Maya 2017 Arnold Renderer

Introduction

Arnold the default renderer in Maya 2017. It's a monte-carlo based raytracer.

The two main reasons to use Arnold are…

1. <u>Industry adoption</u> -- Arnold is used by most vfx/animation studios for rendering their scenes.
2. <u>Easy of use</u> -- Setting up arnold is much easier than other similar renderers (e.g. renderman/mentalray/etc…). This is especially true for artists. You don't have to do things like set up prepasses or cache files for things like shadows. Arnold calculates everything it needs on the fly.

   NOTE: What is is a pre-pass and what are cache files used for? Unsure, but a Google search seems to hint that this has something to do with a concept called deferred rendering/shading/lighting. You do multiple passes over the scene to perform calculations for things that will be used in the render, then do the actual render.

   NOTE: This isn't a simple raytracer. There's some fancy stuff happening here. See https://computergraphics.stackexchange.com/a/18 for a overview of the topic.
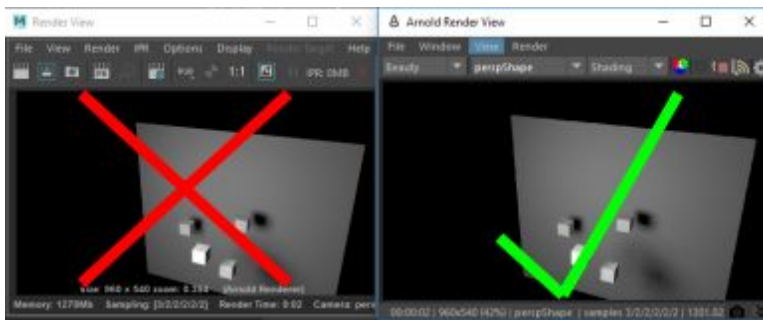
Setup

Before you do anything, you should setup your environment for working with Arnold.

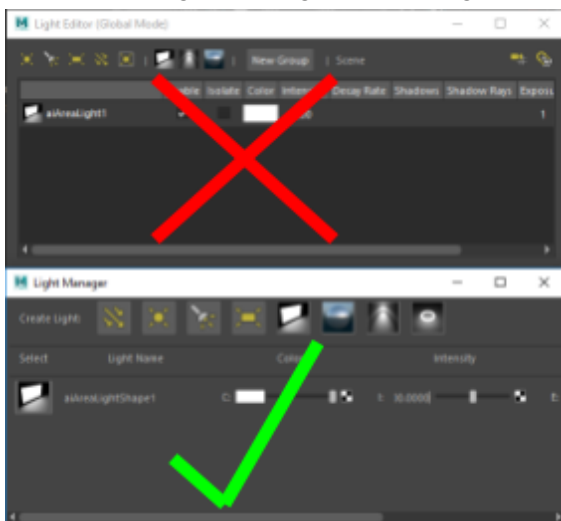1. Make sure Arnold is set as the renderer (it should be by default).
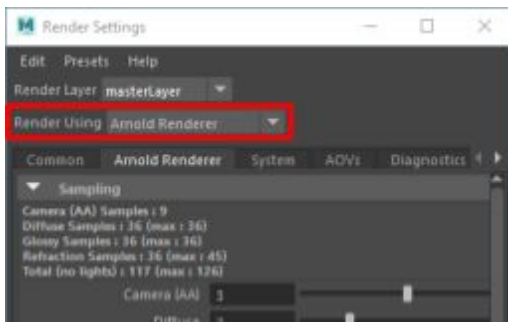
2. Use Arnold RenderView to view renders (different from Maya's render view).
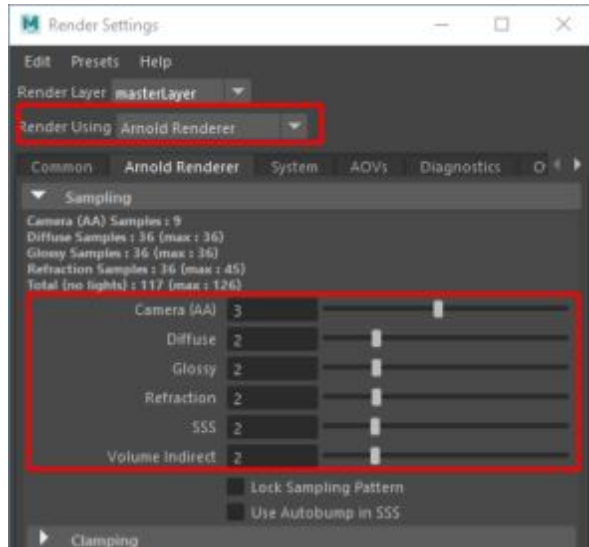

3. Use Arnold Light Manager to view lights (different from Maya's light editor).

Renderer Setup

You can make sure that Arnold is the renderer being used by going to render settings and choosing Arnold Renderer. This should already be the default.

The main quality control setting here is under the sampling section. The defaults here are good for draft renders. If you want a final renderer, you would bump these numbers up.

The main quality setting here is Camera (AA). A setting of 10 will generate a good quality render. But, keep in mind that the number of samples goes up exponentially as you increase this value. The more samples you have the longer your render will take.

> **NOTE**: Camera (AA) slider goes up to 10, but it can be bumped even higher by typing in a value.

In some cases, you may notice noise/dithering with some parts of your render even though you have a high Camer (AA) value. You can find out which parts of your shader are having issues by inspecting AOVs (AOVs are explained later on).

For example, if you notice that subsurface scattering is having issues, you can bump up the the SSS value instead of bumping up the the main Camera (AA). This ends up being not as computationally expensive.

> **NOTE**: One thing you'll notice about arnold vs other renderers is that there is no default light! If you have no lights in your scene, your render will show up pitch black.
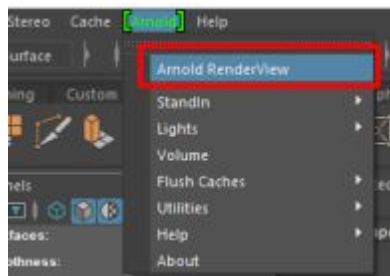
Arnold RenderView Setup

Arnold RenderView is similar to Maya's render view, but streamlined for use with Arnold. You should always use the Arnold RenderView as opposed to the regular Maya Render View.
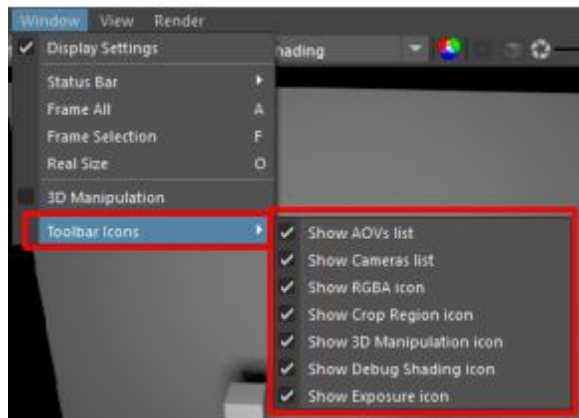
> **NOTE**: Full list of features available here:
> https://support.solidangle.com/display/AFMUG/Arnold+RenderView+Window
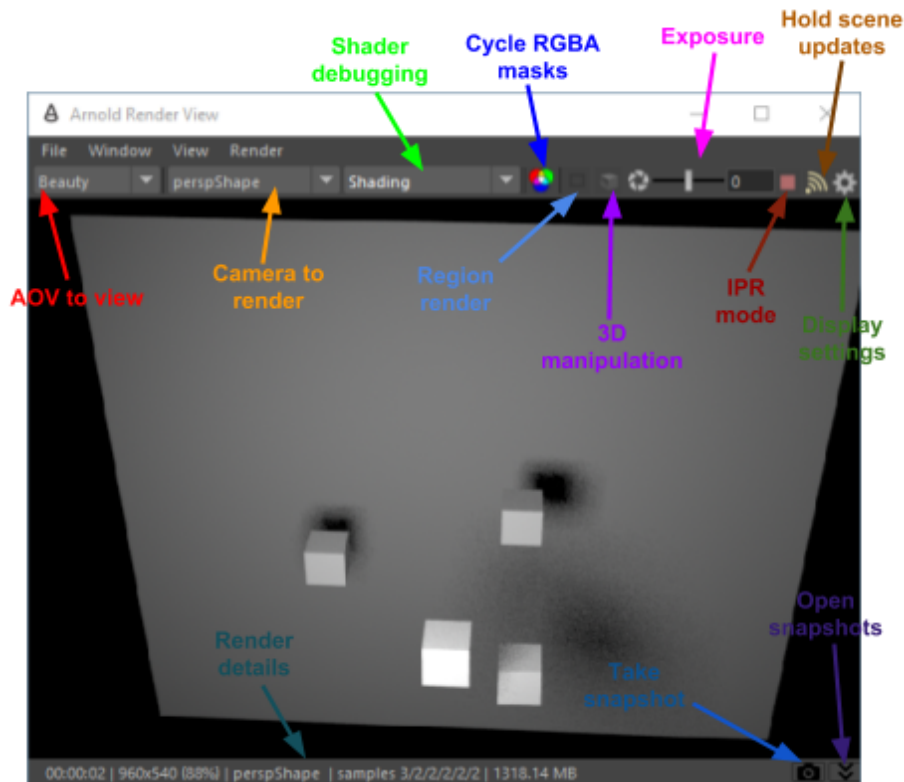
To get to the Arnold RenderView… go to Arnold -> Arnold RenderView (menuset doesn't matter)

Once you're in Arnold RenderView, enable ALL of the toolbar options. You can do so by going to Window -> Toolbar Icons and making sure everything is selected…

Here's a quick overview of the different things in Arnold RenderView. They'll be covered in more detail further on…

Arnold Light Manager Setup

Arnold Light Manager is similar to Maya 2017's Light Editor, but streamlined for use with Arnold. You should use Arnold's light tool as opposed to the regular Maya Render View.

