Maya 2015 Materials

Materials/Shader Primer

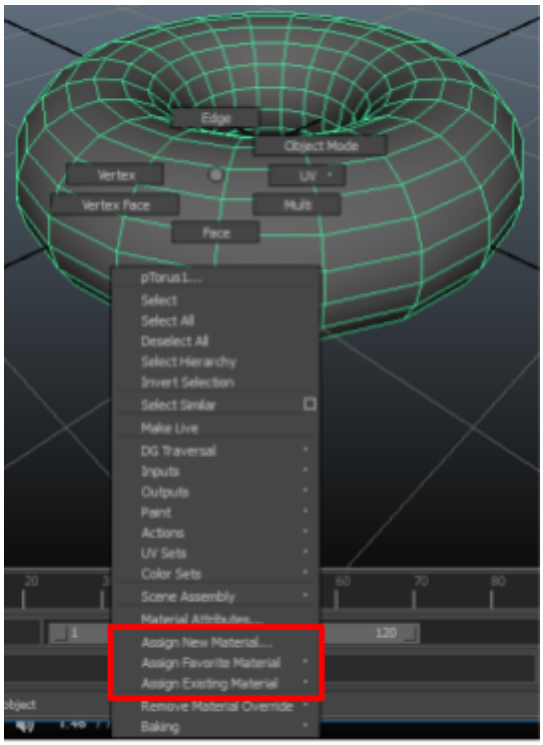
> **NOTE**: This is a poor discussion on materials/shaders. I need to look more into this. It should be good enough as an introduction.

The word materials is synonyms with the word shaders -- they both basically mean the same thing. A shader/material describes the makeup of a surface. It controls how light is absorbed or bounced off of that surface. It also helps define what the surface “is made out of.”

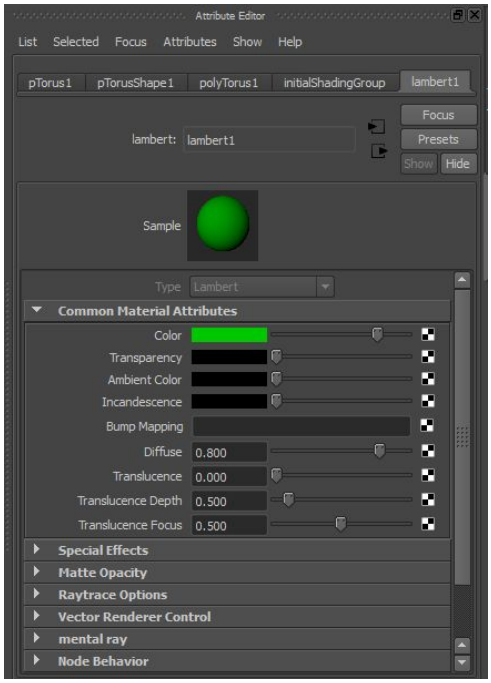
When we talk about what the surface is made out of, we’re referring to the real-time/real-world counterpart. For example, if we were trying to replicate concrete, we would want our material to take up concrete-like properties.

NOTE: Without a shader/material, a surface cannot be rendered. If you have a surface without any type of material on it, it'll basically be invisible. You won't be able to see it.

To assign a new material to an object, right-click and either go to Assign New Material / Assign Favourite Material / Assign Existing Material.

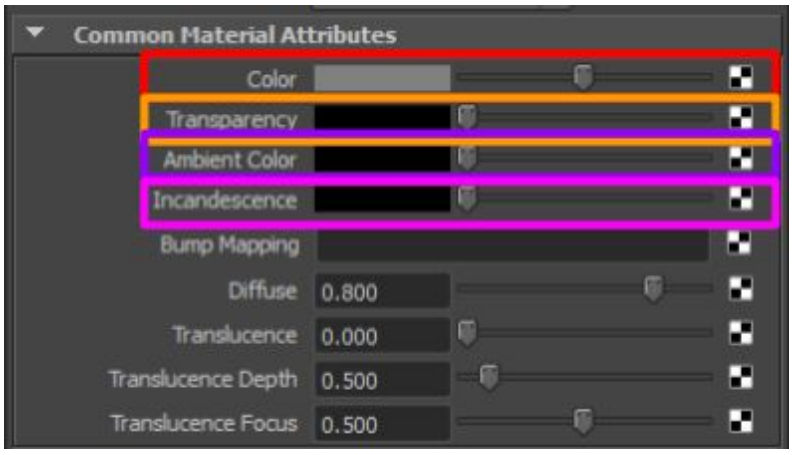


To modify a material's properties, select the object in the attribute editor (Ctrl+A) and navigate to the material tab.



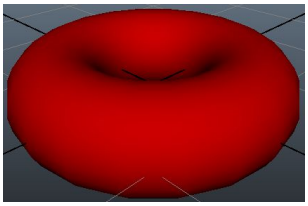
NOTE: When you create an object in Maya, it's automatically assigned a default material. That default material is a lambert shader. Typically you can switch between material types by going to the Type dropdown, but you'll notice that for the default material the Type dropdown is grayed out (see pic above). <u>This means that the default material will always be a lambert shader.</u>

The common types of materials are lambert, blinn, anisotropic and phong. There's a subset of attributes that are common to all of these shaders.



Color — The color of the material.

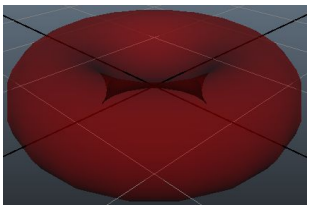
A torus with a red color.



Transparency

The visibility of the object (how see-through it is).

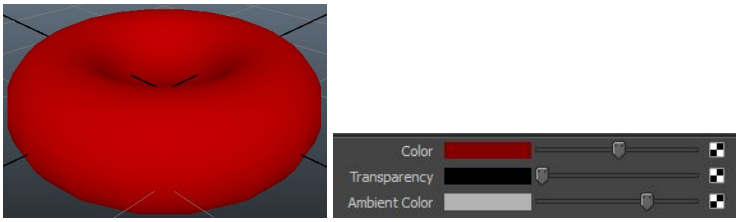
A torus with a red color and 50% transparency.



Ambient Color

“Set to black by default, which means it does not affect the material’s Color. As the Ambient Color becomes lighter, it affects the material’s Color by lightening it and blending the two colors. If there are ambient lights in the scene, the color and brightness of those lights is used to control how much the ambient color contributes to the final color of the material.”

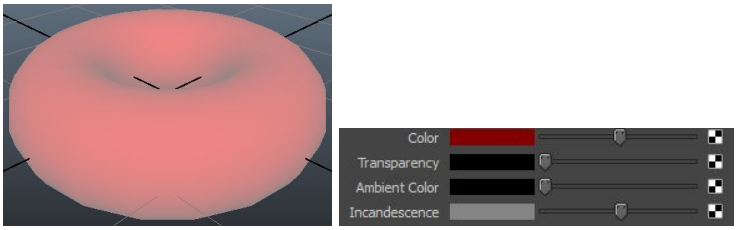
A torus with a dark red color and a light gray ambient color.



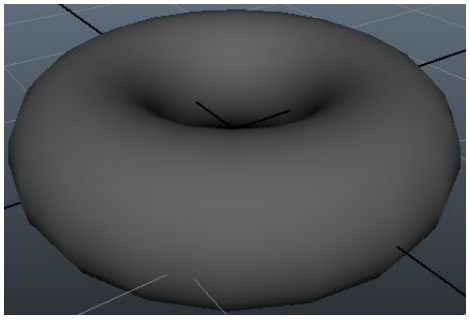
Incandescence

“The color and brightness of light that a material appears to be emitting. (Incandescent objects do not illuminate other objects.) For example, to simulate lava, use a bright red Incandescence. The default color value is 0 (black). Although incandescence makes a surface appear to glow, it does not actually act as a source of light in the scene.”

A torus with a dark red color and a gray incandescence.

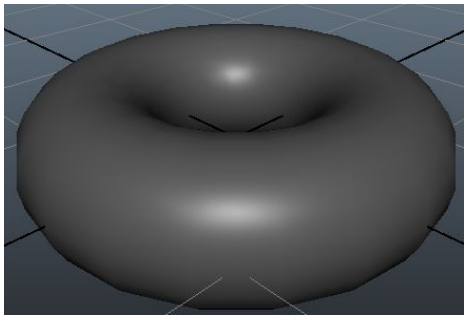


Lambert Shader



A lambert shader only has the common attributes listed above. It does not come with a hot spot/ specular highlight (talked about more in the other shaders).

Blinn Shader

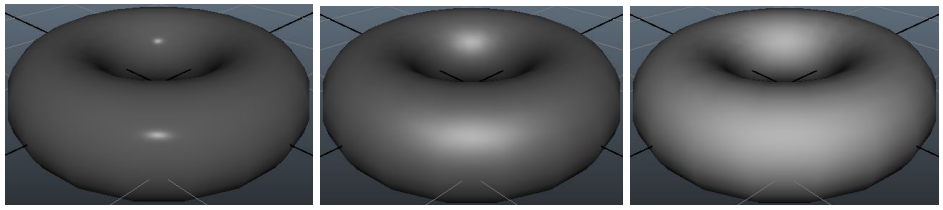


Blinn shaders come with a specular highlight / hotspot. This shader is good for replicating metals. You can access the attributes for the specular shading in the Specular Shading rollout portion of the attributes.

Eccicentricity

Controls the size of the specular highlight/hotspot.

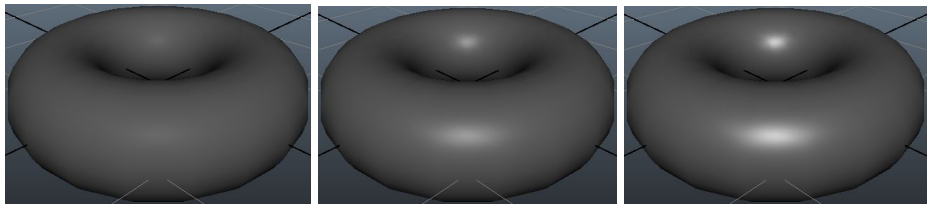
A torus with a 0.1, 0.5, and 0.9 eccentricity.



Specular Rolloff

Ability of the surface to reflect its surroundings. What's the difference between this and eccentricity? Eccentricity controls the size of hotspot (white area), while specular rolloff controls the amount of light reflected off the hotspot.

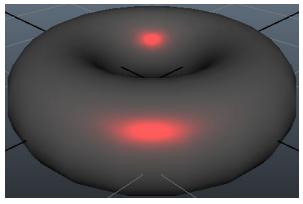
A torus with a 0.3 eccentricity + 0.1, 0.5, and 0.9 specular rolloff.



Specular Color

The color of the hot spot.

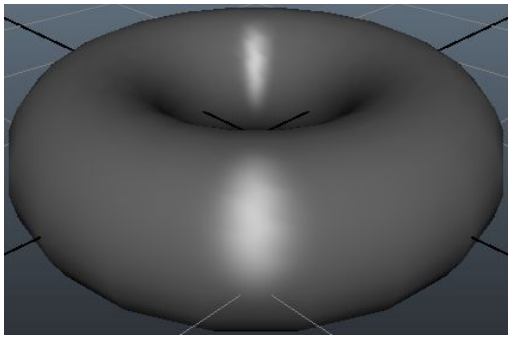
A torus with a red specular color.



Reflectivity

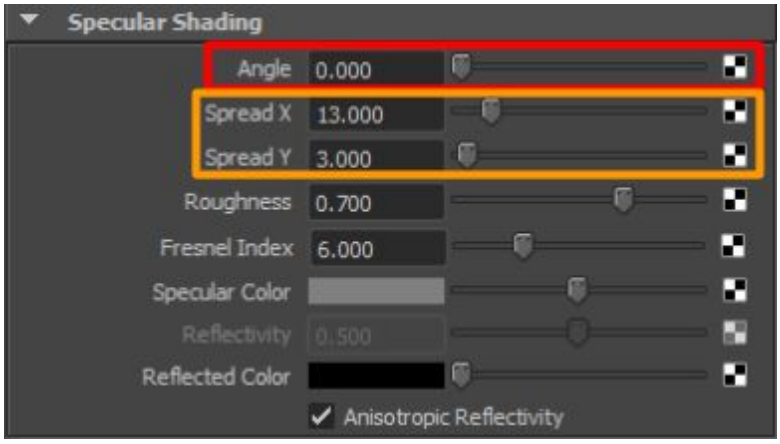
Controls how much stuff reflects off of the material? You won't be able to see the reflectivity in real-time + you need to have other objects in the same scene that the surface can reflect.

Anisotropic Shader



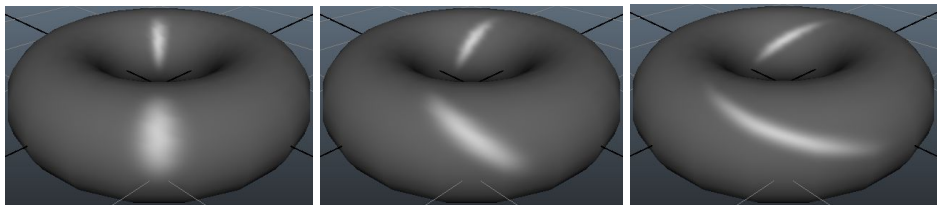
An anisotropic shader is like a blinn shader, except that it allows us to control the specular highlight a little bit differently. Anisotropic shaders are good for simulating lighting effects on surfaces with very small detail -- this causes the specular highlight/hotspot to breakup or otherwise react differently.

Some of the same properties here are available in the blinn shader. Check out the blinn shader section to find out what they do.



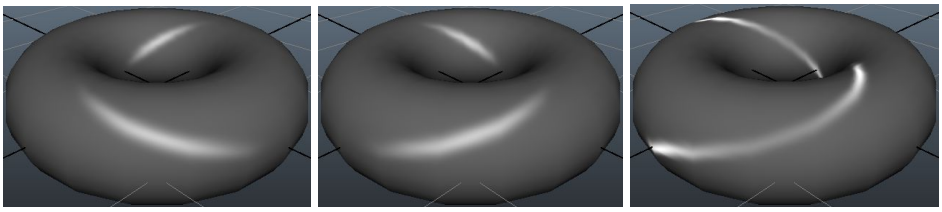
Angle — Angle of the specular highlight

A torus with a 0, 45, and 90 angle.



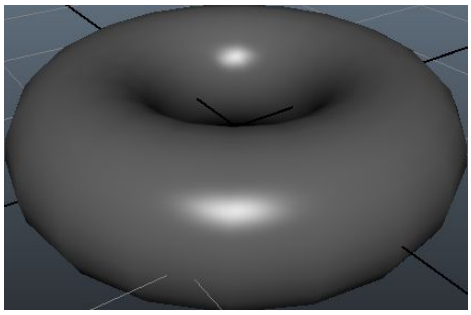
Spread X/Y — How “spread out” the specular highlight / hotspot is.

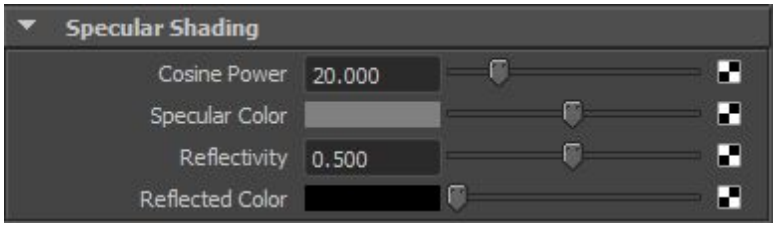
A torus with a spread of 13/3, 3/13, 1/15.



Phong Shader

An phong shader is like a blinn shader, except that it has fewer attributes and is better suited to replicate plastic materials.

