Logo for my example. Save that image on your computer, then in Blender, erase the initial cube and open the Transform Panel if not already open on the right side of the window ("N" key or the small "+" in the upper right corner of the window). Scroll down the list and find the "Background Images" panel. Check the box and open the panel. You will see an "Open" button that will allow you to load your image. Load your image and it should show up in the background of the 3D window.

The image will only display in a principal ortho view (7, 1, or 3-5 key switches between ortho and perspective). You will notice that you can control which views the image displays in, if you want to display a movie or image as a background, the transparency of the image, the size and X,y offset.

Make sure you are in the Top Ortho View and create a Plane from the Add-Mesh menu. Go to wireframe view ("Z" key) and Edit Mode (Tab key). Delete 1 vertex so all you have are 3 vertices.

Your next step is to move the 3 existing vertices to the edge of the shape where you wish to start. Select an end vertex, press "E" to Extrude and continue outlining your shape. The more care you take in shaping, the better the logo will look. Continue around the shape until you get back to the beginning. While holding down the Shift key, press "F" to Face. This will connect the 2 ends and close the shape. You will now have the basic shape.
Verticies and Faces - Logo Design

The next step is to create the inner edge of the shape. To do this you need to **copy** (not extrude) a vertex over to the inner edge (**Shift**-"D"). From there, continue to extrude and close the inner edge as you did with the outer edge. Notice that the Blender logo also has a blue inner circle. We will also copy and extrude a circle for that ring. If you have other details to add, do that at this time.

Before we face the mesh, we will need to separate the verticies into different meshes that will receive different materials. Select those verticies using the "B" or "C" commands and hit "P" to partition or separate them from the main mesh. For my example, I will select the inner ring that will get a blue material. After separating all the verticies, go back to Object Mode.

It's now time to face the mesh. We could select 3-4 verticies at a time and hit "F" to face them, but that would take a long time! Instead, we will use the **Ctrl**-"F" menu. First, enter **Edit Mode** for one of your meshes and make sure all verticies are selected ("A" key). Hit **Ctrl**-"F" and select "Fill". If the shape is complex, not closed, or has double verticies somewhere, this option may not work and forces you to find the problem or face it manually. Once it is filled, you may want to go back into the **Ctrl**-"F" menu again and select the "Tris-to-Quads" option to convert triangles to quads for less faces and a cleaner look. Do this for all meshes, then switch to the **Front View** and **Extrude** the meshes to a desired thickness, like you did with the lighthouse.

You logo is finished for now. We will not be addressing this as an actual exercise, but after reading the chapter on **Materials and Textures**, you can come back and add color to your logo.

**Call the instructor when finished**
Boolean Operations:

Boolean operations allow you to cut or join meshes by using other meshes. In other words, a mesh can be made combining 2 meshes different from the **Join** command. When using **Join**, the 2 shapes still retain all vertices. When using **Boolean**, a new shape is calculated (union) and removes interior geometry. A mesh can also be used to cut a hole in another mesh (difference) and a shape can also be made from where the 2 shapes intersect with one another (intersect).

In the sample shown below, a cube and a sphere have been placed overlapping each other. With the **cube** selected, we will be applying a **Boolean Modifier**. This is the first time we have accessed the **Modifier** buttons. If the resolution of your computer is not set so that you are able to see the Modifiers button, hold down your mouse wheel to scroll over the buttons to gain access to it.

Click on the **"Add Modifier"** button. You will see a variety of modifiers that can be added and many will be discussed later. For now, select the **Boolean** modifier.

In the Boolean panel, you will see a block where you can select the object you wish to use to modify the cube. Clicking in the box will give you a drop down of all objects in the scene. Selecting the sphere will display the changes to the cube. Below, you can see what each option will display:

- **Intersection** (what is shared)
- **Union** (joins the meshes)
- **Difference** (subtracts the mesh)

By hitting the **"Apply"** button, the new shape becomes set and the sphere can be removed.
To begin this exercise, start by opening up your **Lighthouse** file from the previous exercise. We are going to use Boolean operations to cut some simple windows in your lighthouse.

Begin by adding a **Cube** (Shift “A”-Add-Mesh-Cube) to your scene and scale it to an appropriate size and shape. Using your principle views of #1, #3, and #7, place the cube in a good location for a window. With the cube still selected, make note of the cube’s name, displayed in the lower left corner of the viewport. We will need to know that name later. The name can also be changed in the Transform window.

Now select the **Lighthouse** and enter Wireframe view (“Z” key). Go to the **Modifiers** Panel and add a **Boolean Modifier**. Select the **Cube** from the list under **Object**. By changing the **Operation** from “**Intersect**” to “**Difference**”, you should see a cut in the lighthouse to match the cube. Hit “**Apply**”.

Now you can move the cube to a different spot and add another Boolean modifier to cut another window using “**Difference**” and “**Apply**”. You can even use different mesh shapes to cut other window and door shapes. Press “F12” to see a rendered view of your results.

**Remember to add the Boolean Modifier to the lighthouse and not the cube!**

**Call the instructor when finished**