> **NOTE**: Full list of features available here:
> https://support.solidangle.com/display/AFMUG/Light+Manager

To get to the Arnold Light Manager… go to Arnold -> Utilities -> Light Manager (menuset doesn't matter)
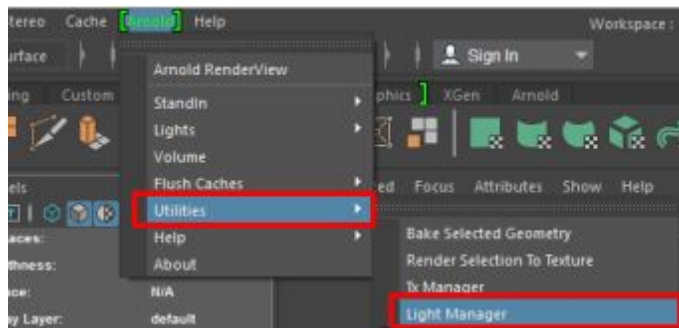
Here's a quick overview of the different things in the light manager...
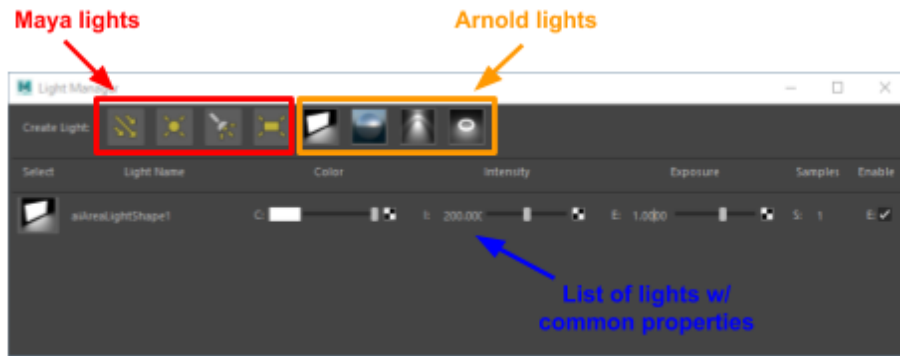
Arnold RenderView

To get to the Arnold RenderView… go to Arnold -> Arnold RenderView (menuset doesn't matter)

NOTE: Once you're in Arnold RenderView, enable ALL of the toolbar options. You can do so by going to Window -> Toolbar Icons and making sure everything is selected…

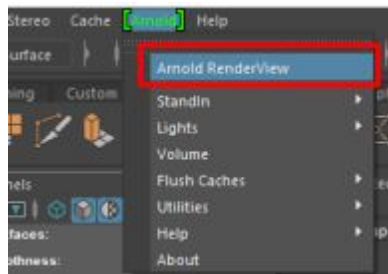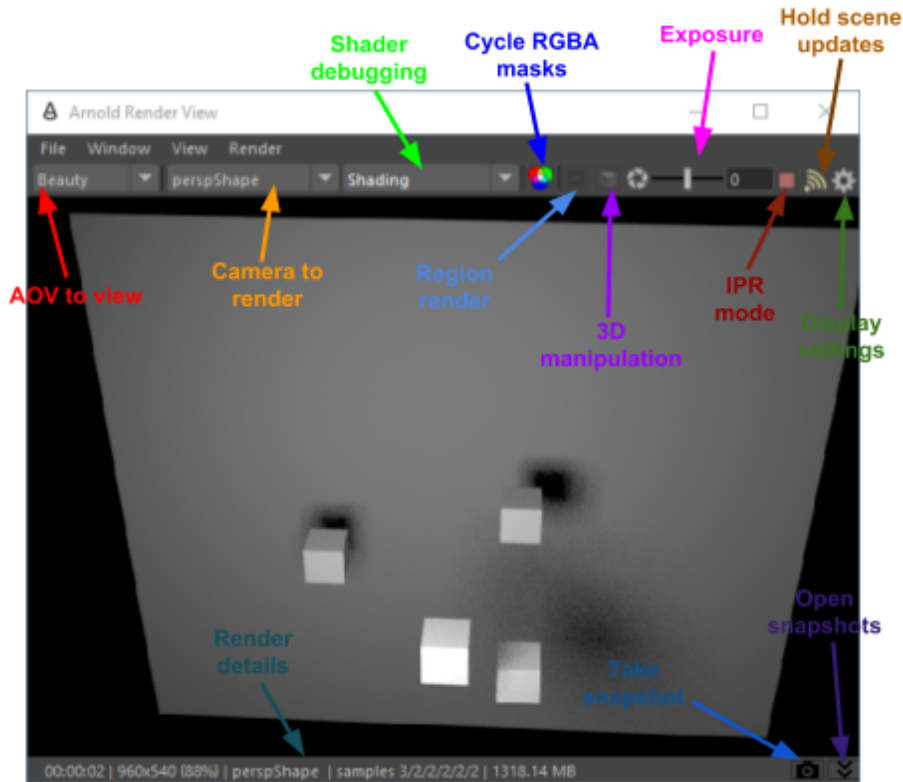**NOTE**: One thing you'll notice about arnold vs other renderers is that there is no default light! If you have no lights in your scene, your render will show up pitch black. Keep this in mind if you ever do a render but it comes out pitch black.

NOTE: Slow renders? Set a lower test resolution by going to View -> Test Resolution

AOV to view

AOVs will be described later on, but if you have AOVs set you can select them in this drop down and view them here. For example, if you wanted to see how a specular pass would look just on its own, you can have that as an AOV and view it directly in this view.

The "Beauty" value is the one selected by default. This is the option for the full render.

HINT: Here's a description of AOVs from the arnold website… AOVs (Arbitrary Output Variables) provide a way to render any arbitrary shading network component into different images. For example, an artist might find it convenient to separate direct and indirect lighting contributions and later recombine them during compositing.

Beauty   Normal   Specular   Z
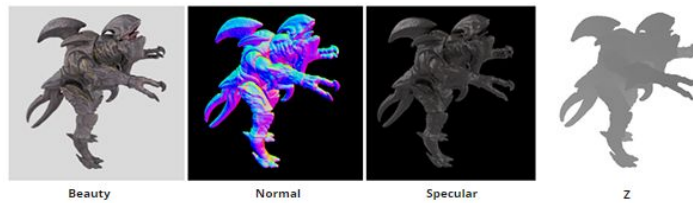
**Camera to render**   Select the camera you want to render with this dropdown.

Shader debugging   Select different ways of shading the scene. Use this to help with debugging your scene. For example, if you select normal your render will show the normals for the object in your scene, and you can easily spot things like polygons facing the wrong way.

Region render   Allows you to select a region on the render that will continuously get rendered instead of the entire scene. Use this when renders are really taking a long time and you only want to focus on one specific area.
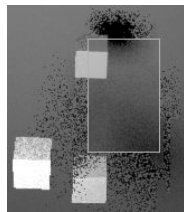
If you mouse into the box, you'll see crosshairs in the center. Click-and-drag the crosshairs to move the box around, or click-and-drag the corners to expand/shrink the box.

Cycle RGBA masks   Pick individual channels in the render: red, green, blue, or alpha.

3D manipulation   If this is selected, you can pan, rotate, and zoom via the Arnold Render View just like you normally do when you're in a viewport (Alt+MMB/LMB/RMB). You can also select objects through the Arnold Render View by clicking on it (but you can't do fancy selections like marquee or multi-select).

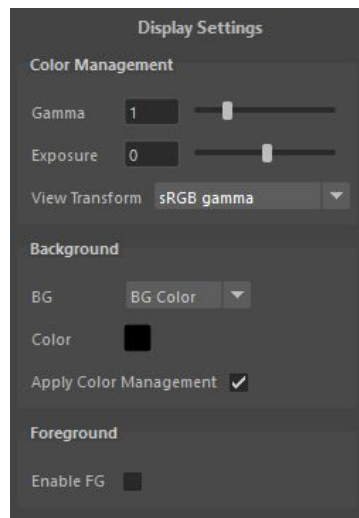**Exposure**   Expose the display image up or down, in f-stops.

IPR mode   This enables/disables automatic updates whenever the scene is changed. The user will then manually trigger a new render by calling a Render.

NOTE: A lot of times Arnold won't pick up new things when it does scene updates like this. You'll need to go to Render -> Update Full Scene (Ctrl+U shortcut).

Hold scene updates   If IPR mode is enabled, enabling this will stop renders from happening on a change.

If IPR mode is disabled, this turns into a button that you can click to render the scene.

Display settings   Opens up a panel on the side that lets you change various settings with your display…

Gamma is self-explanatory.
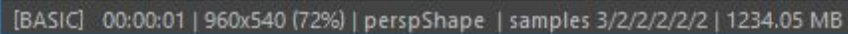
I don't know what View Transform does.

Exposure mirrors the exposure option in the toolbar -- expose the display image up or down, in f-stops.

Background and Foreground are self-explanatory.

NOTE: Color management is not on by default as it is when you use the normal Maya Renderer. You have to manually set things like gamma here in the display settings.

Render details

This is from the Arnold website. It does a better job of explaining what's here than I can…

[BASIC]   00:00:01 | 960x540 (72%) | perspShape | samples 3/2/2/2/2/2 | 1234.05 MB

Just below the render buffer, a Status Bar provides information about the render in progress. When a previously stored snapshot is displayed, information about this previous render is displayed.

- If Debug shading mode is used, the debug mode is shown (OCCLUSION, UV, NORMAL, etc).
- If Isolate Selected mode is used, the name of the selected node is shown. A 'lock selection' option 🔒 is available for isolate selected, which ignores selection changes.
- "Rendering..." appears when a render is in progress.
- Render time appears when a render is finished. Note that this render time corresponds to the last AA step, which corresponds approximately to the render time it would take to render this in batch mode.
- Resolution: width x height.
- Zoom factor: 50%, 1:1, 200%, etc.
- Camera name: displays the name of the camera that is being rendered.
- Sampling info: AA samples / GI Diffuse Samples / GI Glossy Samples / GI Refraction Samples / GI SSS samples / GI Volume Samples.
- Memory usage: displays the memory used for the current render.

Take snapshot

Takes a snapshot of the current render and saves it in memory.

NOTE: When you view the snapshot again, you'll get the rendering details in the status bar.

Open snapshots

Open the snapshots panel on the bottom.

Click any snapshot to view. When you're viewing a snapshot, the take snapshot button turns into an eye instead of a camera. Click the eye to go back to viewing the render.

 vs

> **NOTE**: When you view a snapshot, you'll get the rendering details for that snapshot in the status bar.

Arnold Light Attributes

These settings apply to all types of Arnold lights (more or less). Some of these settings can also be set on Maya lights -- you'll need to go to the Arnold section within the attribute editor to find them.