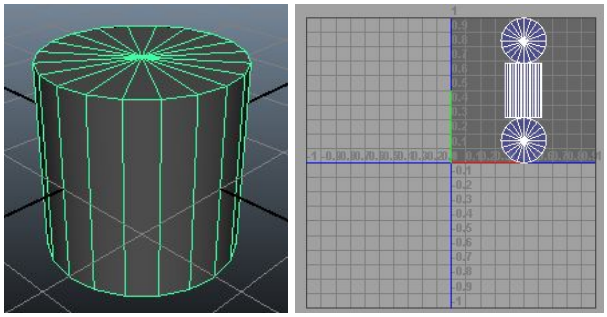




The only option that’s new here is cosine power. The larger the cosine power, the smaller the hotspot / specular highlight becomes.

UV Primer

UV’s are points on a surface that describe a mappable area. They provide a “holdout” area for images and other related material-esque data to be placed. You can think of it as a clean sheet of paper being wrapped around parts of your polygon object.

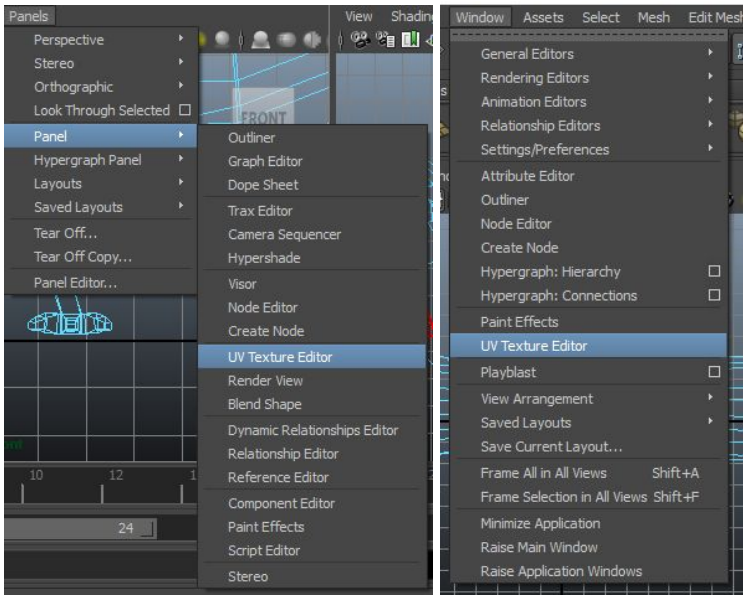


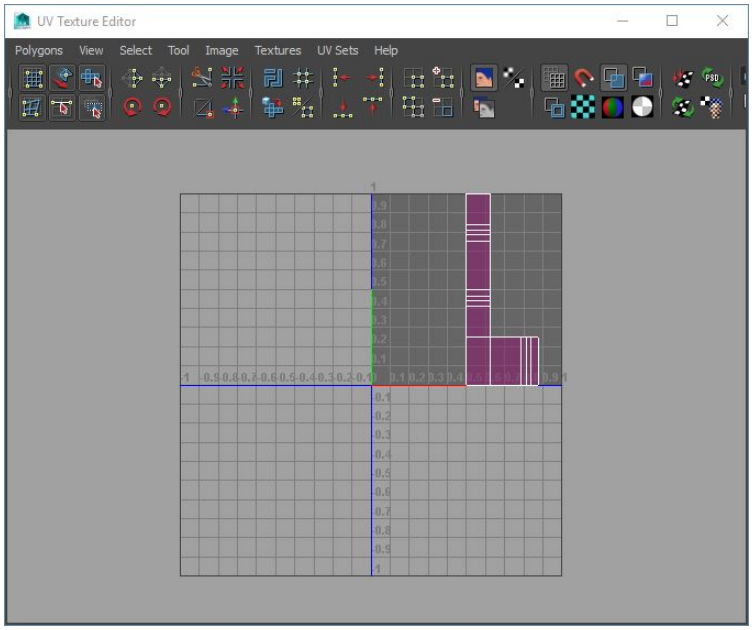
The goal with UVs is to make them human readable (and proportional to the real geometry). That is, when you open your “sheet of paper” in something like photoshop, you should instantly know which regions match to which parts of your polygon object. In our example above, the top and bottom of the cylinder maps to the top and bottom circle (respectively) and the body of the cylinder is in the middle. With more complex objects such as models of animals, the head,arms,legs,etc.. may be broken off into their own identifiable sections.

To create/modify UVs, open the UV Texture Editor. You can do this by ...

1. Changing a viewport panel by going to the menu in the panel and selecting...
   Panels -> Panel -> UV Texture Editor

2. Opening a new window by going to…
   Window -> UV Texture Editor





NOTE: If you've done something similar to box modeling to create your object, you'll notice that your UVs look nothing like your object (instead they look like the original object you started from). This is essentially junk and you can leave it as-is. As you create new UVs, these old mappings will disappear.

Creating UVs

NOTE: Before doing any of this, make sure you get rid of any history nodes on your object + freeze the transform on your object (make the current transform permanent) + open the UV Texture Editor

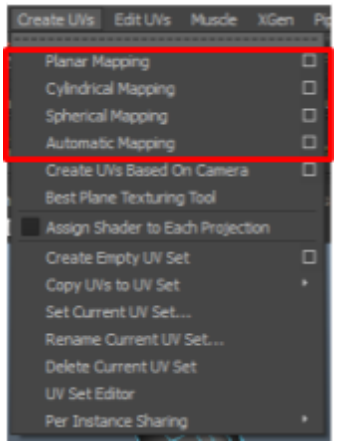
1. To delete history, select the object and go to Edit -> Delete By Type -> History.
2. To freeze transform, select the object and go to Modify -> Freeze Transform.
3. Go to Window -> UV Texture Editor

PROTIP: If the model you're working on is symmetrical, you can create UV mappings only for one side and then use the mirror-cut tool to mirror the model and automatically create UVs for the other side. You'll need to go to the UV Texture Editor and flip/move the shells around, but other than that there's not much else to do.

You can create UVs by selecting an object (or object faces) and selecting one of the options under the Create UVs menu. The type of mapping you choose depends on the the shape of what you're creating UVs for. When you select one of these mapping types, you'll be presented with some geometry around the selection you made.

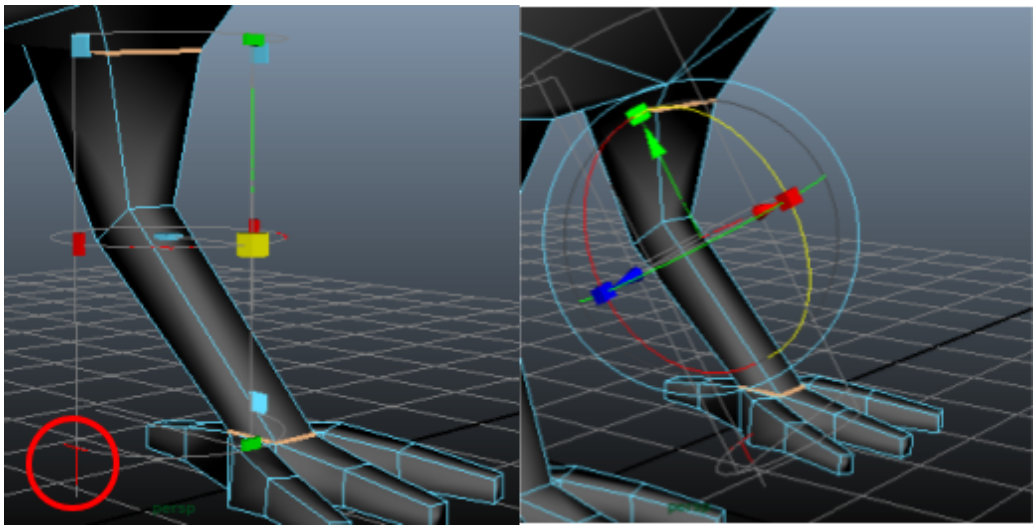
- Planar Mapping -- when faces are roughly facing some plane (e.g. side of building)

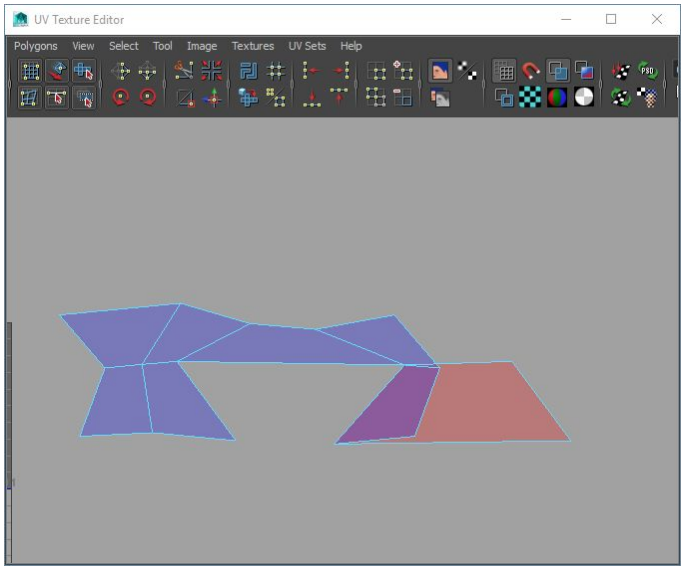
- Cylindrical Mapping -- when faces roughly form a cylinder (e.g. leg)
- Spherical Mapping -- when faces roughly form a sphere (e.g. apple)
- Automatic Mapping -- multiple planar projections, when something has lots of grooves and valleys (e.g. human face?)



> **NOTE**: For best results, option the options instead of just running the tool (click the little box on the right-hand side of the menu)

You'll need to orient that geometry to best suite your selection. You can do this by clicking the T symbol next to the placeholder that shows up (pressing T will expose the manipulator). You'll get a view of how the UVs look in the UV editor pane as you orient.





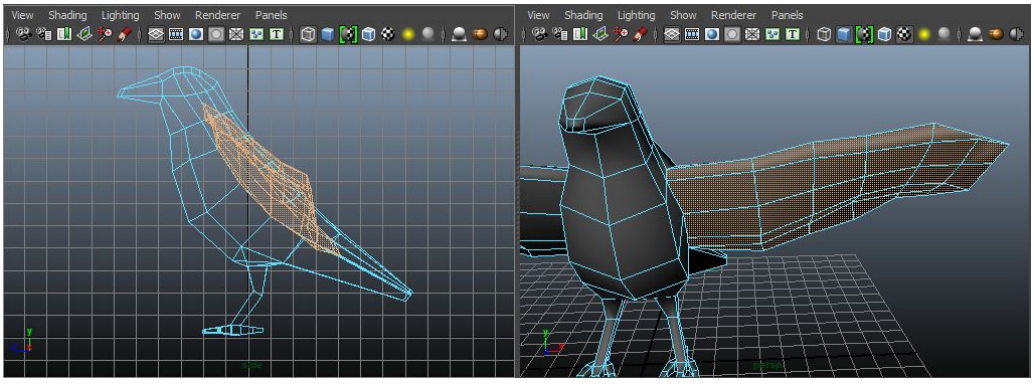
A lot of times, you'll need to manually fix these UVs by hand. More on this in the "Modifying UVs" section.

Planar Mapping

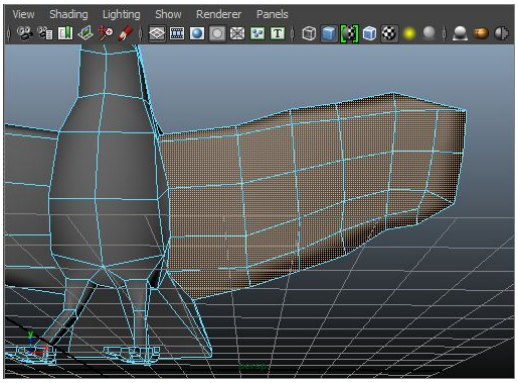
Planar mapping maps UVs based on a plane. This is good for mapping flat-ish surfaces that are all generally facing the same way. A good example of this may be a bird's wing that's been panned out.

To create a planar map…

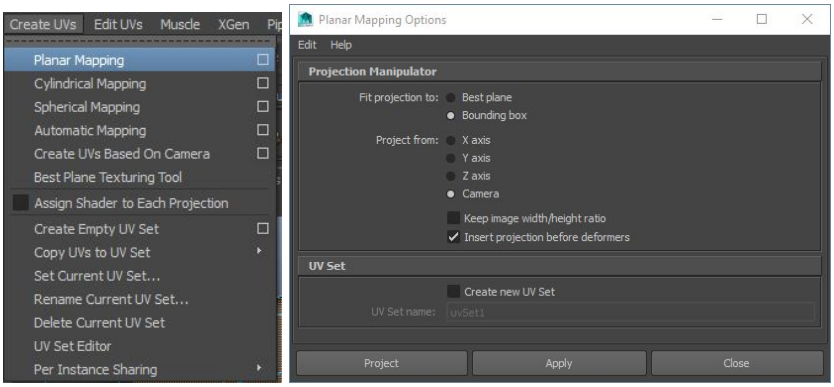
1. Select the faces/object you want to create a mapping for.



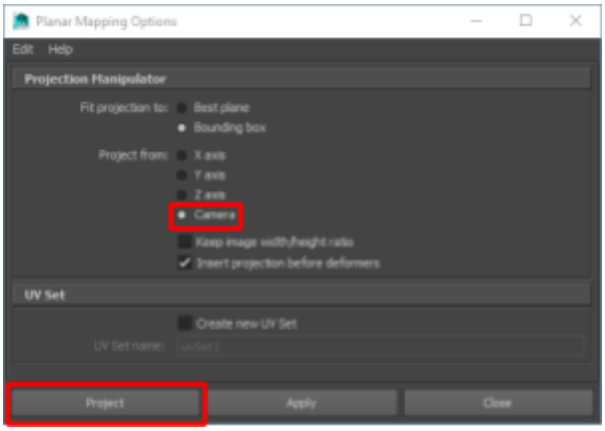
2. Orient the perspective camera such that it's looking at most of the faces straight-on.



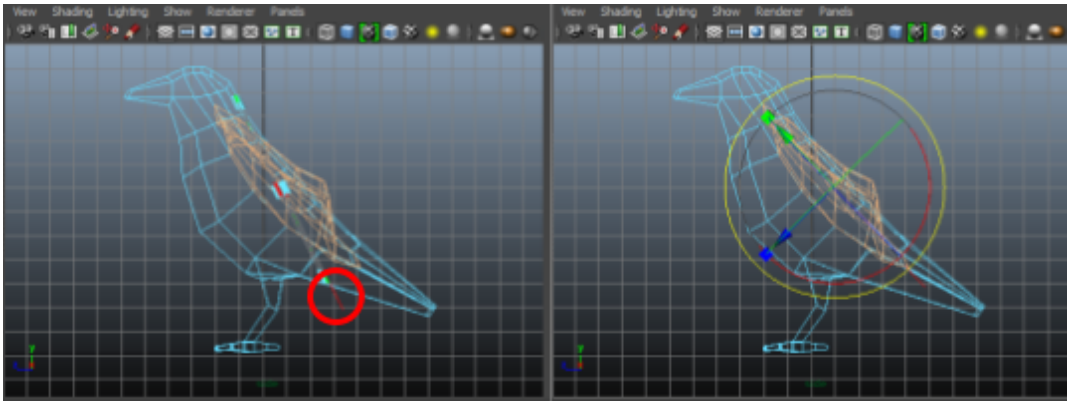
3. Go to Create UVs -> Planar Mapping and open the the options (little box on the right).



4. In the options, select Camera for the "Project from" option + hit Project.

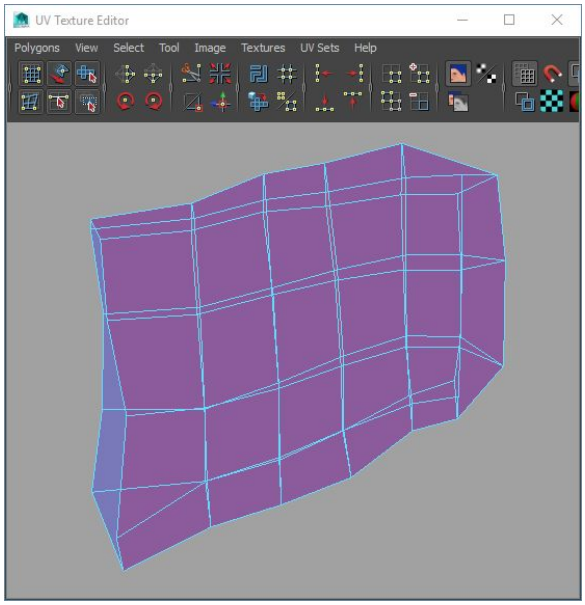


5. Hit T on the manipulator and orient it as best you can.



As your orient, you'll see the mapping show up in the UV Texture Editor (more complete guide on the UV editor below). One specific thing to note with this example is that the polygons on the wing wrap around, so what happens is that we get UVs that…

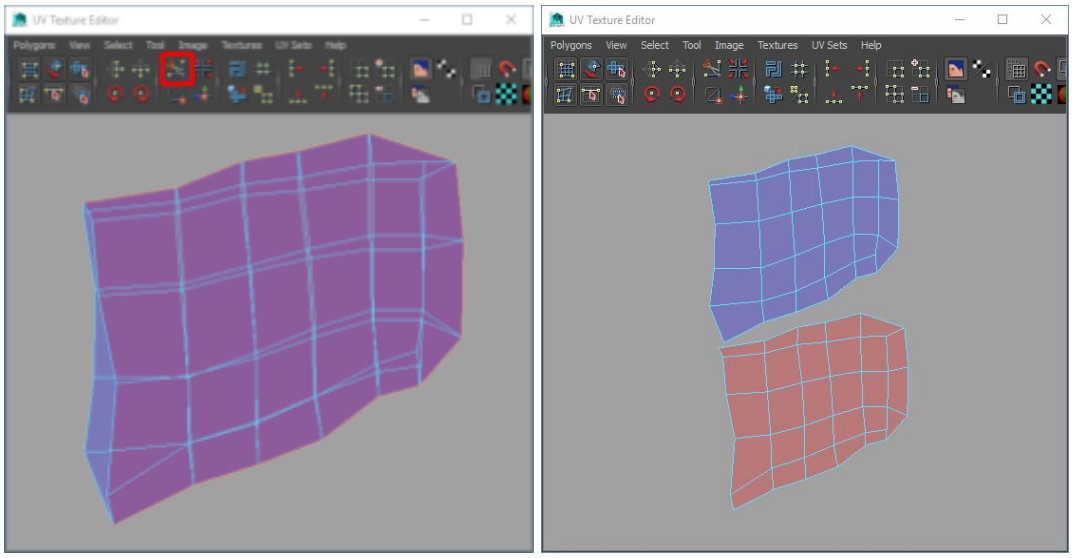
1. overlap each other
2. are flipped around (the top half is flipped)



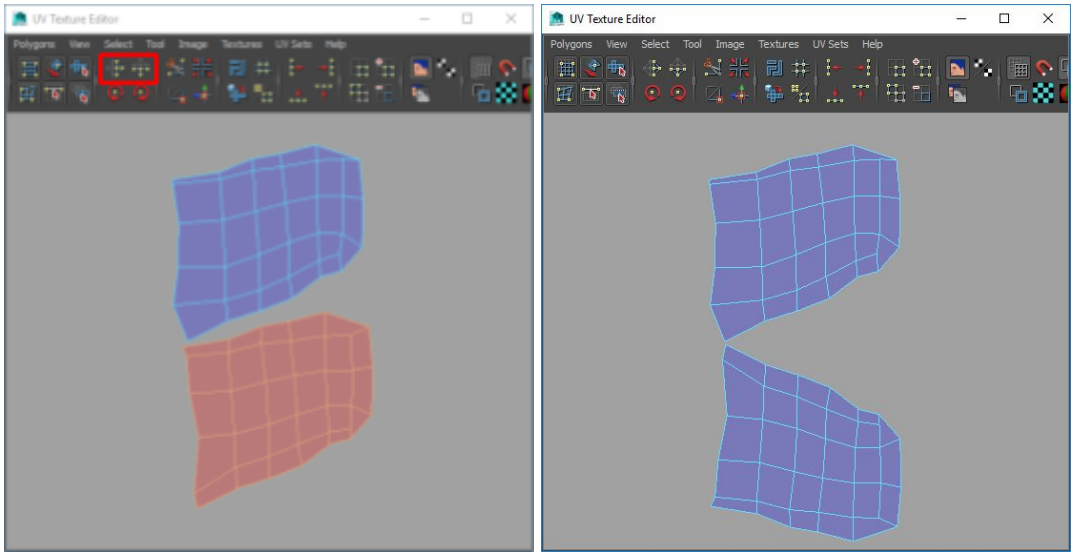
> **NOTE**: This may not always be the case. Sometimes your polygons won't wrap around. For example, The face of a building doesn't wrap around. And, you could have avoided this problem entirely by mapping one side of the wing at a time.

We can fix this in the UV Texture Editor pretty easily…

To fix the overlap, you select the edges that split the top part of the wind from the bottom part of the wing and choose the cut tool. Once cut, simply select the shell and move it such that it no longer overlaps.



To unflip the top-half of the wing (now that it's been split)...



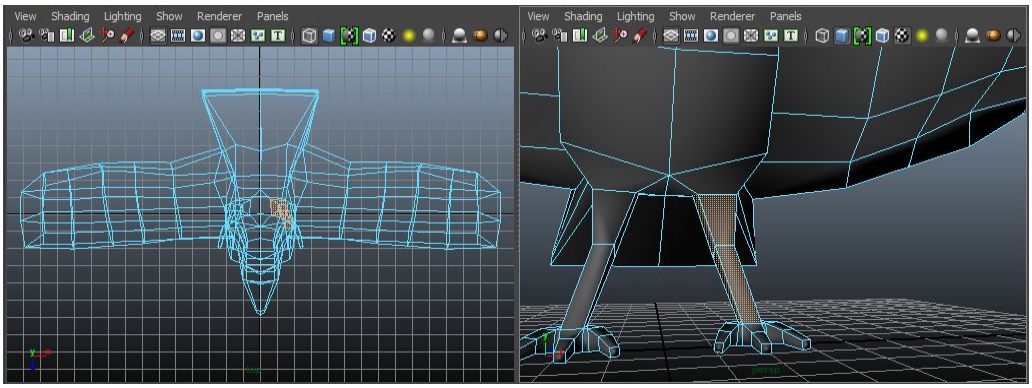
> **NOTE**: There's a bug here with the flipping tools. You need to explicitly select all the UVs instead of just selecting the shell. This is described further in the section on flipping UVs.

Cylindrical Mapping

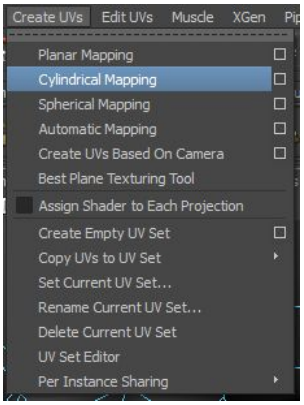
Cylindrical mapping maps UVs based on a cylinder. This is good for mapping parts of meshes that roughly map to a cylinder. A good example of this may be a bird's leg.

To create a cylinder map…

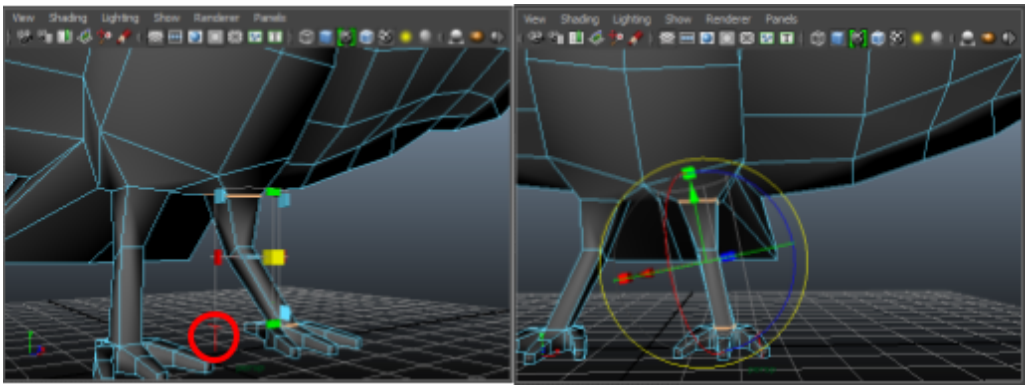
1. Select the faces/object you want to create a mapping for.



2. Go to Create UVs -> Cylindrical Mapping.



3. Hit T on the manipulator and orient it as best you can.

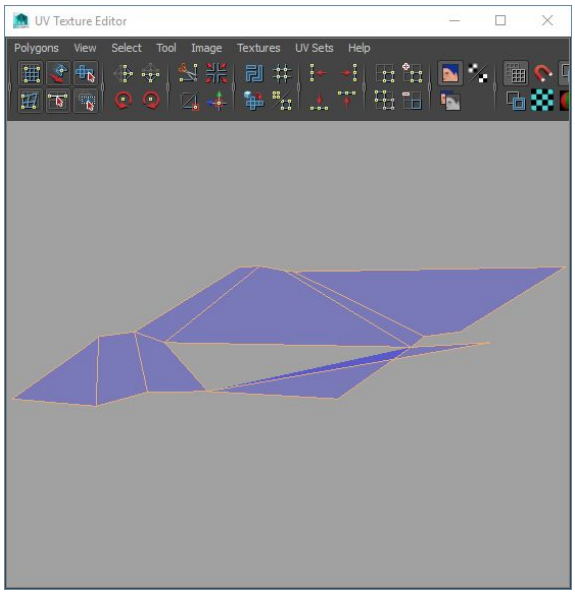


As your orient, you'll see the mapping show up in the UV Texture Editor (more complete guide on the UV editor below). One specific thing to note with the cylinder mapping tool is that a lot of times, no matter how you orient the the cylinder, the UVs will require manual edits to correct.

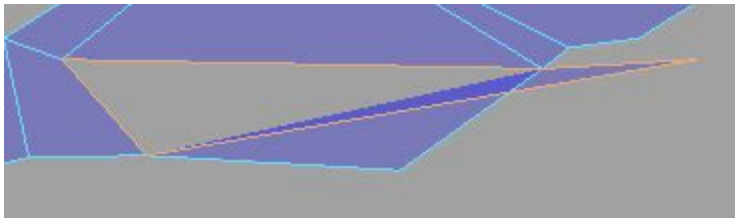
You can do some things to avoid overly poor mappings (e.g. leave out the top/bottom of the cylinder if there is one), but you'll almost always still require manual edits.

> **NOTE**: Don't try to do two separate pieces with one mapping. Otherwise, you'll end up with UVs where it looks like everything matches up but none of the edges will be bound together.

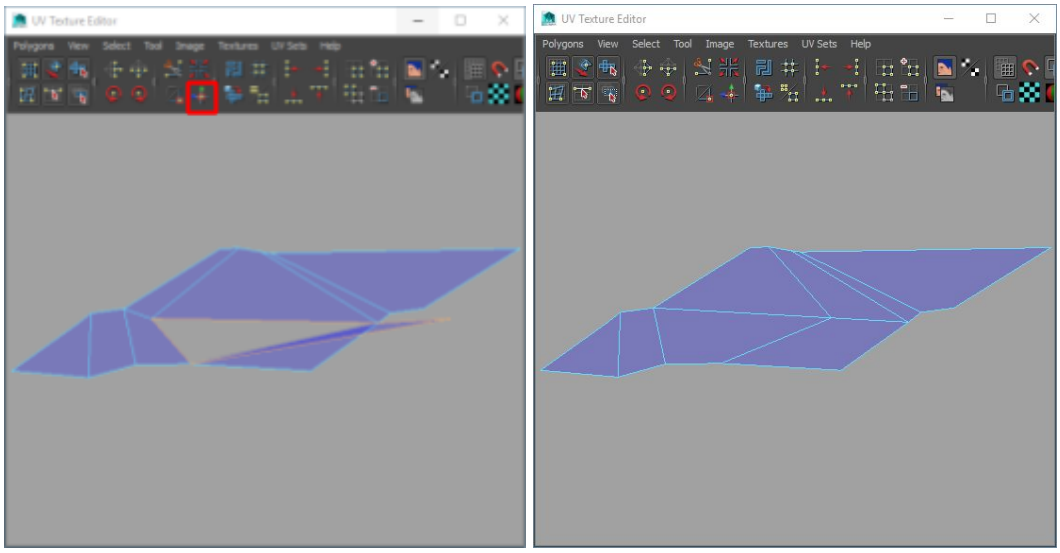
In this example, the UVs actually needs to have some the edges fused to get a proper-ish mapping…



You'll notice that the UVs for one of the polygons is warped out / not properly attached to the rest. You can select these 2 edges and their corresponding edges will automatically highlight.

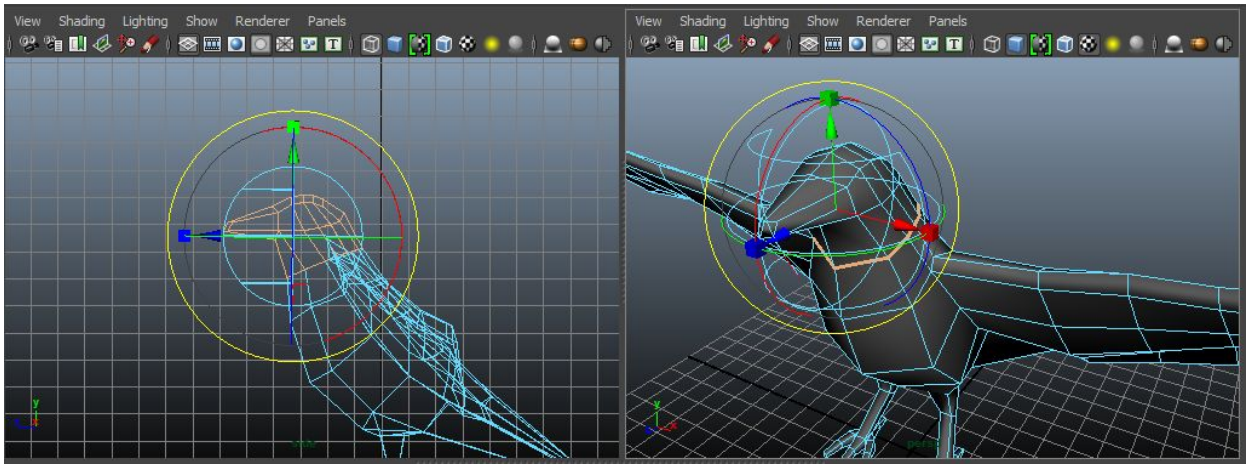


If fused these 2 edges, you'd get a nice contiguous piece of geometry for the leg that we're mapping. To do this, select the edges and choose the Move and sew tool.