The following snapshot is for an Arnold area light. But, most of these settings can be found in pretty much every other light Maya light.
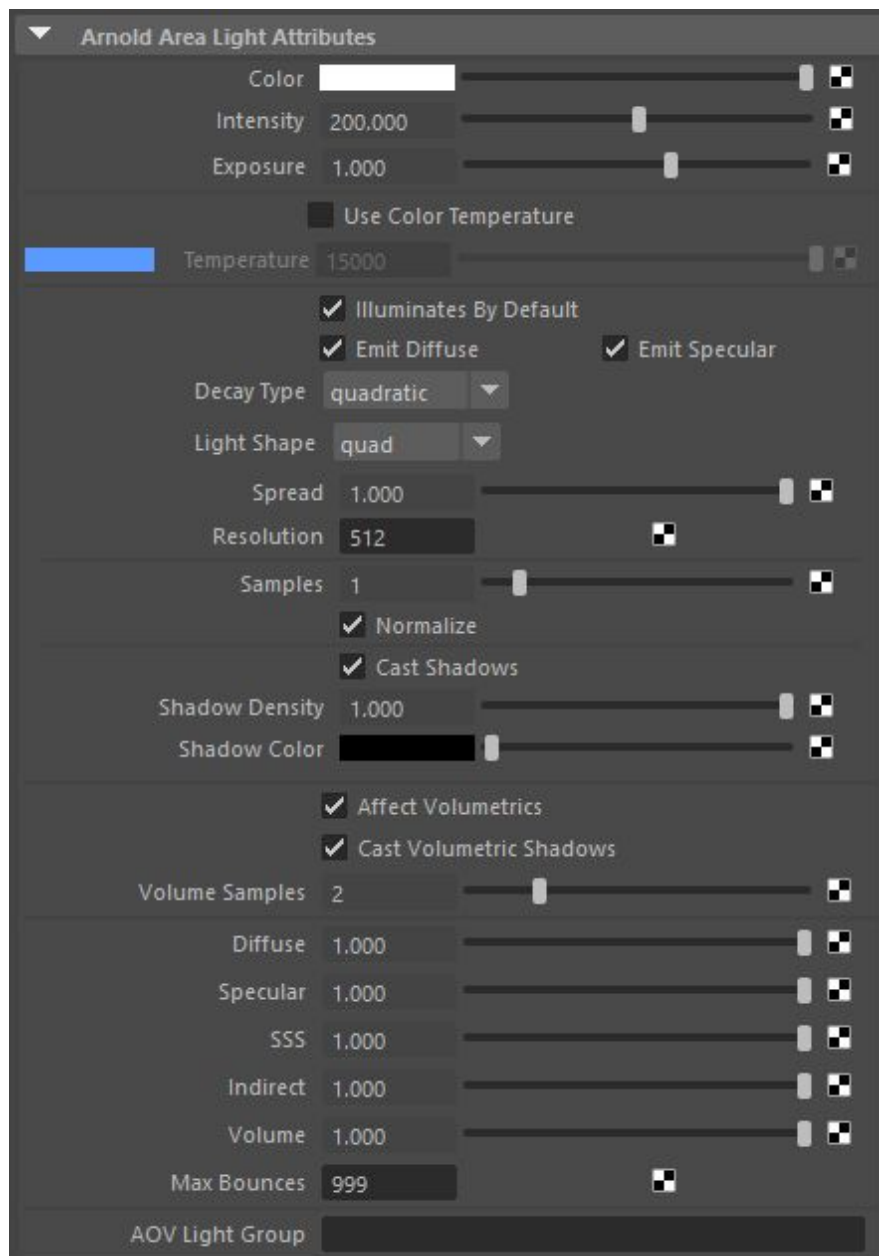
Color and Intensity
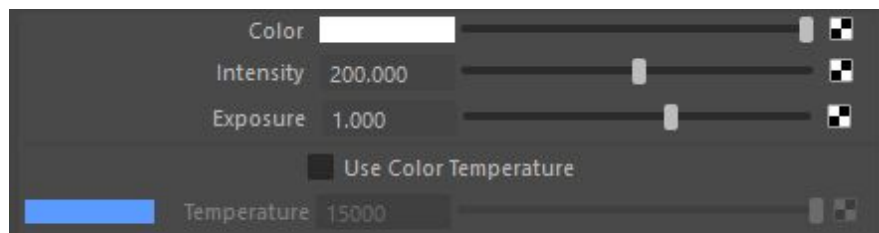
Color   Color of your light.

Intensity   Intensity of your light. This works the same way as a regular Maya light.
                          The higher your intensity is, the more light will be given off.

Exposure   Intensity of your light. This is different from the above setting in that it's
                          measured in f-stops (just like real photography). It's designed to help you
                          interact with real cinematographers. For example, the cinematographer
                          may come and ask the artist to increase something by half a stop -- you
                          can do that directly here in this setting.

                          This is exponential… each time you go up by 1, it doubles the intensity of
                          your light.

                          NOTE: This is linked to the intensity in that the exposure uses the
                          current intensity value as the basis for its setup.

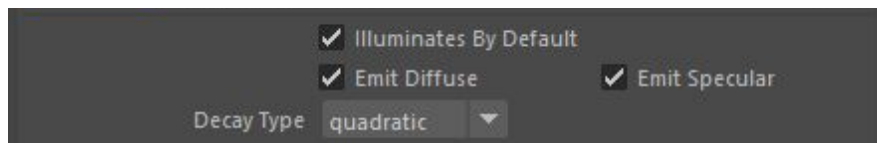   **NOTE**: Unlike intensity, exposure won't show up in your viewport. It may
                          render properly but if you have lighting turned on in the viewport, the
                          object will not actually get lit in the viewport.
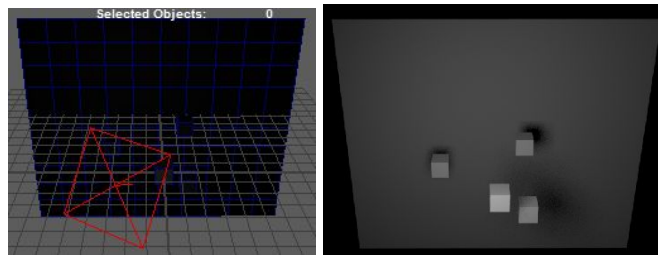
Temperature   Changes the color based on Kelvin (e.g. a cool color or a warm color).

                          NOTE: If you set this, it'll override the color attribute.

Illumination Specifics

Illuminated by Def.   Disable this if you don't want your light to illuminate everything / if you
                          want your light to illuminate specific things. You'll need to manually link
                          your lights if you do this. Look up Maya light linking for more information.

Emit Diffuse	Allow the light to affect the material's diffuse component.
Emit Specular	Allow the light to affect the material's specular component.

NOTE: It looks like this only applies if the rays coming from a light DIRECTLY hit the material. If the rays are INDIRECT (e.g. they bounce off something else before hitting the material in question), it will apply to the material's specular component.

In the example below, the only light in the scene has emit specular turned off. Notice how the specular highlight isn't showing when emit specular is turned off, but the reflections of the boxes (specular highlight of boxes) are still showing.
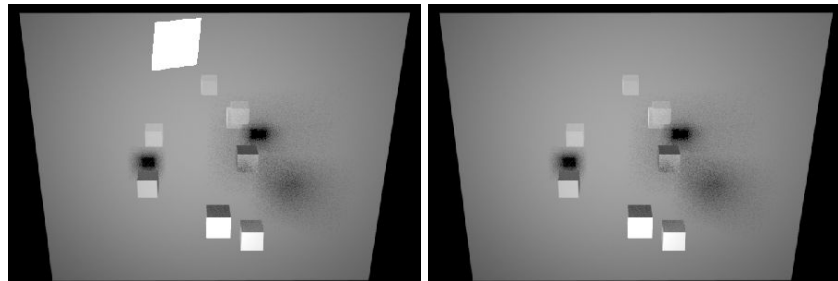
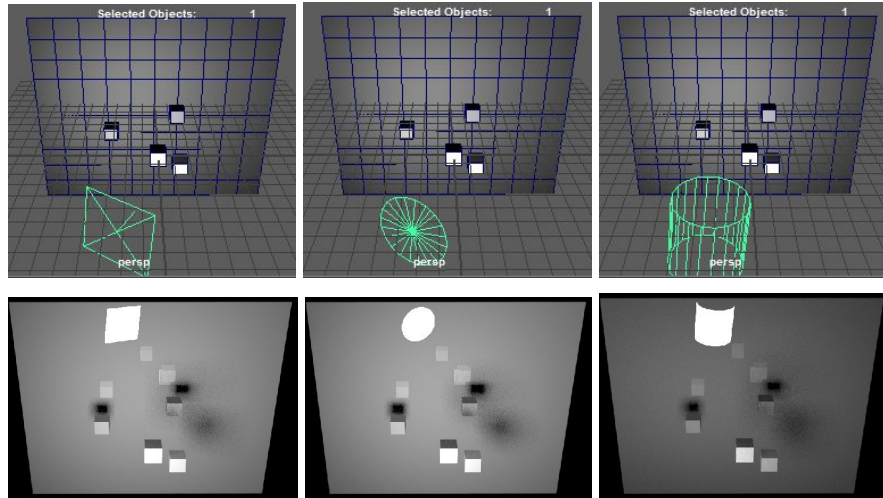|	
Decay Type	The falloff for a light. Quadratic is the default and the most realistic (uses the inverse square law -- look it up if you want).

Recommended you don't change this from quadratic.

Shape, Spread, and Quality

|	
Light Shape	The shape of the light. Can be quad, disk or cylinder.

NOTE: This applies to area lights only? The shape of the light shows up in specular highlights.

Spread
Emits light focused in the direction along the normal. The default spread value of 1 gives diffuse emission, while lower values focus the light more, until it becomes a laser like beam at value 0. Low spread values can be noisier than the default high spread, so be careful when using them.

The following example is spread of 1.0 vs 0.5 vs 0.25 vs 0.1...
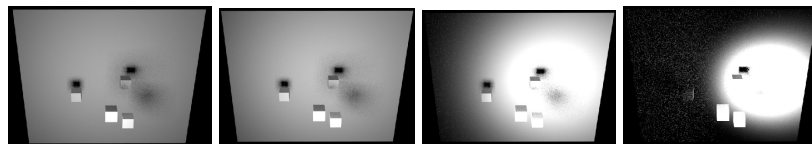
NOTE: This wasn't explained during the course. The description above is from the Arnold documentation.

Resolution
This has to do with the topic of importance sampling. This isn't fully described, but from what it sounds like importance sampling has something to do with the images you apply to your lighting (e.g. if you loaded up a texture for the color of your light). It splits the image up and looks for the brightest part and sample those more vs the dark parts where it won't sample them as much.

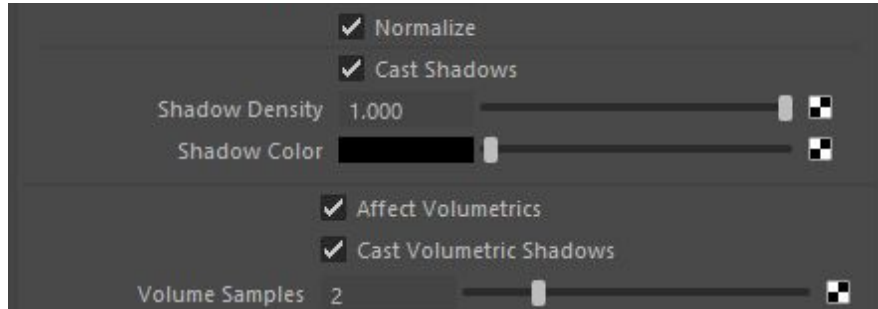This is the resolution you use to control that.

Samples
The quality of the light / the quality of the shadows. This is an override for the global samples setting.

The higher this value is, the longer things will take to render.

NOTE: Also check out the Volumetric Samples in the volume section.
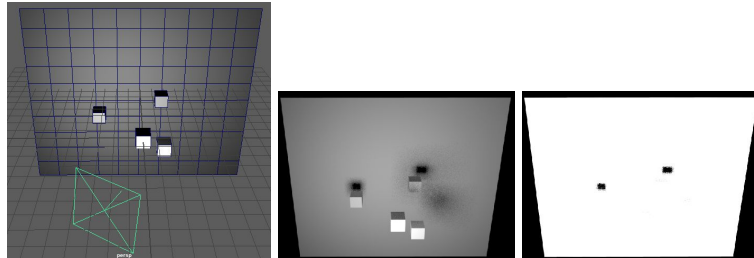
Shadows and Volumetrics

Normalize

If this is turned on, the scale of the light controls how soft the shadows are rather than the intensity of the light (Applies to area lights only? Scaling does nothing with photometric lights).

That means that if this is on and you scale your light up, you will get softer shadows, NOT more light. The example below shows a scaled up light. The first render is with normalize on while the second is with normalize off.

Cast Shadows

If turned off, the light won't cast any shadows.

Shadow Density

The shadow strength.

It looks like if this is < 1.0, some light will be let through.