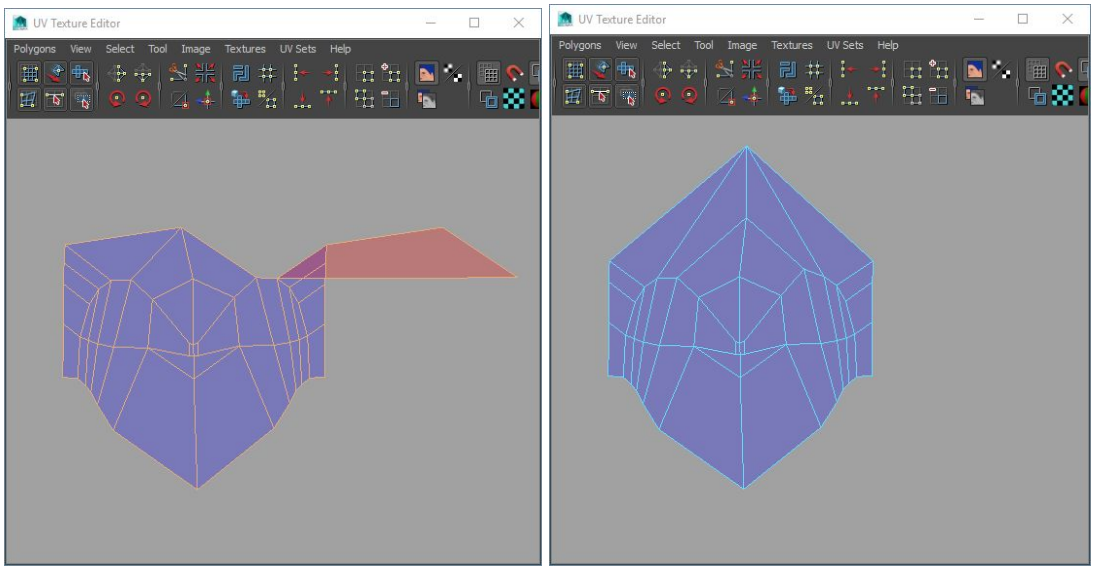
Spherical Mapping

Spherical mapping is similar to cylindrical mapping, but your manipulator is a sphere isn't of a cylinder. You can still do all the same stuff (e.g. press T and transform as needed).



Just like with the cylinder mapping tool, the sphere mapping tool will most likely require manual edges to UVs to correct. Depending on how you orient things, you can minimize the manual effort.

In this example, it's (somewhat) obvious what's out of place / which of the edges have to be fused together to get a nice contiguous mapping for the geometry we tried to UV map.

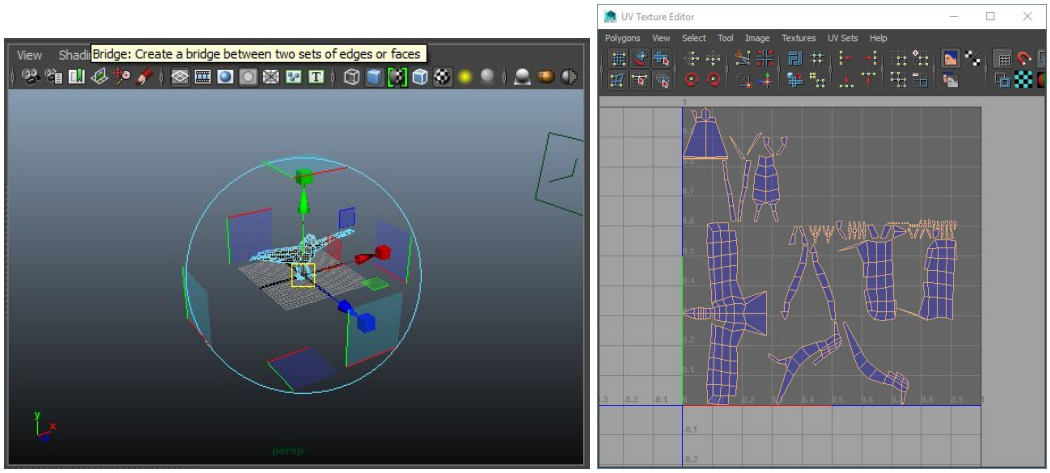


Won't go into much more detail here. See cylindrical mapping section -- most of that applies to spherical mapping as well.

Automatic Mapping

Automatic mapping is similar to planar mapping, but instead of just having 1 plane maya will project many planes to try to get a good mapping. I haven't played with this enough to know how it works, but just by looking at the mappings it generates it looks to do an okay job. Some manual edits will be required.

Note that this mapping option doesn't have a T for you to click on to enable transforming. Transformation is enabled by default.

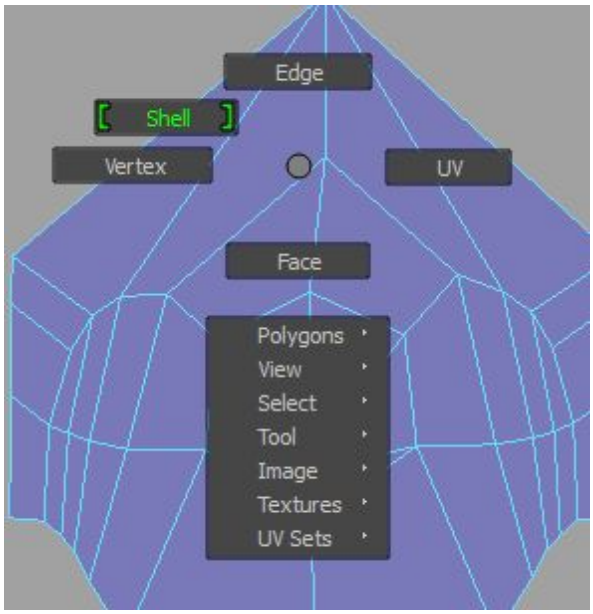


NOTE: There are tons of settings in the tool options.

Modifying UVs

In the UV Texture Editor, you can modify UVs by hand. You can select which components you want to modify just like you would in a normal viewport + modify them around with the same manipulator tools (move/scale/etc..). The selections you make will show up in your viewports as well.

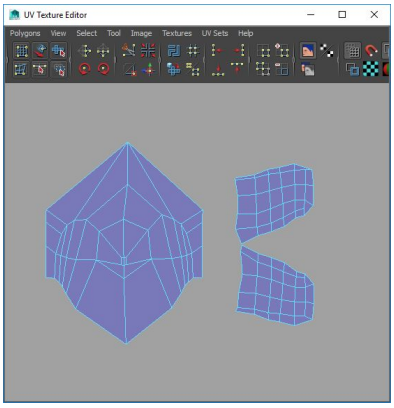
Right-click in the window to open a marking menu and choose the component selection type you want….



- **Shell** -- allows you to select one contiguous UV mapping.

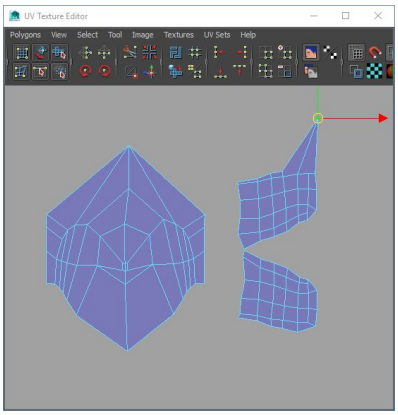
  In the example below, we have 3 shells: one for the face, one for the top of the left wing, and one for the bottom of the left wing.

  NOTE: There are some issues when selecting by shell and trying to flip. See section of flipping UVs/shells for more information.



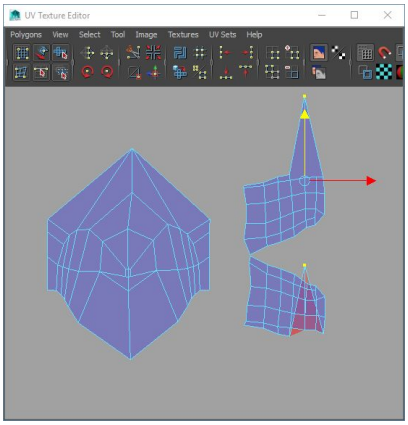
- **UV** -- allows you to manipulate specific UV point(s).

  In the example below, we've stretched out one of the UVs for the bottom wing.



- **Vertex** -- allows you to manipulate the UV(s) for one or more vertices.

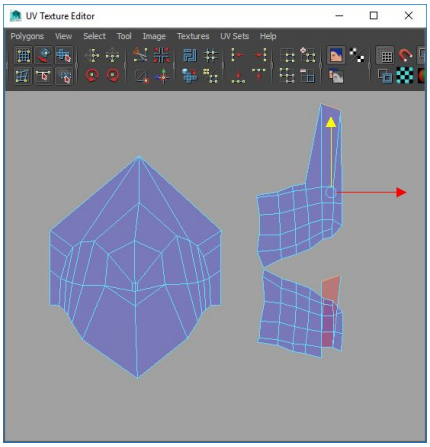
  In the example below, we select the same point as we did for the UV and stretch it out. But, note how we automatically get a selection on the shell for the other side of the wing. This is because the vertex is shared between the 2 shells.



NOTE: You could get exactly the same effect by choosing to select by UV (instead of vertex) and manually selecting these 2 points.

- **Edge** -- allows you to manipulate the UV(s) for one edges.

  This is similar to selecting by vertex. When you select an edge, the corresponding edge will also get selected (assuming that there's another shell with a corresponding edge). In the example below, we select an edge that's a part of 2 different shells and move it.



NOTE: You could get exactly the same effect by choosing to select by UV (instead of edge) and manually selecting the relevant points.

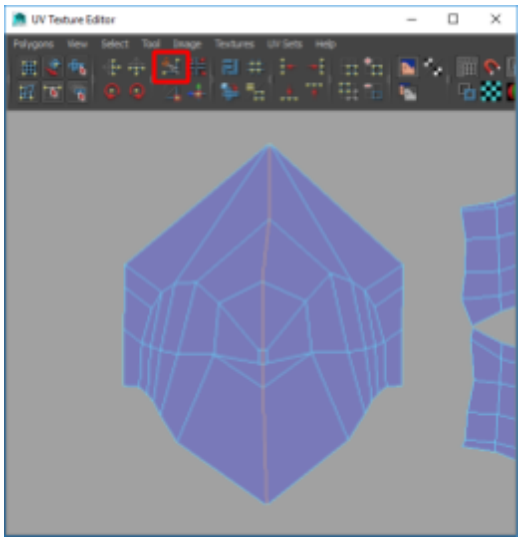
Cutting Edges/Shells

A lot of times you'll come across cases that where you'll need to cut up your shell into smaller pieces. Reasons for this include…

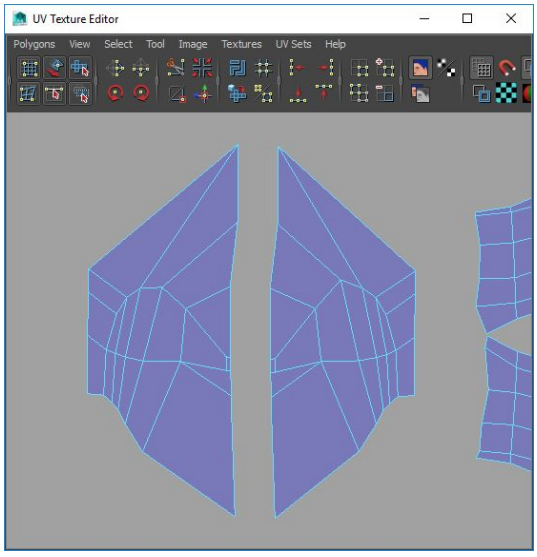
- You'll get distortion if you keep it in one piece
- The UV shell wraps around in 3d space, causing faces to overlap on each other

- Probably other reasons as well?

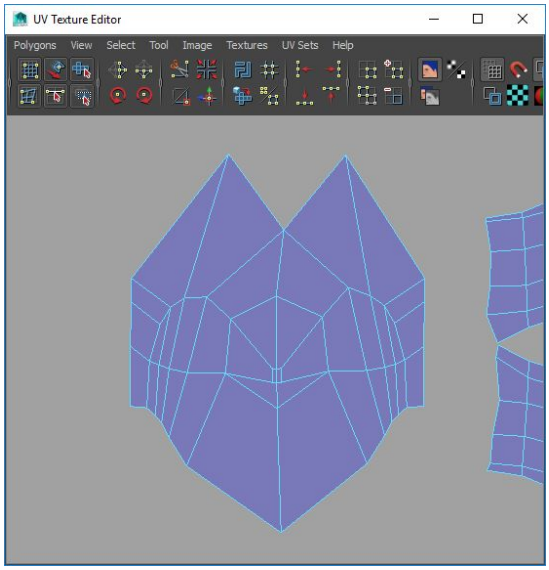
To cut up a contiguous mapping, go into the UV Texture Editor and select the edges you want cut and select the cut by edges tool…



Depending on your edge selection, you might end up with 2 separate shells. In the example above, we do indeed end up with 2 separate shells.



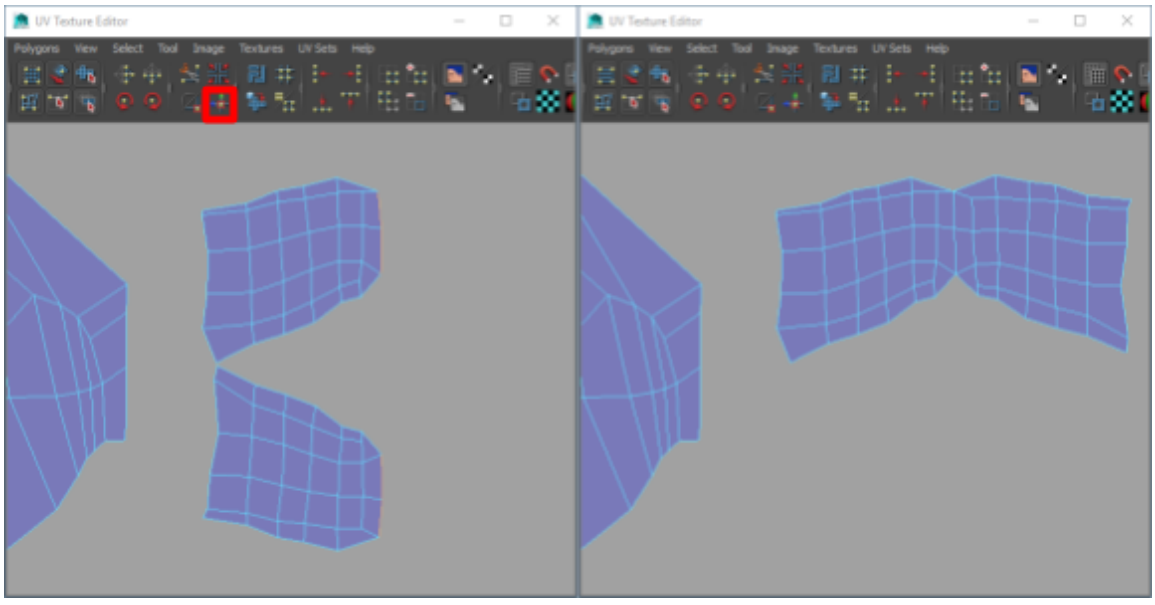
But, if you only selected some of the edges, maybe the topmost edge in our selection, you'd still have 1 shell but you could separate the mapping for those faces from each other.



Combining Edges/Shells

If you want to merge edges together, you can use the move and sew tool. Just like cutting, merging can be done on the same shell or it can used to combine separate shells.

If you want to merge, first select the edge(s) you want to merge and then select the move and sew tool…

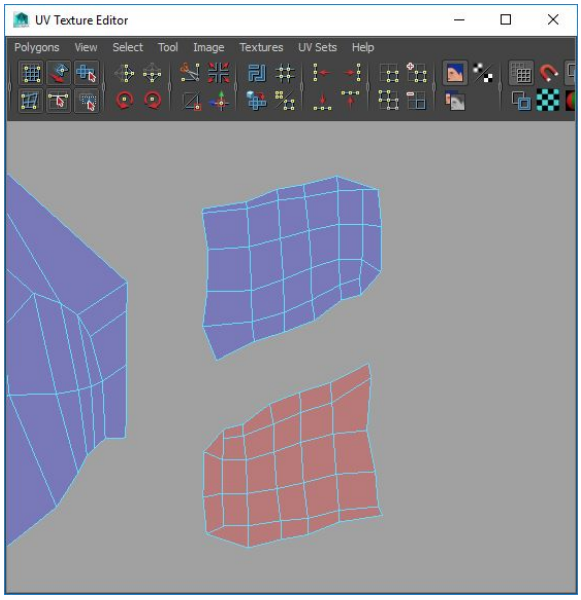


In the example above, we combined the shell of the bottom bird wing to the shell of the top of the bird wing.

Flipping UVs/Shells

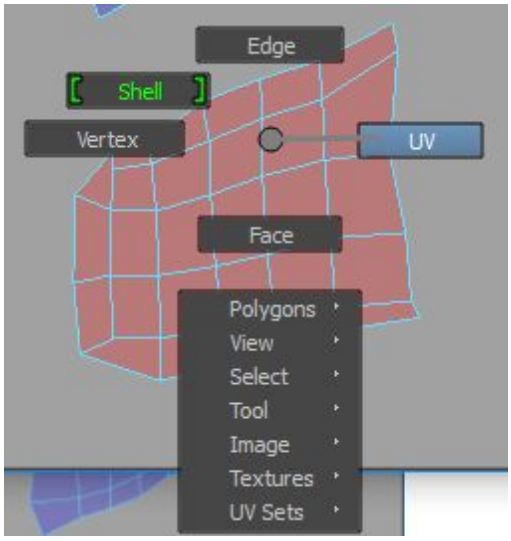
In certain cases, depending on which mapping tool you used / how you used the mapping tool / where you used the mapping tool, some of your UVs may come out flipped. To flip them around, you can use the UV flip tool.

You can tell when UVs aren't oriented correctly when they appear pink in the UV Texture Editor…

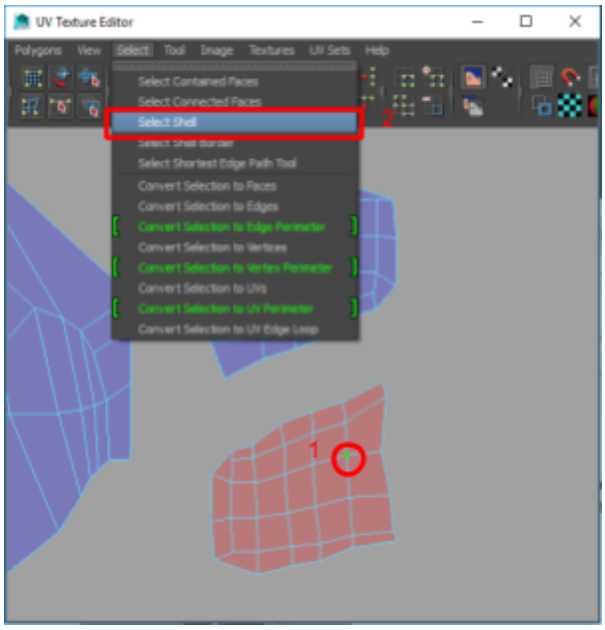


To correct this, you need to flip the shell around with the flip tool. The key thing with this is you cannot do this in shell selection mode. If you do, it'll look like it worked but all the edges will be cut from each other (but still touching).

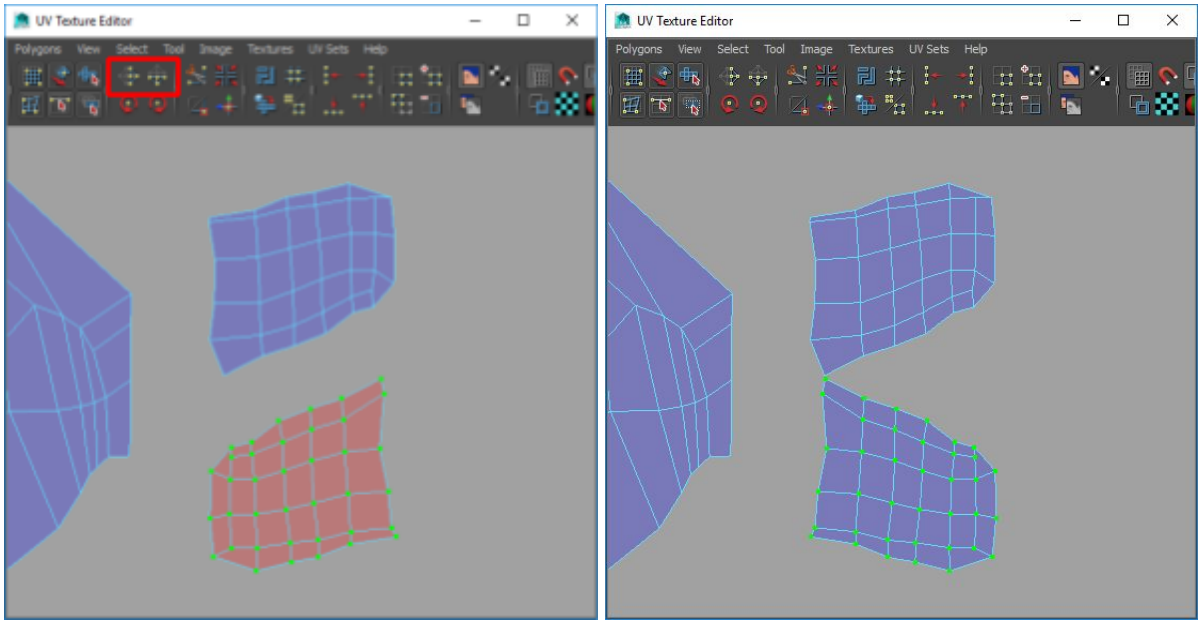
To flip a shell, first go into UV selection mode…



Then select a single UV on the shell you're trying to flip and go to Select -> Select Shell…

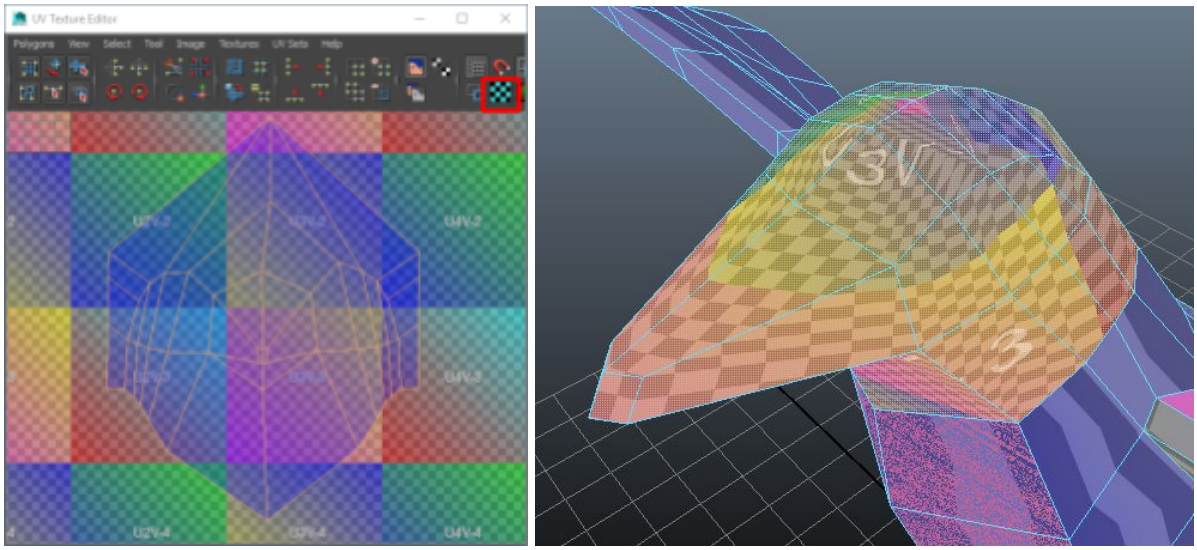


All the UV points in the shell should now be selected. Click one of the flip tools to flip.



Fixing Distorted UVs

Once you've mapped out your UVs, you'll want to check to make sure that there's as little distortion as possible. You can do this by enabling the Display checkered tiles option in the UV Texture Editor. Enabling this will cause the background of the UV Texture Editor to show checkered tiles, and those checkered tiles will get mapped to your viewports.



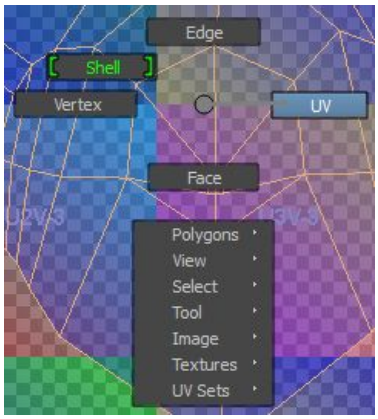
In the example above, you can see that the checkered tiles on each face of the head look heavily distorted. You can see some faces have the tiles smooshed and others have the tiles stretched.

It doesn't really matter what direction the checkers are facing, but it matters that they're all the same size. These clearly aren't all the same size.

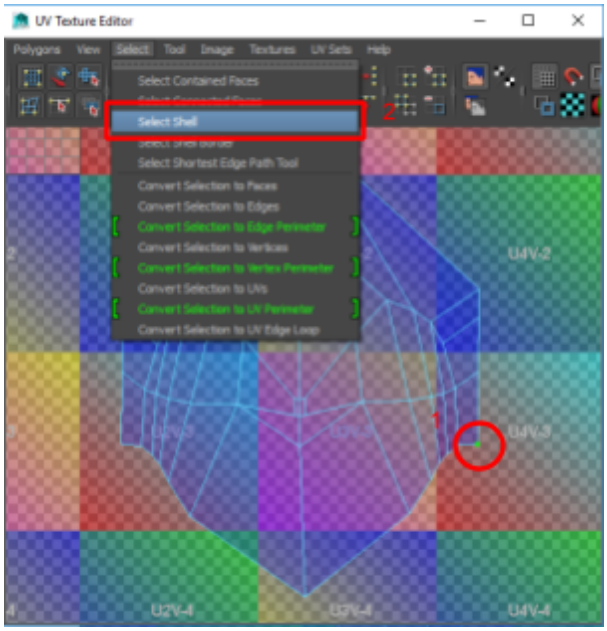
> **NOTE**: The size of your UVs will only matter when you're exporting as a texture image for an artist to draw on. For now, it's fine to have different shells be different sizes, so long as distortion is kept to a minimum.

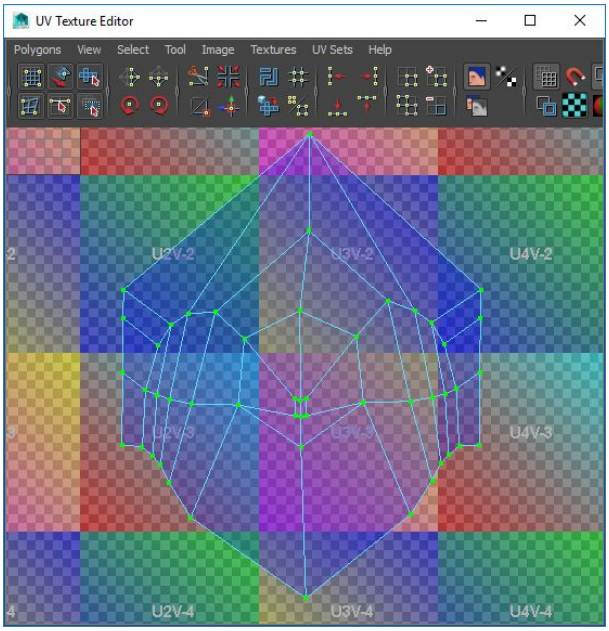
Maya has a tool to fix this called the unfold tool.

To use the unfold tool, first go into UV selection mode…

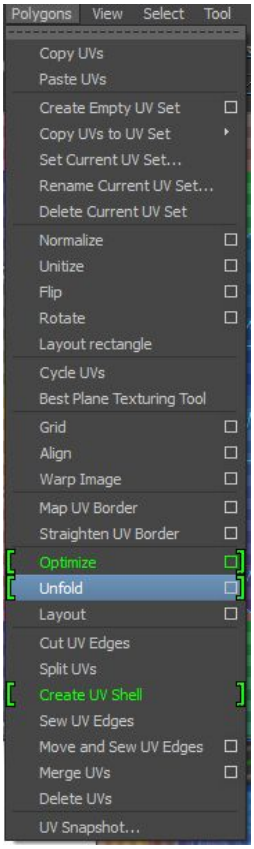


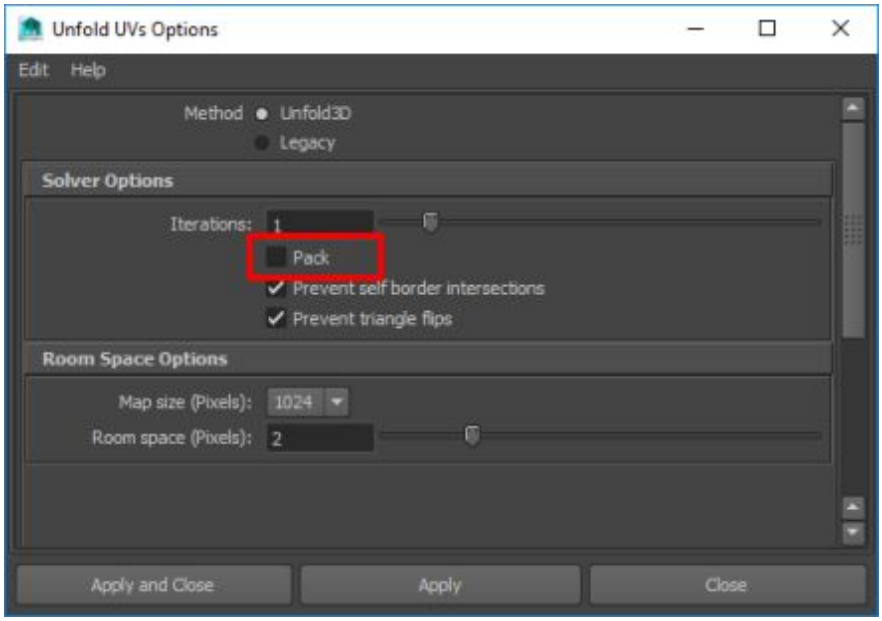
Then, select a single UV on the shell and go to Select -> Select Shell…



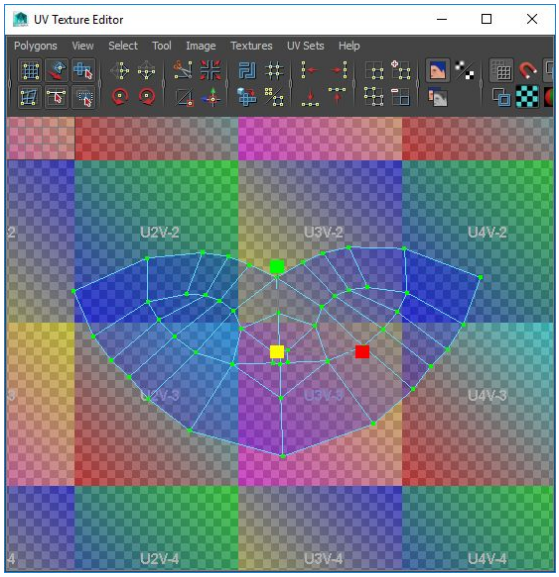


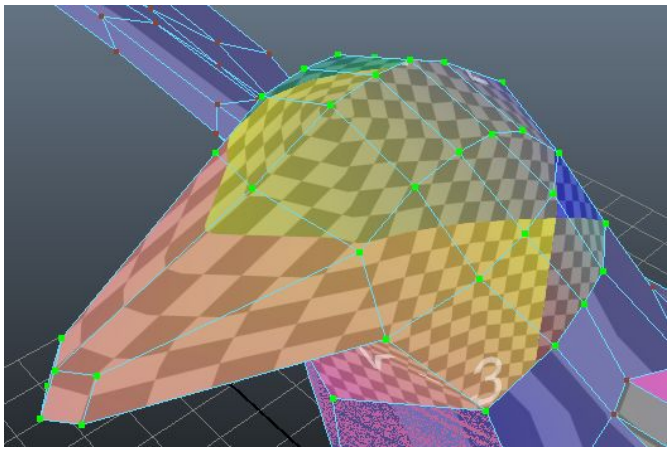
With the UVs selected, go to Polygons -> Unfold and open the tool options (little box on the right). In the window that opens up, make sure the Pack option is unchecked and hit Apply.