Shadow Color

The color of the shadows being cast.

Affect Volumetrics

Lights up volumes in your scene (e.g. haze/fog/god rays/etc..).

A lot of the time you'll have filler lights to light up parts of your scene that are too dark, but you don't want those lights to effect the volumes. This setting helps with that -- volumetric lighting is expensive in terms of
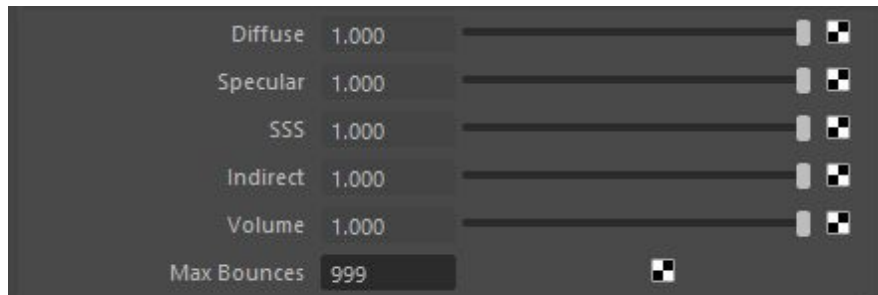
render time.

NOTE: Can't you just do this with light linking? Maybe this is here because light linking is a Maya-specific thing?

Volumetric Shadows Whether or not the light cast shadows in the volumetric light.

**Volume Samples** Similar to samples, but specific to volumes.

Material/Shader Weights

Specifies how much of the light effects different parts of a shader. For example, you can turn down the weight this light has on the specular of a material -- turning it all the way to 0 would be like unchecking the Emit Specular option.

Max Bounces controls the maximum number of times a light can bounce off a surface. For example if Max Bounces was set to 0, none of the rays would be bouncing off the polygon they hit.

Arnold Light Types

Arnold comes with 4 light types: Area lights, Skydome lights, Mesh lights, and photometric lights.
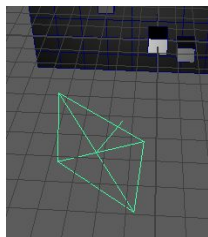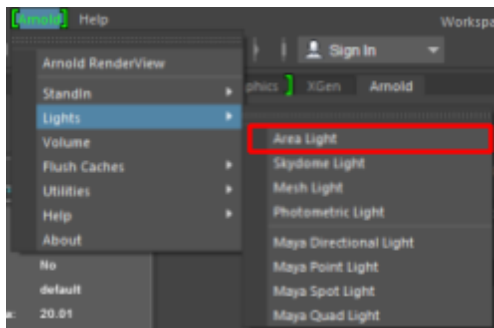
To add a light, you can use the Arnold shelf or you can go to Arnold -> Lights -> (pick light here).
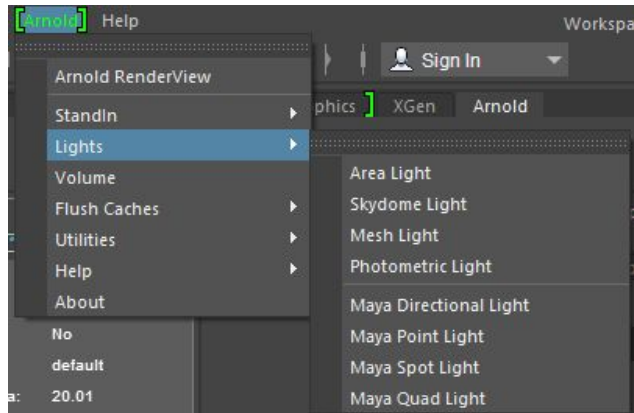
Area Light

An area light is a basic light. It can be shaped as a quad, disk, or cylinder.

To add, go to Arnold -> Lights -> Area Light.

Note that, if normalize is on, the scale of the light controls how soft the shadows are. Make the light smaller for harder shadows, or larger for softer shadows.

If normalize is off, the scale controls the intensity.

Skydome Light

A skydome light is a giant light that goes all around your scene in a giant sphere/dome shape. Typically used for ambient/fill lighting?

To add, go to Arnold -> Lights -> Skydome Light.
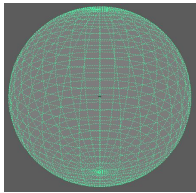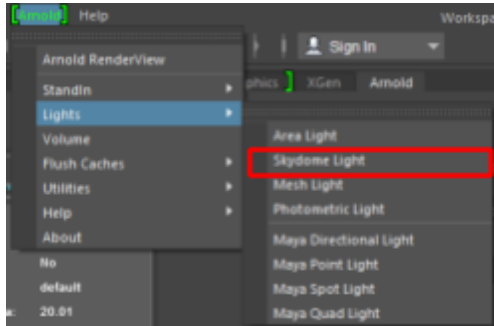
> **NOTE**: This seems very similar to a mentalray IBL node (image-based lighting node).

Typically, what you want to do with a skydome light is to apply an image texture to the color attribute (instead of assigning a solid color). The type of image you should be using is either a latlong, angular, or mirrored_ball.
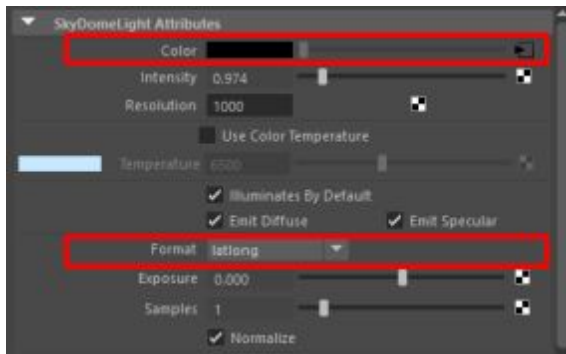
> **NOTE**: Resolution has to do with importance sampling. This increases the accuracy of light coming from the image. See the resolution description of the lighting attributes section for more information. You typically want to bump this up for interior scenes (or so the course video says).

NOTE: These image formats are discussed further on http://www.hdrlabs.com/tutorials/index.html. The text is replicated below.

What are the differences between a light probe, spherical image, LatLong, vertical cross, cubic (etc) versions of HDRs?

Depending on what application you are using, the names of the shapes of the HDR will change.

Most 3D programs want/need an image that looks like an unwrapped world map. This file can be called "Equirectangular", "Spherical", "LatLong", and also a "Latitude Longitude" file. These are called different names, but they are all exactly the same!

Vertical Cross, Horizontal Cross, and Cubic HDRs… these are all just six 90-degree views of a scene or panorama. They just happened to be place together in a certain shape (vertical or horizontal cross) or saved out as six separate cube faces as six different files. Retouching is pretty easy with these as long as you do not try to retouch any of the edge pixels. If you need to do some cloning or color correction across the seams, then convert the image to a spherical image and work on that. Then convert back to a cubic format if needed.

"Light Probes" are full 360x180-degree spherical (or LatLong) HDR files that have been converted into a ball shape. Visually, it appears that they are chrome balls, but in reality they have a mathematically much simpler distortion and they may or may not have been created and captured that way. A few 3D programs directly support Light Probes (ball-looking) images, but almost all support LatLong shaped HDR images. When you make an HDR from a series of pictures of a chrome ball, this too, is considered a "light probe". In fact, any fully immersive HDR panorama can be considered a light probe, no matter what unwrapping format it is in. They are also sometimes called "Light Maps" as well.

Light Probe
Angular

Spherical
Equirectangular
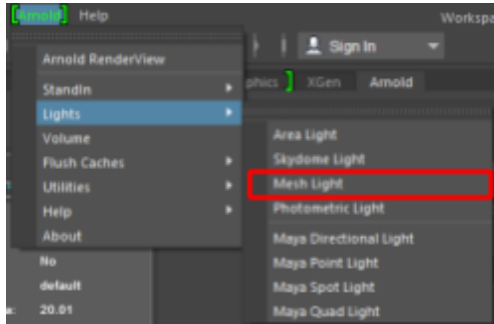LatLong
Latitude / Longitude

Vertical Cross
Cubic*
*6 faces can be attached or seperate

Mesh Light

A mesh light turns your mesh into a light.

To add, first select your object then go to Arnold -> Lights -> Skydome Light.

In the following example, the cube with the red wireframe became a mesh light. The plane in the background has a high smooth specular. Notice how the mesh light causes a specular highlight but the actual cube giving off the light isn't visible anymore.
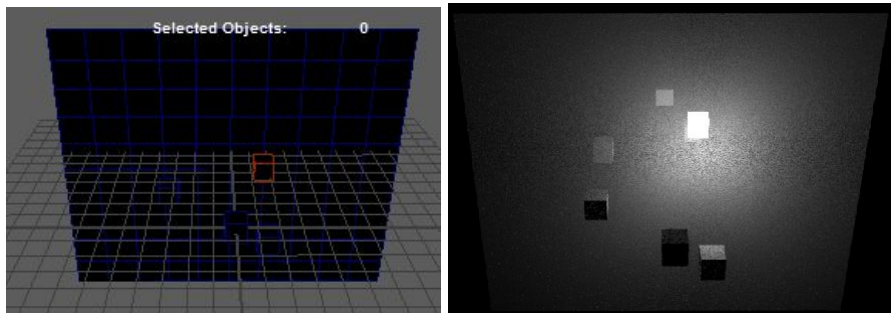
> **NOTE**: You can make the object visible as well by going to the lighting properties (discussed below) and enabling Light Visible.

You can control the lighting properties by going to the shape node in the attribute editor and navigating to the Arnold section. If you want to change it back to a normal object, you can select

polymesh in the Arnold Translator dropdown (instead of mesh_light).
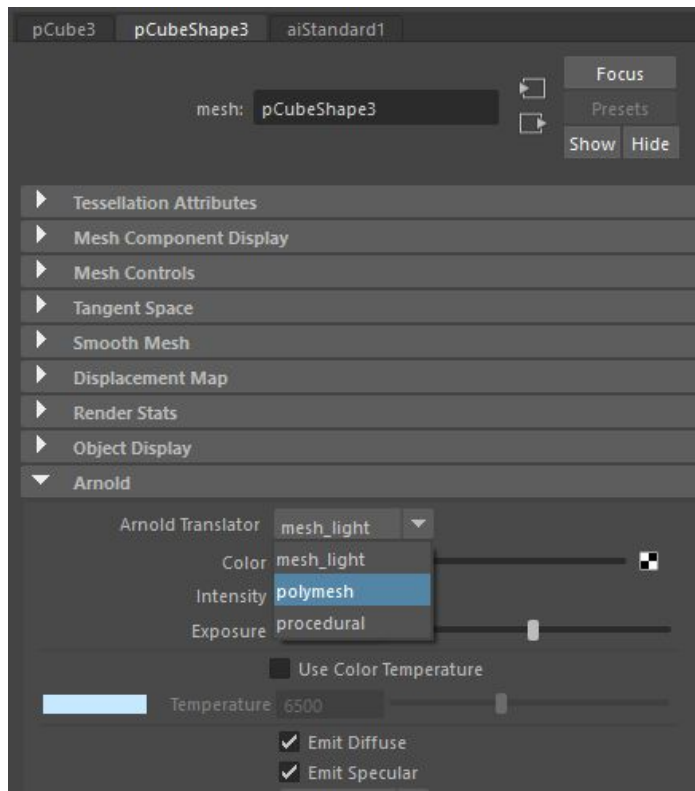
NOTE: No light will be given off in the viewport even if lighting is enabled.

Photometric Light

Photometric lights use data measured from real-world lights, often directly from bulb and enclosure manufacturers themselves. You can import IES profiles from companies such as Erco, Lamp, Osram and Philips; their IES files provides accurate intensity and spread data for a given light model.
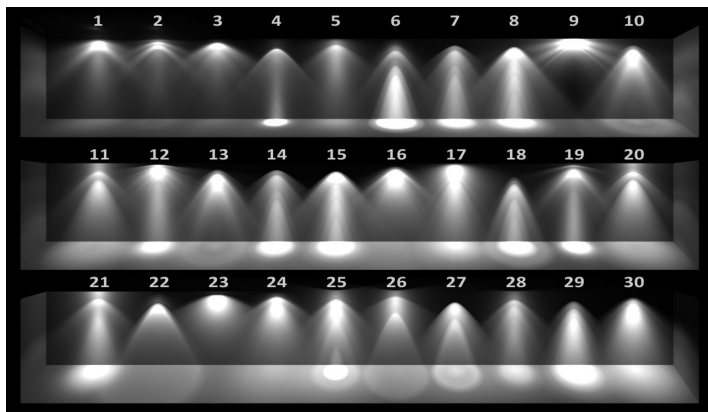

To add, first select your object then go to Arnold -> Lights -> Photometric Light.
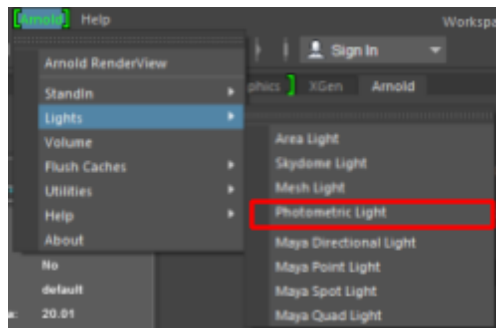
Once you do that, go into the light attributes and select an IES profile to use (you can find a bunch for free on the Internet).

Also, unlike an area light, changing the scale does not soften the shadows. Instead, you can set how soft you want your shadows to be by using the Radius attribute.

NOTE: Scale does nothing? Even if normalize is on/off.
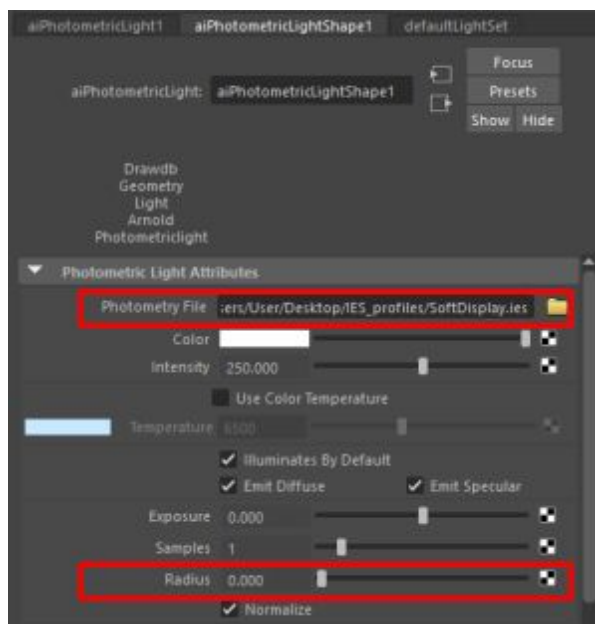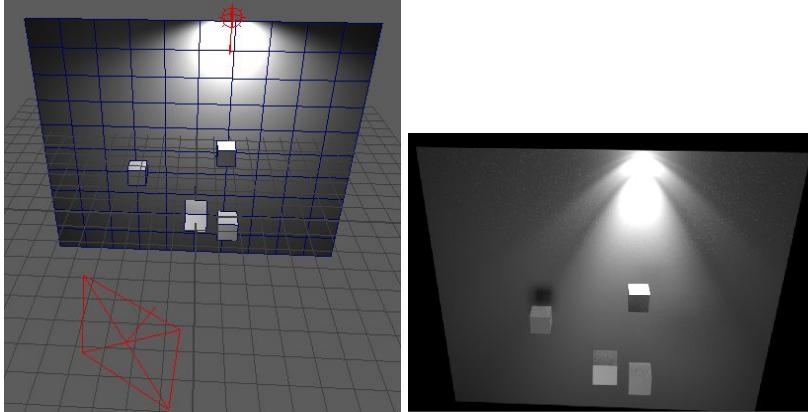
Arnold Object Smoothing/Subdivision

Typically, you don't want to use the standard Maya way of smoothing an object because it'll make your viewport super slow for large high-poly scenes. Instead, you can tell Arnold to automatically apply subdivision to an object when it renders.

The standard Maya way of smoothing is to select an object and press 3 to apply catmull-clark subdivision (or 1 to turn it off). This applies it immediately, meaning that the new smoothed version is visible in your viewport.

The Arnold way is to go into the Arnold section of the shape node, select the subdivision type + number of iterations. The smoothing/subdivision will only be applied in the render, meaning your viewport will be fast because your objects will be low-poly.

The types of subdivision provided are...
- catmull-clark
- linear (doesn't smooth faces but does smooth normals)
- none

Here's an example of a catmull-clark subdivision with an iteration count of 2. Note that the viewport object is still a cube, while the renders have been rounded. The first renderer is a full render while the second render is a wireframe render showing the added/smoothed polys.
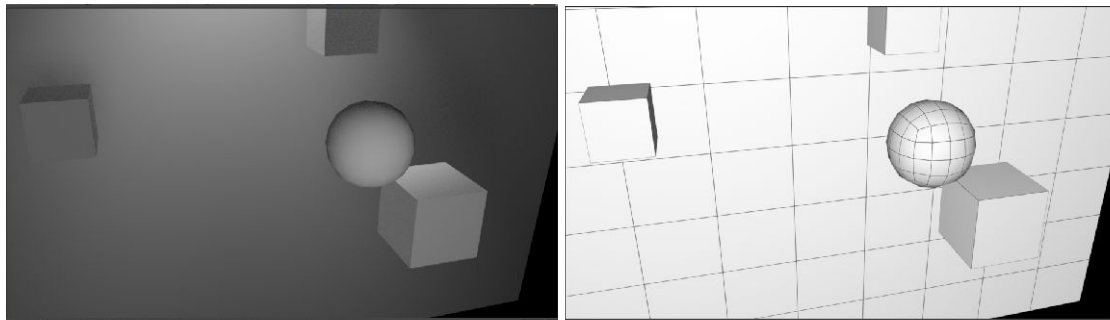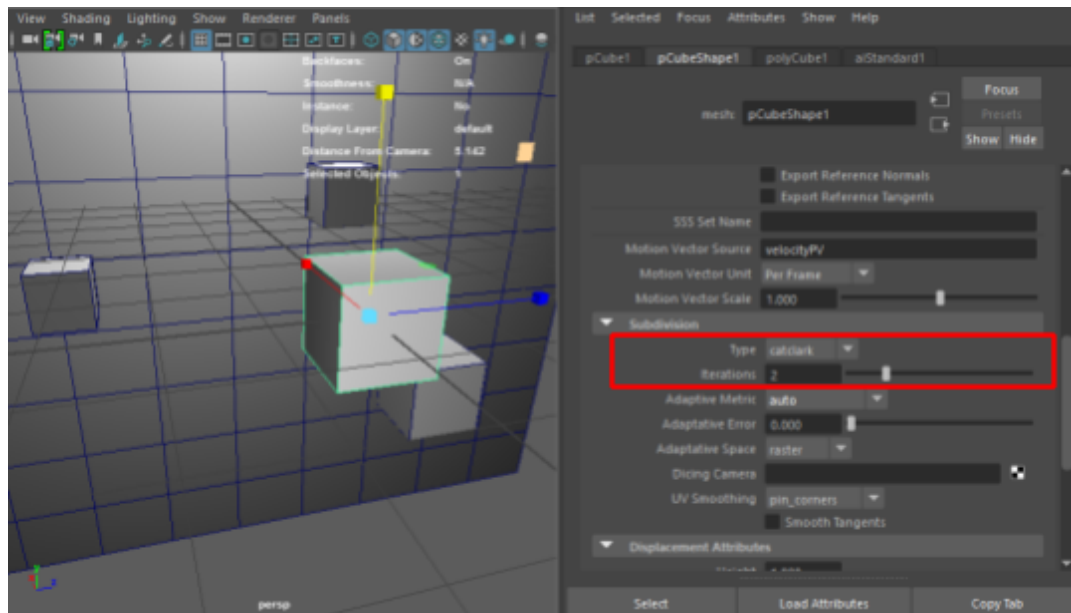
Adaptive Error

One cool feature of the subdivision function is that you can apply level-of-detail-esque subdivision. That is, polygons that are closer to your camera will get subdivided more than polygons that are further away.