The selection will shrink down. Scale it back up using the scale tool.

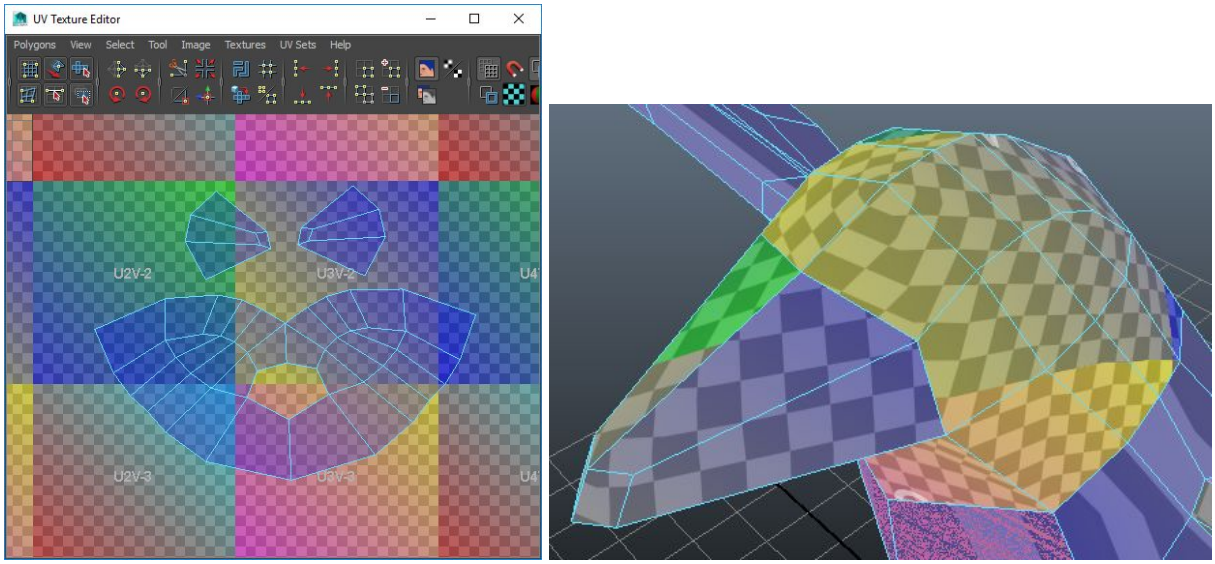




NOTE: The scaling tool it bugged. If you want to uniformly scale, you need to select from the BOTTOM LEFT edge of the yellow box. Selecting the top/right edges will cause the scaling to not be uniform.

Compared to before, this looks a lot better. But, it still has problems (the beak looks super skewed). Turns out that in a lot of cases where you have faces converging into a point-like shape (like this bird's beak), it's hard to keep everything as a single UV shell.

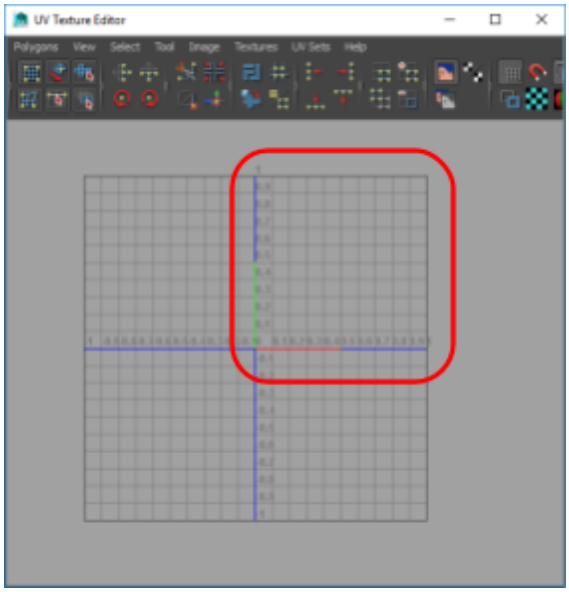
Everything other than the beak looks fine, so we can simple remove the portions of the beak as into their own shell and use the unfold tool again on each of the shells.



In the example above, we took out the beak and split it into 2 pieces. After unfolding the head and the pieces of the beak, a lot of the distortion has gone away.

Saving UVs as Texture (Snapshotting)

Once you have all your UVs mapped out, you can use the unfold tool to pack them into the 0.0 to 1.0 texture space.



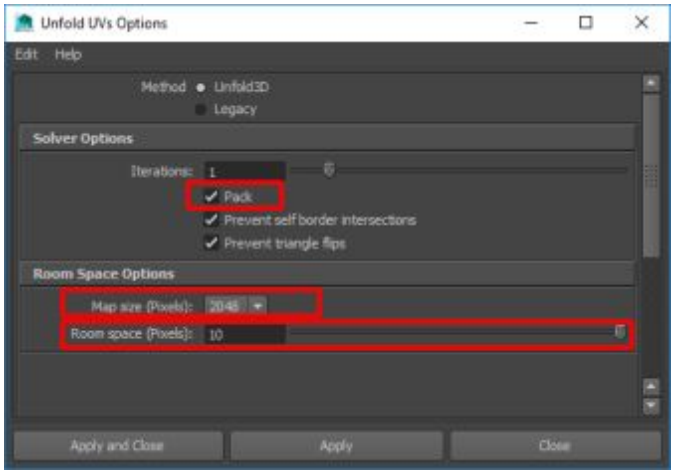
> **NOTE**: For many larger models, we don't pack all the UVs into the 0 to 1 texture space. Instead, we'll pack pieces of the model into different regions. For example, if you had a human body, maybe the head would go into x=0-1/y=0-1, the torso in x=1-2/y=0-1, the left leg in x=0-1/y=1-2, etc.. This way we don't end up with mega textures that can't all be loaded into memory at once.

Select your object in the viewport.

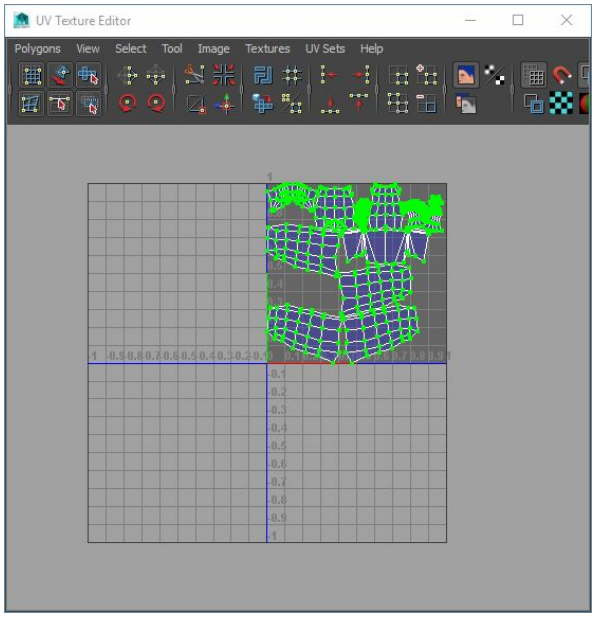
In the UV Texture Editor, go to Select -> Convert Selection to UVs. Then, go to Polygons -> Unfold and open the options.

Set the following options and hit apply…

- **Pack** is selected
- **Map size** is set to how large you want your 0.0 to 1.0 texture area to be (2048 is a good value)
- **Room space** is the amount of space you want between your UV shells (10 is a good value, any lower and you might get 'texture bleeding')



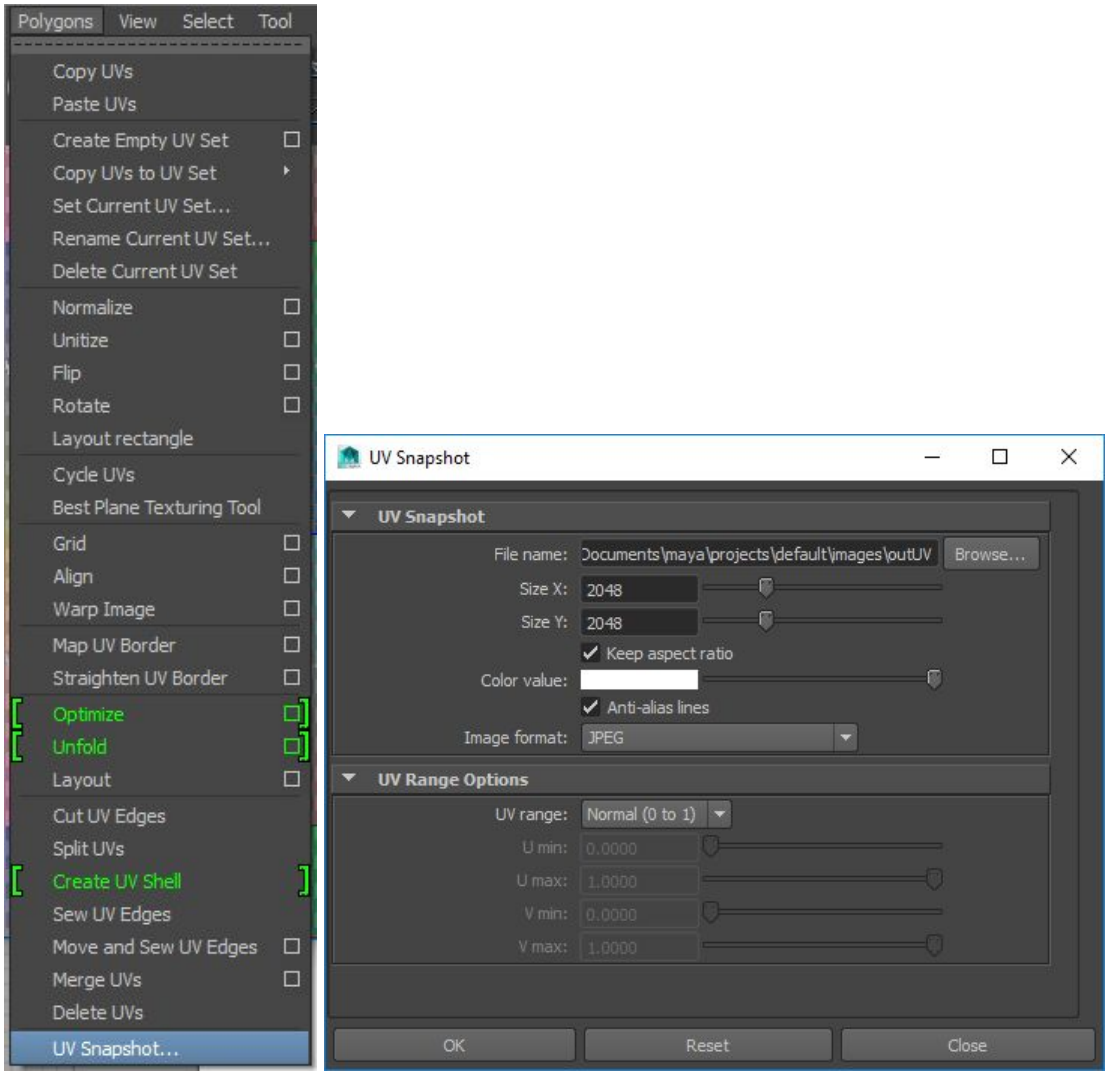
After this, all your UVs should be sized evenly and packed into the 0 to 1 texture space.



While this is okay, most times you'll want to move these around by hand a bit to make sure that related regions are close to each other. You can use the Move UV Shell tool to move shells and make sure they don't collide.

Just remember: At this point you only want to move and you never want to resize. No matter where you move things, you'll want all your shells to ultimately be in the 0 to 1 range before you export a UV snapshot.

At this point, you can export your UV snapshot by going to Polygon -> UV Snapshot…

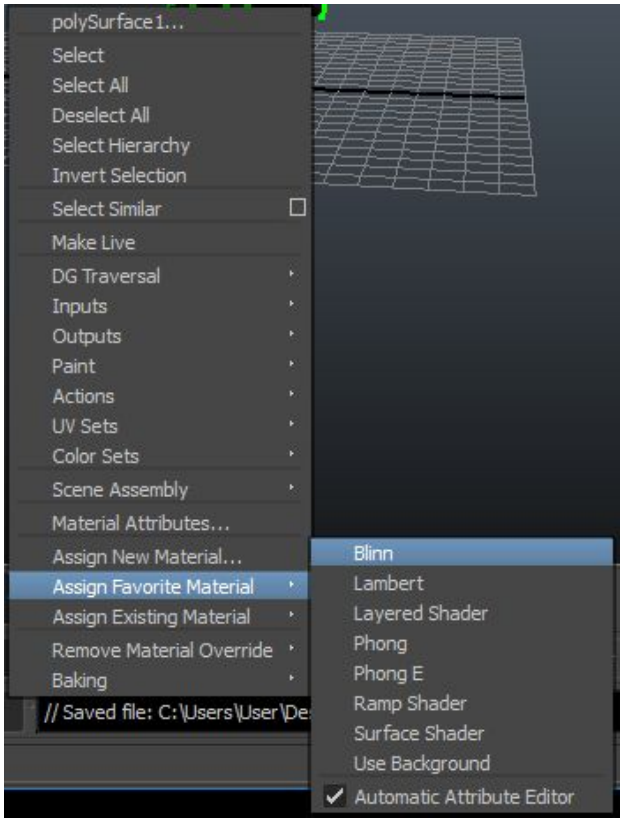


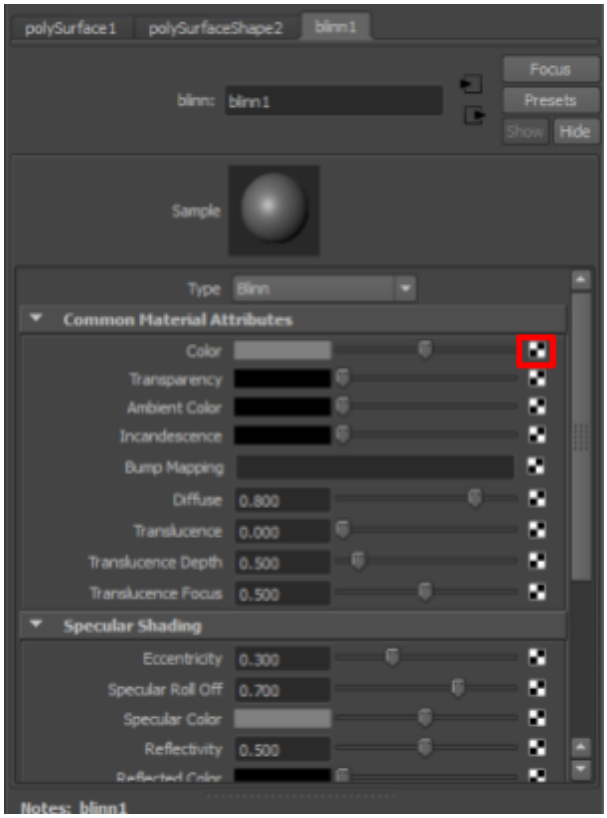
Set the location of where to dump the snapshot + set the size X / size Y to the map size value you chose in the pack tool + select your image format. Hit Ok to save the snapshot image.