To do this, you can use the adaptive error slider.
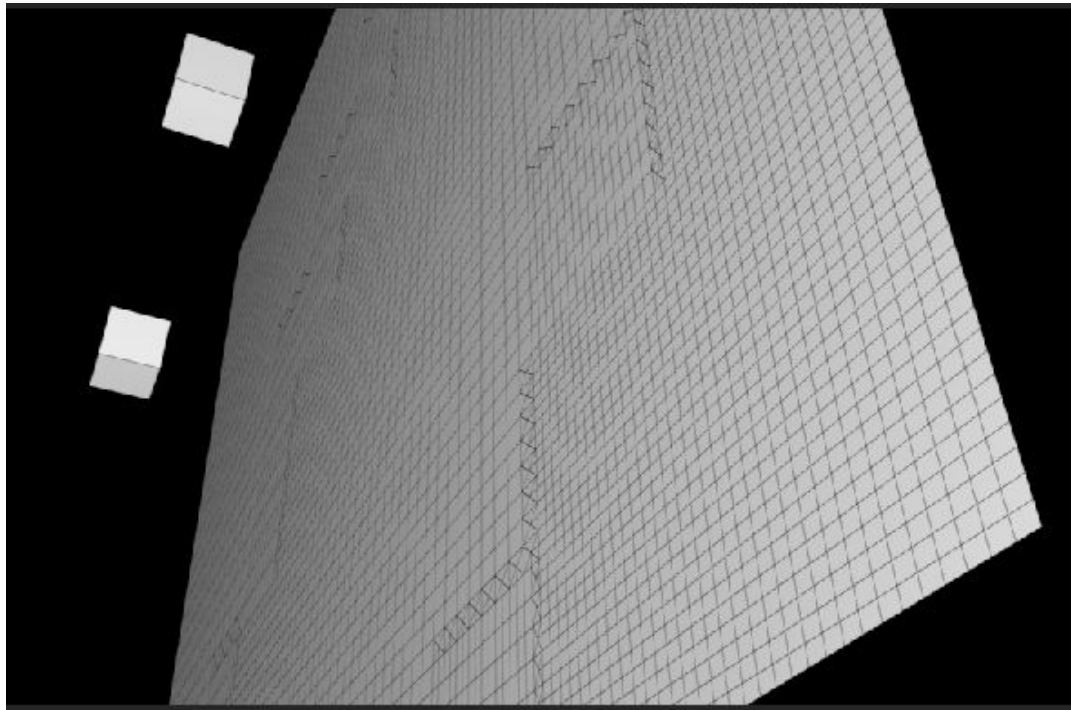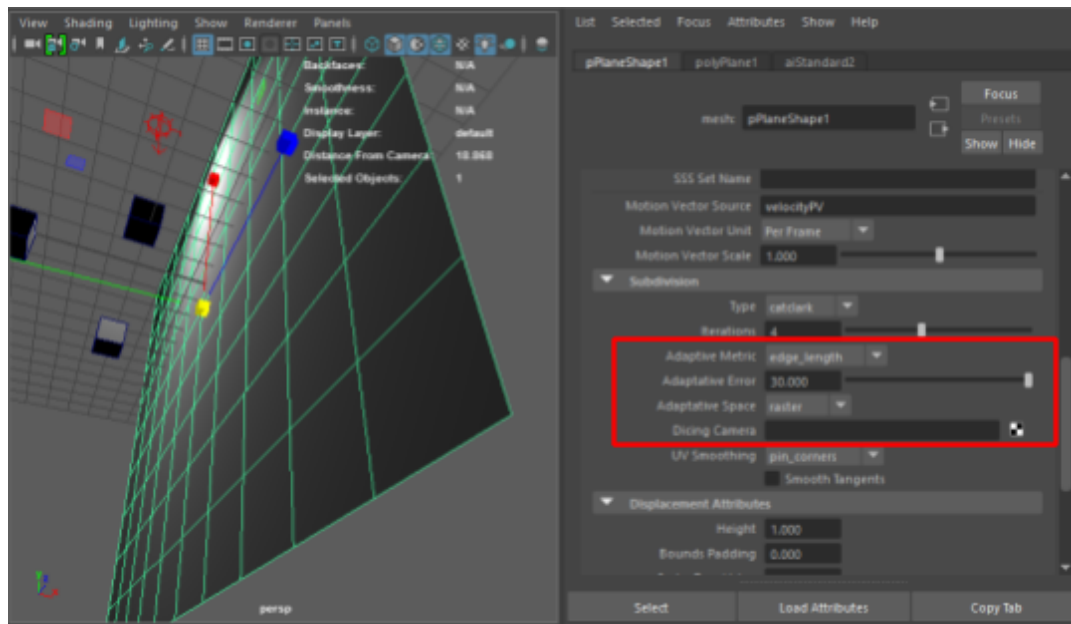
Adaptive Metric   Adaptive metric is how things are calculated. You can use edge_length when you're doing displacements (measured in pixels -- this is what's used most of the time). Don't use auto or the other one -- they don't seem to work very well.

|	
UV Smoothing	UV smoothing I'm not sure about, but the options here are the same as those in regular Maya smoothing. Look those up if you need more information?
Smooth Tangents	Smooth tangents is something you want to use if you have anisotropic specular highlights. The highlights can sometimes appear steppy because the polygons are no longer uniform.
	NOTE: I tried to get steppy highlights to show up with an anisotropic specular that was heavily skewed -- couldn't do it. Maybe because my plane is flat so it doesn't really matter??? Need heavy curves in my object maybe???

One problem with this feature is that if you're animating your camera/object, faces will pop in and out via the tessellation that's happening. You can fix this by setting the Dicing Camera attribute to a camera that doesn't move. That camera will be used to make decisions on which polys to smooth.

Arnold Standard Material (aiStandard)

The aiStandard material shader is Arnold's basic material. You can use it to do pretty much anything you would do with a normal material: matte, diffuse, specular, specular highlights, reflection, bump/normal maps, etc…
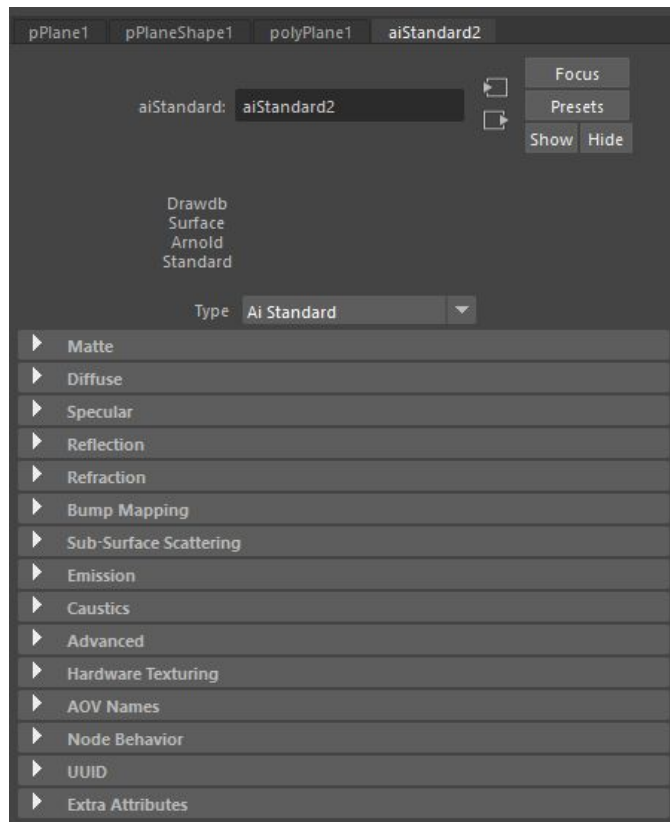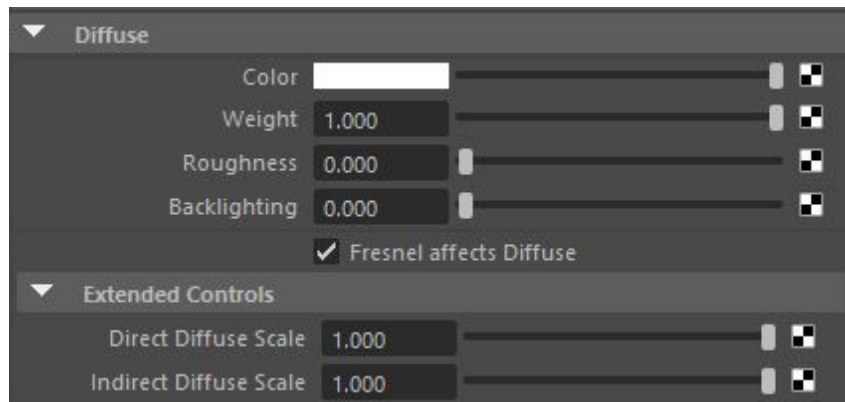
Diffuse

Diffuse reflection is the reflection of light from a surface such that an incident ray is reflected at many angles rather than at just one angle as in the case of specular reflection.
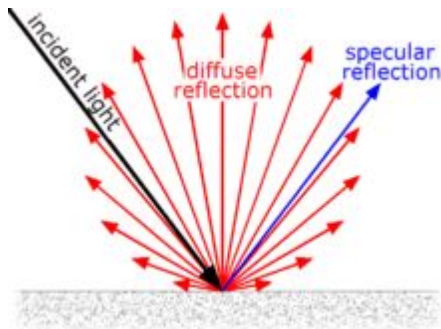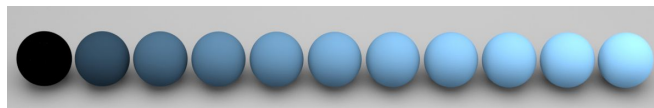

https://en.wikipedia.org/wiki/Diffuse_reflection

Color The diffuse color sets how bright the surface is when lit directly with a white light source (intensity at 100%).

Weight How much diffuse-ness to apply to this material.

Below is a weight scale of 0 to 1.

Roughness The diffuse component follows an Oren-Nayar reflection model with surface roughness. A value of 0.0 is comparable to a Lambert reflection. Higher values will result in a rougher surface look more suitable for materials like concrete, plaster or sand.

Below is a roughness scale of 0 to 1.
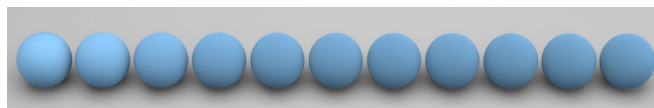
Backlighting Backlight provides the effect of a translucent object being lit from behind (the shading point is 'lit' by the specified fraction of the light hitting the reverse of the object at that point). It is recommended that this only be used with thin objects (single sided geometry) as objects with thickness may render incorrectly.
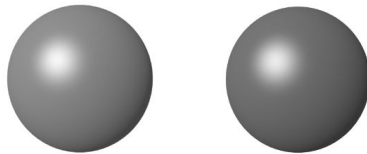
Below is a backlighting of 0 vs 1.
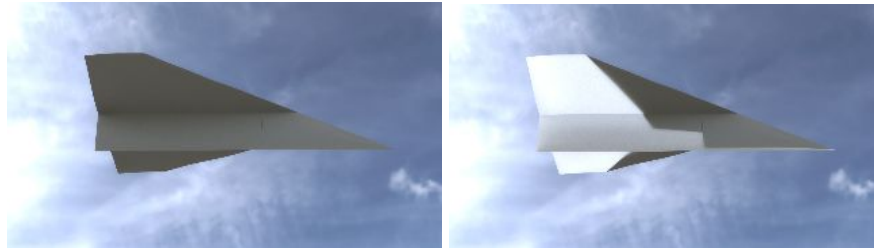
Fresnel affects   Specify whether Fresnel affects the diffuse component.
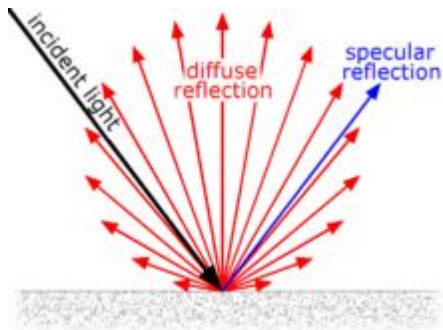
Disabled vs enabled.

Direct/Indirect scale   The amount of diffuse light received from direct/indirect sources only.