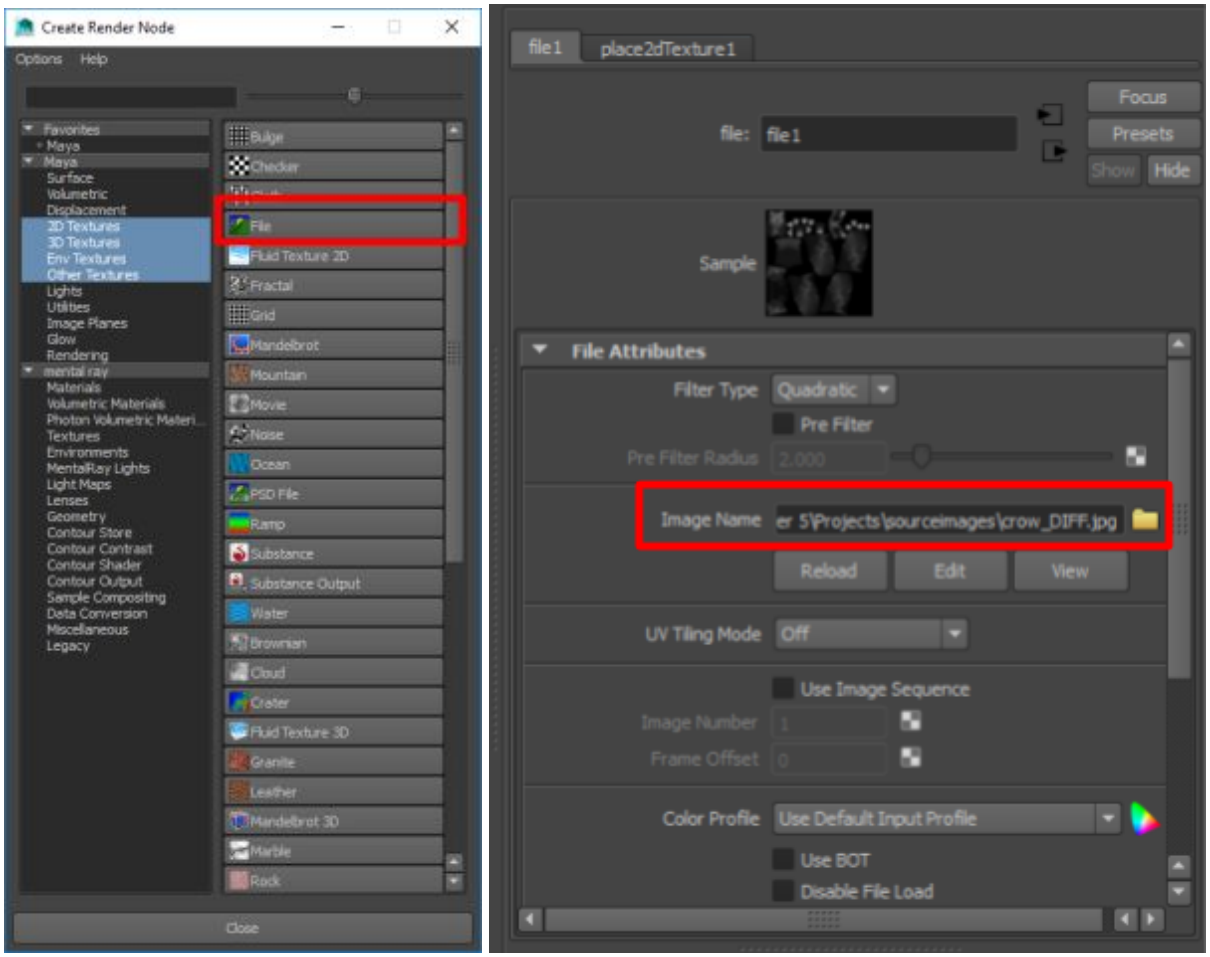
Texture onto UVs

Once you've painted your UV snapshot, you can apply it onto your model by applying a new shader/material (e.g. Blinn) and setting the color attribute on that shader to the image.

> **NOTE**: It looks like you need to Delete By History before you do this.


polySurface1...
Select
Select All
Deselect All
Select Hierarchy
Invert Selection
Select Similar
Make Live
DG Traversal
Inputs
Outputs
Paint
Actions
UV Sets
Color Sets
Scene Assembly
Material Attributes...
Assign New Material...
Assign Favorite Material
Assign Existing Material
Remove Material Override
Baking
// Saved file: C:\Users\User\De
Blinn
Lambert
Layered Shader
Phong
Phong E
Ramp Shader
Surface Shader
Use Background
Automatic Attribute Editor


polySurface1
polySurfaceShape2
blinn1
Focus
Presets
Show
Hide
blinn: blinn1
Sample
Type Blinn
Common Material Attributes
Color
Transparency
Ambient Color
Incandescence
Bump Mapping
Diffuse 0.800
Translucence 0.000
Translucence Depth 0.500
Translucence Focus 0.500
Specular Shading
Eccentricity 0.300
Specular Roll Off 0.700
Specular Color
Reflectivity 0.500
Notes: blinn1

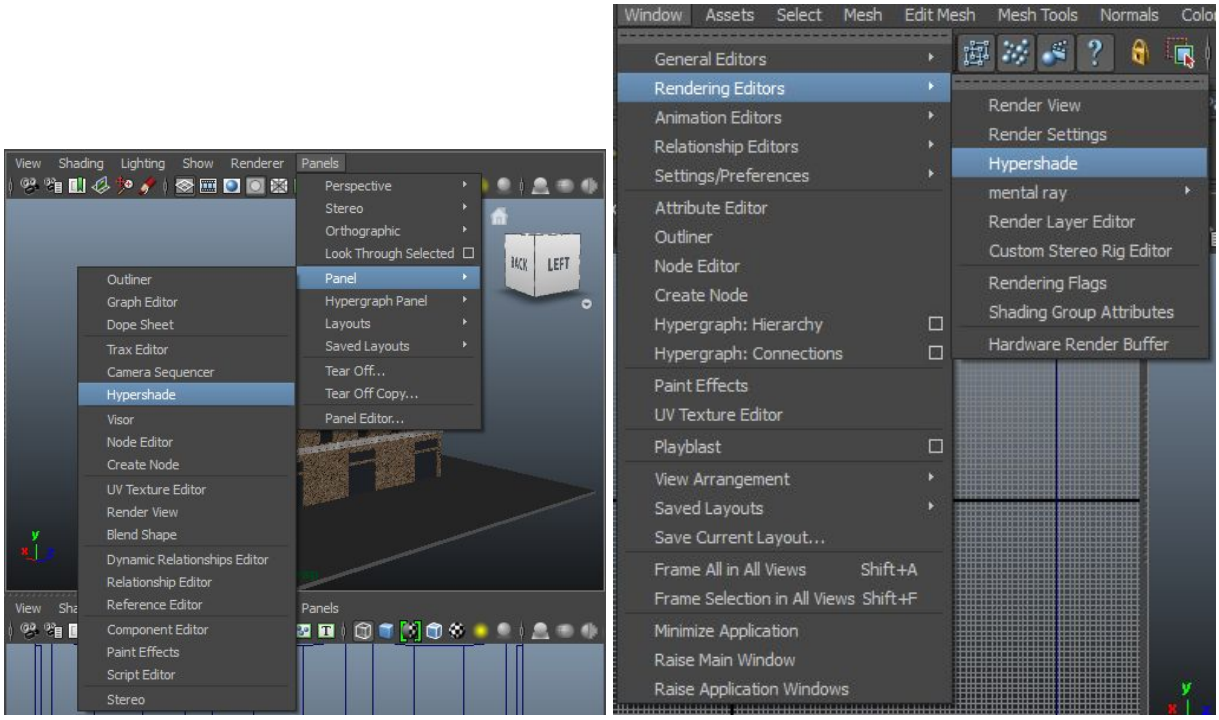


Hypershade

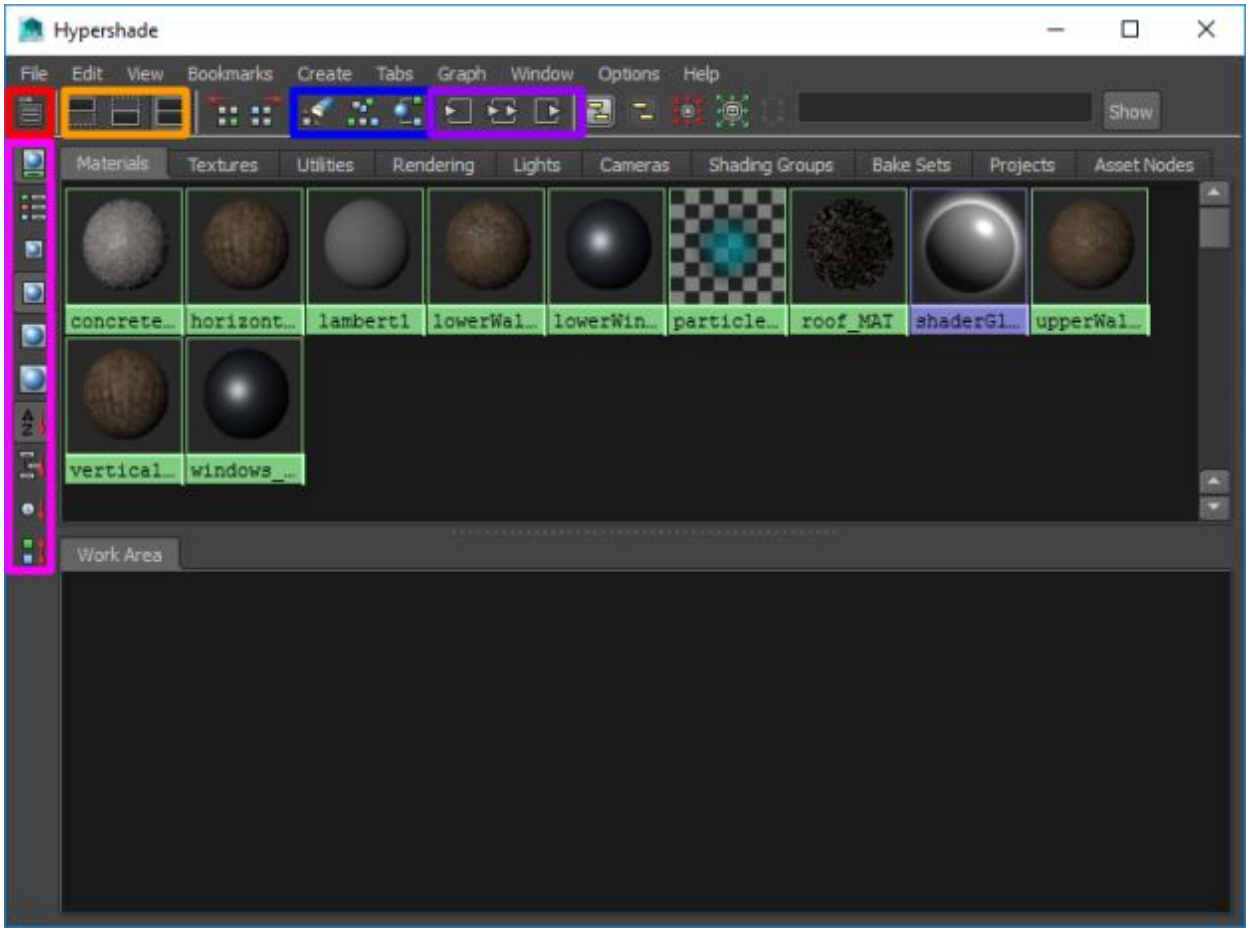
Most shaders are made up of a DAG structure where nodes feed into each other. The Hypershade is a tool inside of Maya that exposes this and allows the user to create/modify these nodes and connections.

There are 2 ways of opening up the hypershade…

1. In a panel, you can go to Panels -> Panel -> Hypershade (opens in panel)
2. Go to Window -> Rendering Editors -> Hypershade (opens as new window)



NOTE: You can only have one instance of the hypershade open.



Create control

Use this button new create new shaders / textures / <node type here>. Opens up a panel that allows you to select different types of nodes

Panel controls

By default, the hypershade has 2 panels open…

1. The top panel exposes various nodes: materials, textures, etc…
2. The bottom panel is a work area where you can view/create/modify connections between nodes

These buttons control which panels you want visible. It should be obvious what button does what.

Work area controls

Helpful buttons that control the work area.

1st button clears the work area
2nd button re-arranges the nodes in the work area
3rd button graphs out the shader(s) for the currently selected object

Input/output controls — For any selected node (doesn't matter if it's in the top pane or the work area), the …

1st button shows inputs to the node
2nd button shows inputs to AND outputs from the node
3rd button shows outputs from the node

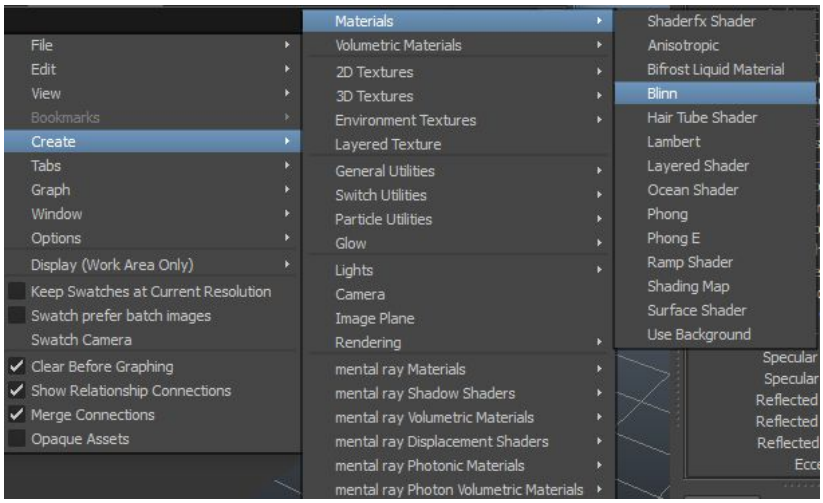
View controls — Controls how the swatches are displayed. Doesn't seem to do anything at the moment.

Creating a Material

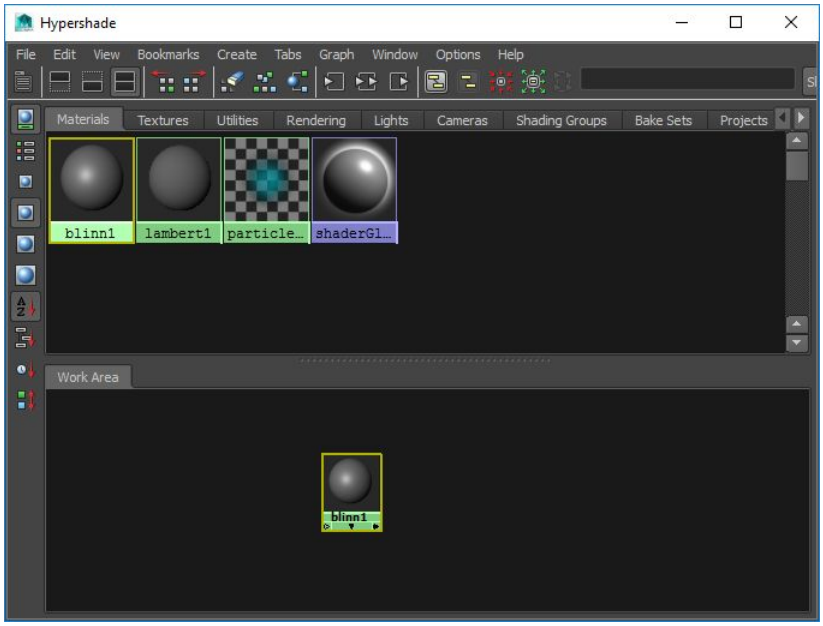
In the following example, we're going to create a new material that combines a couple of different textures with a blinn shader.

Begin by right-clicking either pane and going to Create -> Materials -> Blinn.

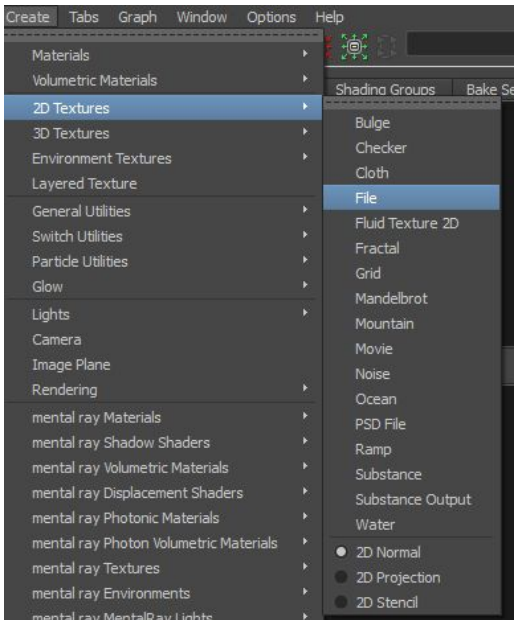
> **NOTE**: You can also do this via the main menu or by using the Create button on the toolbar.