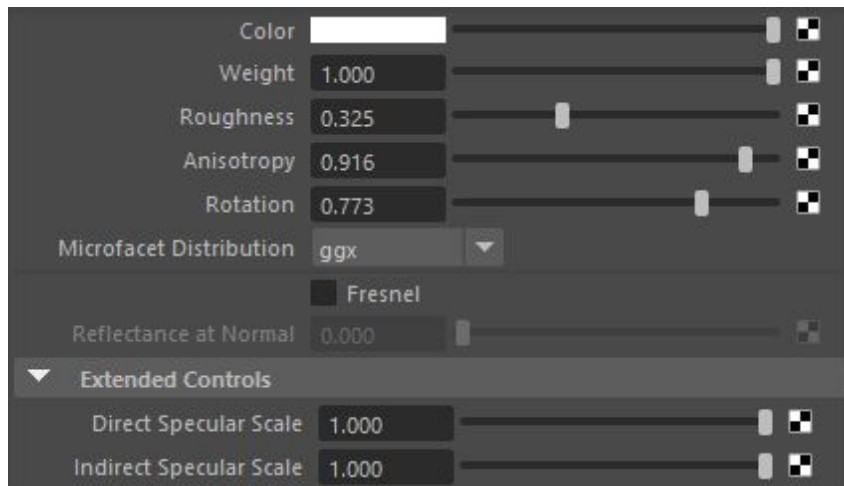Remember that direct = directly from a light source
Remember that indirect = light that has bounced off something

Specular

Specular reflection, also known as regular reflection, is the mirror-like reflection of waves, such as light, from a surface.

https://en.wikipedia.org/wiki/Specular_reflection

|	
Color	The color the specular reflection will be modulated with. Use this color to 'tint' the specular highlight.
Weight	How much specularness-ness to apply to this material. Below is a weight scale of 0 to 1.
Roughness	Controls the blurriness of the specular highlight. The lower the value, the sharper the reflection. A value of 0 will give you a perfectly sharp mirror reflection. Below is a roughness scale of 0 to 1.
Anisotropy	Anisotropy controls the 'skew' of the specular highlight when viewed from different angles. The default value for Anisotropy is 0.5, which means 'isotropic'. As you move this control towards 0.0, the surface is made more anisotropic in the U axis, and as you move the control towards 1.0 the surface is made more anisotropic in the the V axis.

Below is a anisotropy scale of 0 to 1.
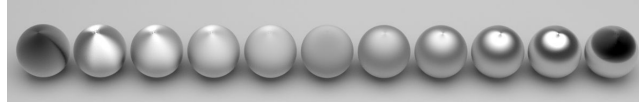
Rotation   The rotation value changes the orientation of the anisotropic reflectance in UV space. At 0.0, there is no rotation, while at 1.0 the effect is rotated by 180 degrees.

Below is a rotation scale of 0 to 1.
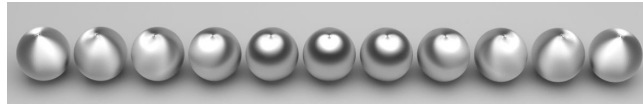
NOTE: This has no effect when anisotropy is at 0.5 -- 0.5 is basically isotropic.

Microfacet Dist   Choose between GGX microfacet distribution or Beckmann (default). GGX is a microfacet distribution. It has a sharper peak and a larger tail than Beckmann. GGX is suitable for modeling light reflection from surfaces more realistically.

Fresnel   Specify whether Fresnel affects the specular component.

Direct/Indirect scale The amount of specular light received from direct/indirect sources only.

Remember that direct = directly from a light source
Remember that indirect = light that has bounced off something

Reflection

This is pretty much the same thing as specular but without all the options. The reflection from this will always be sharp -- you cannot use roughness to blur it.

NOTE: This won't reflect skydome lights. If you want to reflect some type of environment in your reflections, you can go to render settings and set an environment background.
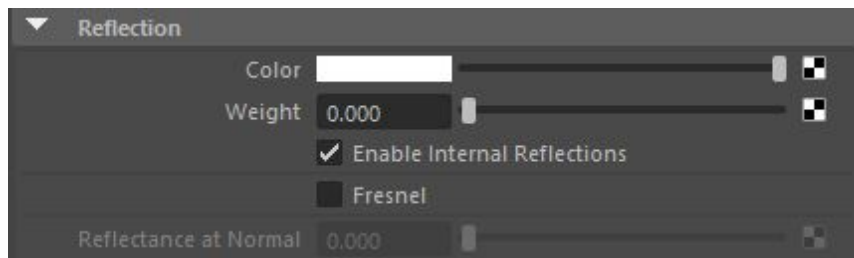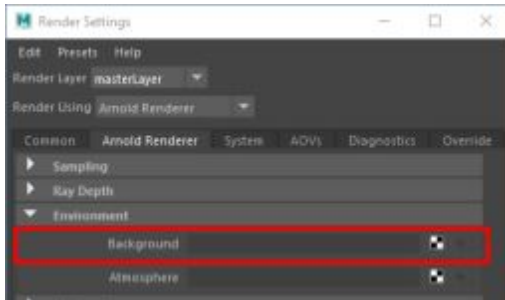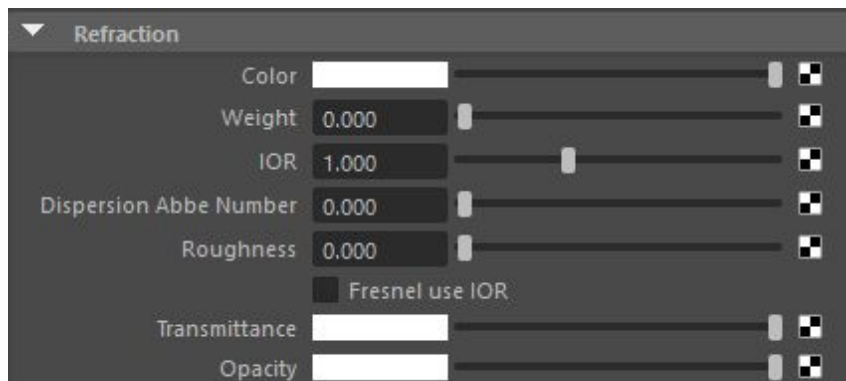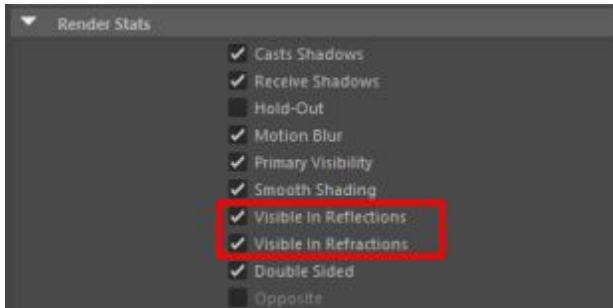
Refraction

This controls the see-through-ness of the material. Use this for things like glass or water.

> **NOTE**: If you want this to work properly, it's super important to go to the Render settings and put in the right ray-depth values for refractions. This controls how many surfaces rays can go through. So for example, if you have a model of an empty wine glass in it, the ray would have to be able to go through AT LEAST 4 polygons/faces….
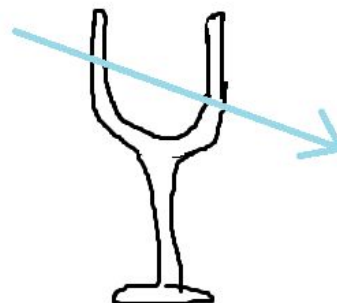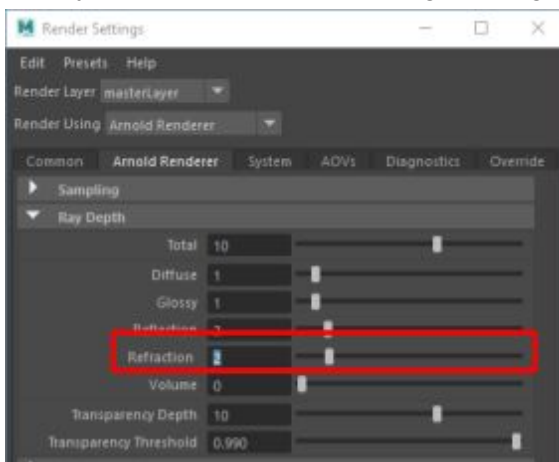
NOTE: Make sure your objects are visible in reflections/refractions by going to the Attribute Editor and navigating down to the Render Stats section. Some stuff (e.g. image planes) will have the visibility disabled by default.
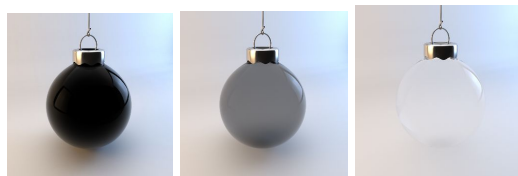
Color   Transparency color multiplies the refracted result by a color. For tinted glass it is best to control the tint color via the Transmittance color since it actually filters the refraction according to the distance traveled by the refracted ray.
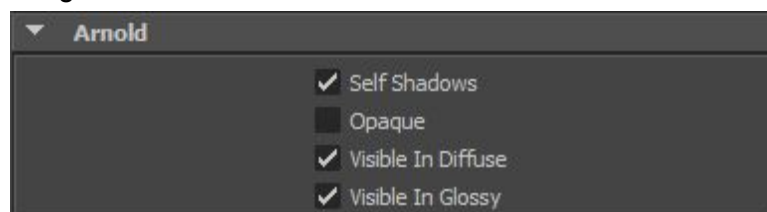
Weight   Weight allows light to pass through the material.
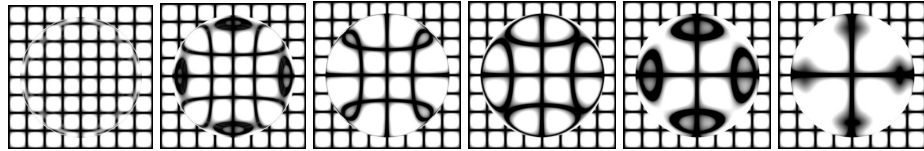
Below is a weight scale from 0 to 0.5 to 1.

Note that you must disable 'Opaque' for the mesh that has been assigned the Ai Standard shader

IOR   The index of refraction used. The default value of 1.0 is the refractive index of a vacuum, i.e., an object with IOR of 1.0 in empty space will not refract any rays. In simple terms, 1.0 means 'no refraction'.

   Below is an IOR scale of 1 to 1.5.

                               NOTE: You can easily look up the IOR for things like water/glass/etc.. On the Internet.

Transmittance Color   Like color, but tints the object more as the ray goes through the object. Thin parts of the object get less tint while thicker parts get more tint.

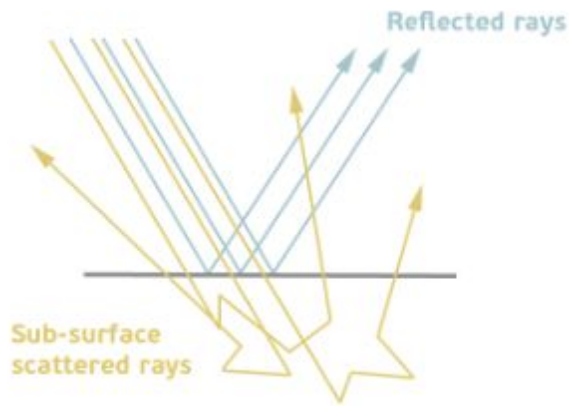   This is a very subtle effect, and a lot of times you won't notice a difference. Objects need to be scaled up.