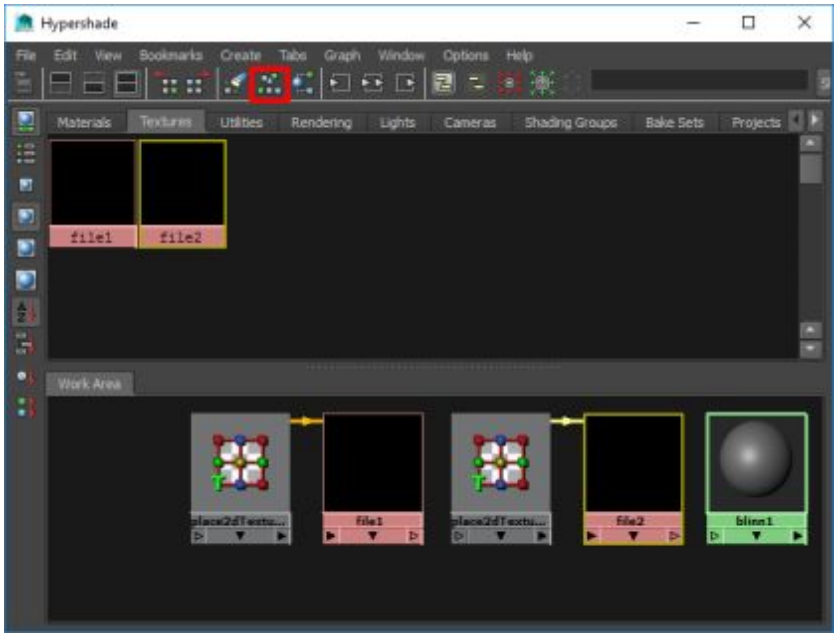
A new node for your blinn shader should show up in your work area + Materials tab + Shading Groups tab.



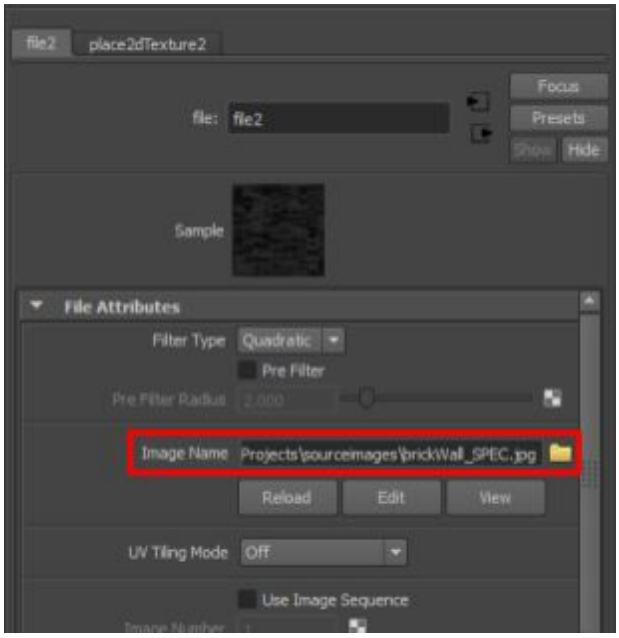
Now, create 2 file texture nodes by going to Create -> 2D Textures -> File.

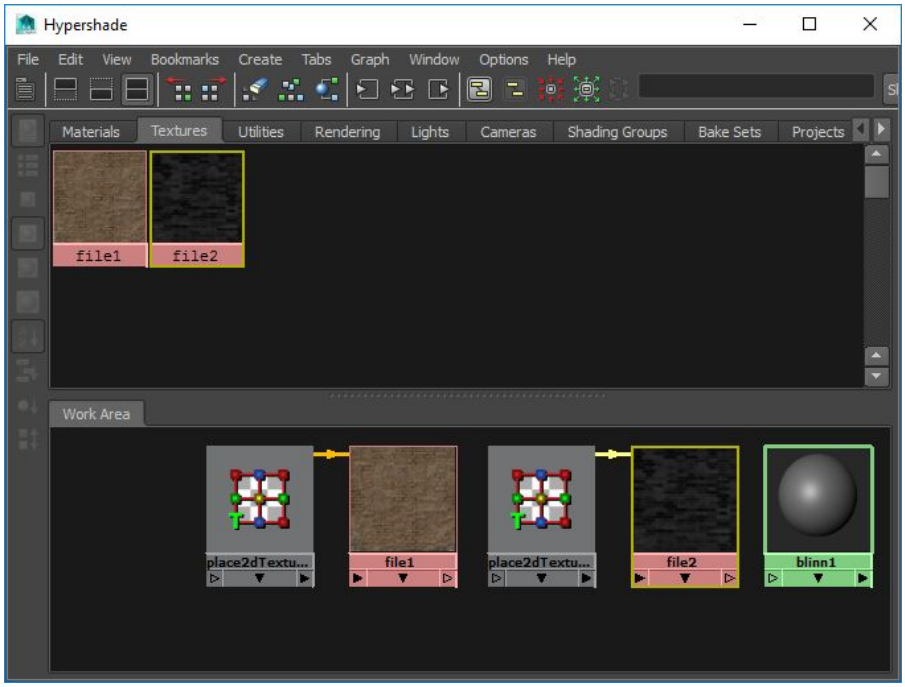


The 2 nodes should be added to your work area + the Textures tab. Hit the Rearrange graph button to properly organize the work area after you do this.



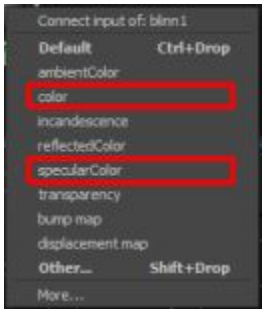
When you select a node in the hypershade window, you can view/change it’s properties in the channel box and attribute editor. For each texture node -- select the node, go into the attribute editor, and open an image file.





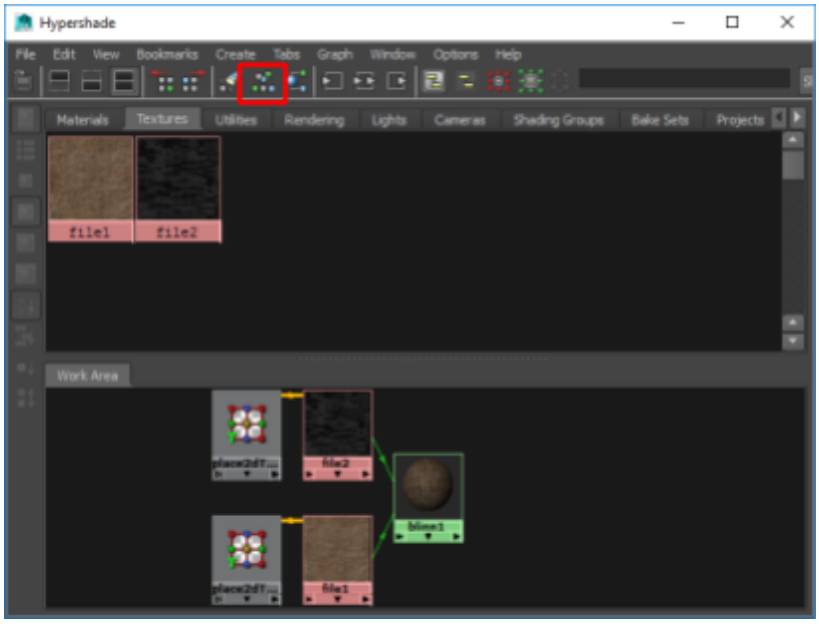
Now you need to connect file1 and file2 to blinn1. File1 should go to the color channel. File2 should go to the specular color channel.

1. Click-and-drag MMB on file1 and drag it to blinn1. In the menu that opens, select color.
2. Click-and-drag MMB on file2 and drag it to blinn1. In the menu that opens, select specular color.

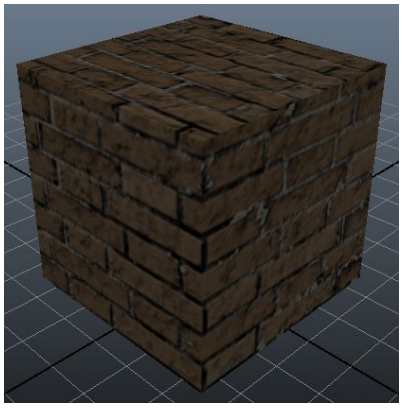


NOTE: Another way to do this is to select blinn1, open up the attribute editor, then click-and-drag the file nodes directly onto the attributes in the attribute editor.

Hit the Rearrange graph button to properly organize the work area after you do this.



Apply your material to your texture as you normally would… Right-click on object, Assign Material -> blinn1.



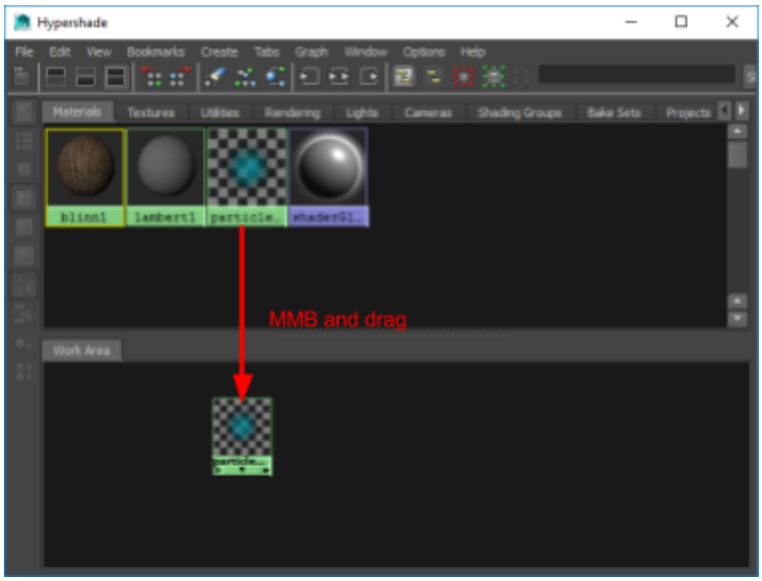
Modifying a Material

Modifying a material is similar to creating a material.

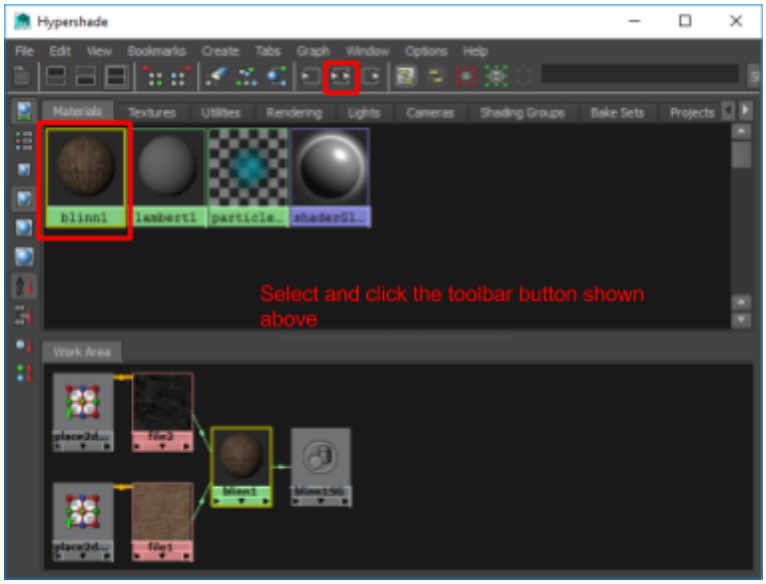
You can create nodes just like you did in the section on creating materials (previous section, just above this one).

You can connect nodes just like you do when you're creating materials (previous section, just above this one).

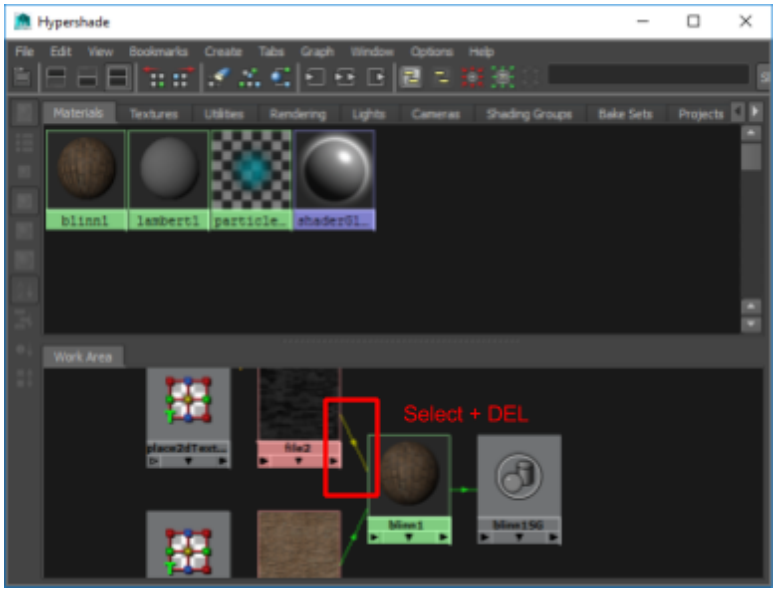
You can drag in existing nodes to the work area from any of the top panes (e.g. textures, materials, etc..) by click-and-dragging MMB on the node and moving it into the work area.



To view the inputs and outputs of a node, simply select it (doesn't have to be in the work area) and select the show inputs and outputs button in the toolbar. If the node wasn't already in the work area, it will be now along with it's input/output connections.

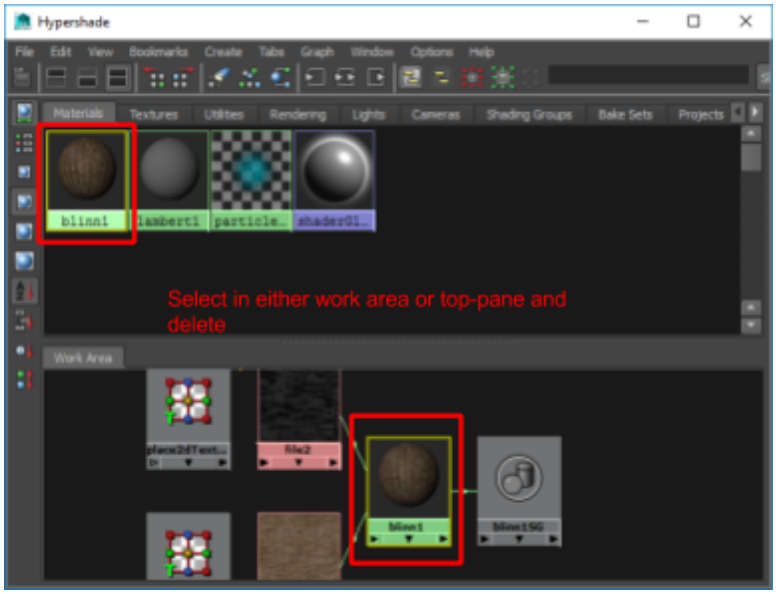


To delete a connection, select the connection and hit the Delete key on the keyboard. Note that this won't delete the node, just the connection.



Deleting a Material

If you want to permanently delete a material/texture/etc... node, select it and hit the Delete key.


Hypershade
File Edit View Bookmarks Create Tabs Graph Window Options Help
Materials Textures Utilities Rendering Lights Cameras Shading Groups Bake Sets Projects
blinn1
lambert1
particle...
shader01...
Select in either work area or top-pane and delete
Work Area
place2dText...
file2
blinn1
blinn1SG