                               Normal color vs Transmittance color (notice how transmittance gets darker the more it goes down in the water)...
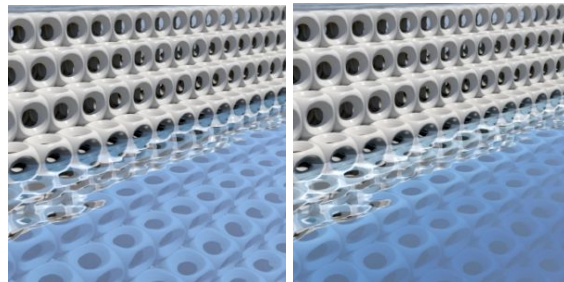
Sub-surface scattering

Sub-Surface Scattering (SSS) simulates the effect of light entering an object and scattering beneath its surface. Not all light reflects from a surface. Some of it will penetrate below the surface of an illuminated object. There it will be absorbed by the material and scattered internally. Some of this scattered light will make its way back out of the surface and become visible to the camera. This is known as 'sub-surface scattering' or 'SSS.' SSS is necessary for the realistic rendering of materials such as marble, skin, leaves, wax, and milk.
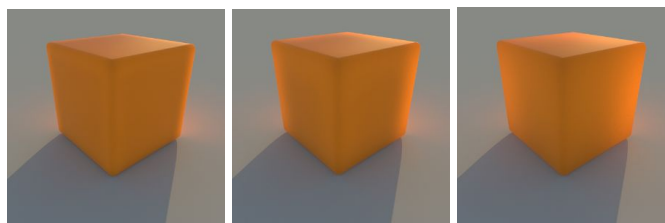
Reflected rays

Sub-surface scattered rays

Sub-Surface Scattering

Color

Weight 0.000

Radius

Diffusion Profile empirical

Color   The color used to determine the subsurface scattering effect.

Weight   The amount of subsurface scattering.

Radius   The radius of the area each sample affects. Higher values will smooth
                        the appearance of the subsurface scattering. Results will vary depending
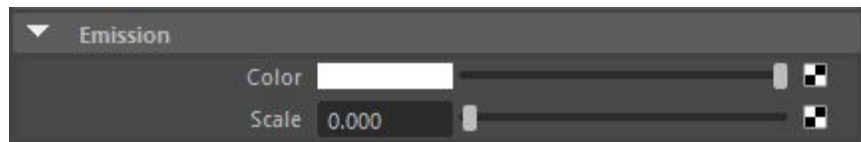   on the scale of the object in your scene. See docs for more details.

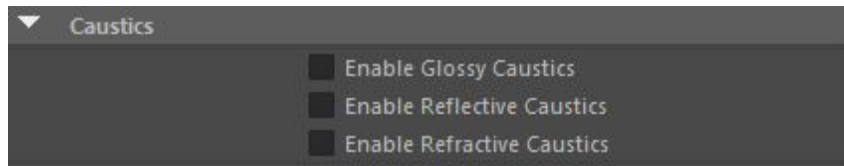   Below is a radius scale from 0.25 to 0.5 to 1.

Emission

Makes your material give off light. If you go to the color and turn up to V in HSV to a super high
value, this'll act like a mesh light.

> **NOTE**: You shouldn't use this over a mesh light. Efficiency reasons or something like
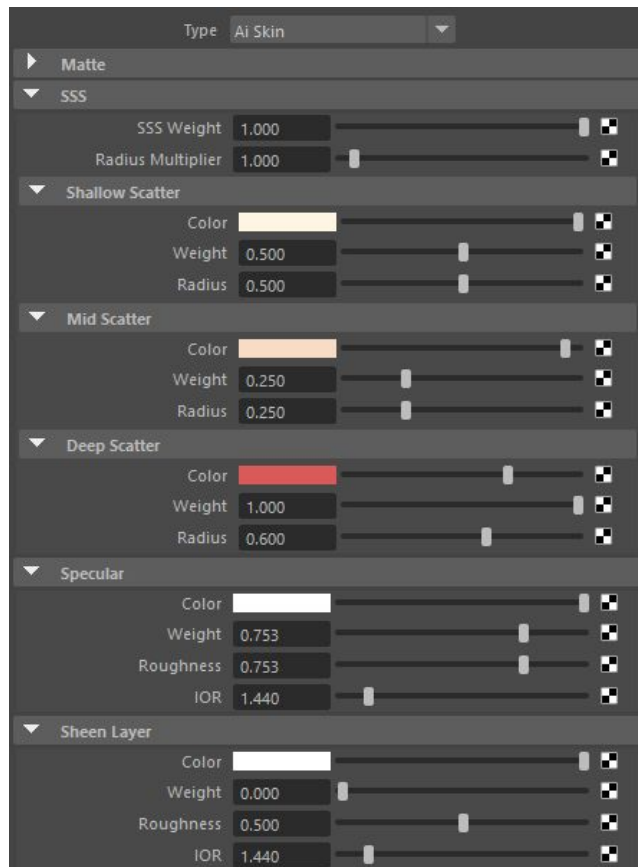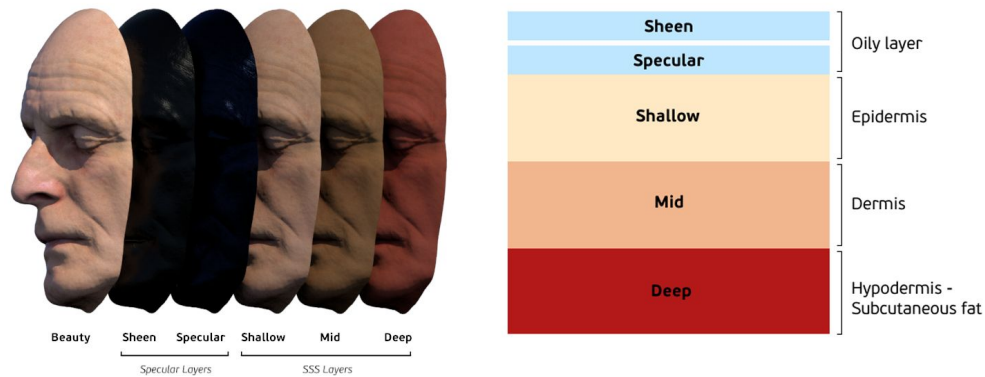> that.

Caustics

"The light patterns at the bottom of a swimming pool" -- you can enable and disable them.


Arnold Skin Shader (aiSkin)

The aiSkin material shader is Arnold's skin material. You can use it for lots of different types of materials where rays go through the materials and scatter out: human/animal skin, vegetation, plastics, etc.. It provides you with 3 different layers of sub-surface scattering.

Beauty   Sheen   Specular   Shallow   Mid   Deep

Specular Layers   *SSS Layers*

	Oily layer
Sheen	
Specular	
Shallow	Epidermis
Mid	Dermis
Deep	Hypodermis - Subcutaneous fat

SSS Layers

Sub-Surface Scattering (SSS) simulates the effect of light entering an object and scattering beneath its surface. Not all light reflects from a surface. Some of it will penetrate below the surface of an illuminated object. There it will be absorbed by the material and scattered internally. Some of this scattered light will make its way back out of the surface and become visible to the camera. This is known as 'sub-surface scattering' or 'SSS.' SSS is necessary for the realistic rendering of materials such as marble, skin, leaves, wax, and milk.
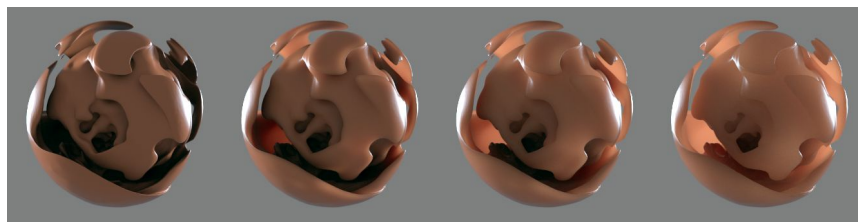
Reflected rays

Sub-surface
scattered rays
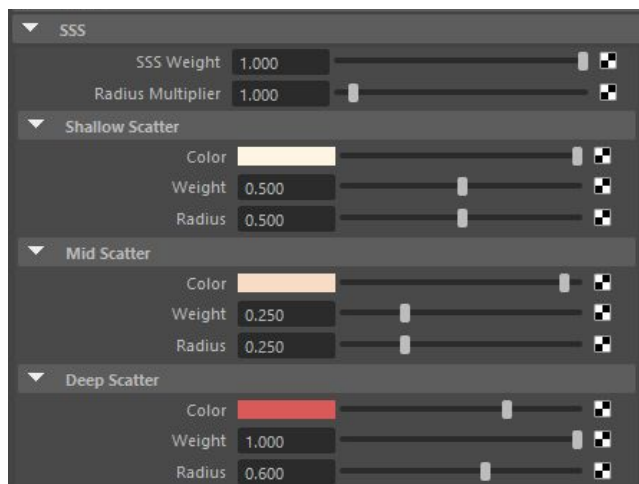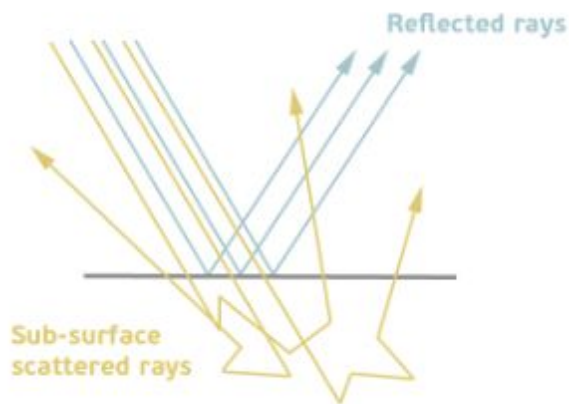
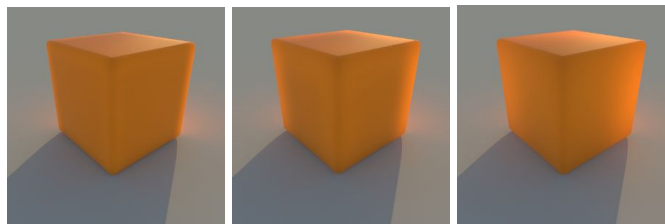|	
SSS Weight	The overall contribution of the subsurface scattering effect.
Radius Multiplier	Overall multiplier of the SSS radius of the three layers.

Radius multiplier of 0 to 100...

NOTE: From the docs… SSS is very scale dependent. You will need to adjust the radius multiplier depending on the size of your model. If you were to render using the default Skin settings, you may get something

that does not look correct. Alternatively, adjusting the scene scale can have similar results.

Color   The color used to determine the subsurface scattering effect.

Weight   The amount of subsurface scattering.

Radius   The radius of the area each sample affects. Higher values will smooth the appearance of the subsurface scattering. Results will vary depending on the scale of the object in your scene. See docs for more details.

Below is a radius scale from 0.25 to 0.5 to 1.

Specular and Sheen

The 'Specular' and 'Sheen Layer' settings are the same. It is recommended that you use 'Sheen Layer' for tight specular reflections and 'Specular' for broader specular reflections.
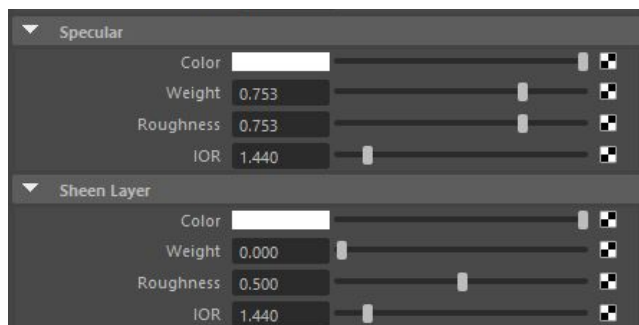
Color   Specular highlight color.

Weight   The amount of specular.

Roughness   Roughness of the specular highlight.

IOR   Index of refraction.

The amount of reflection will be dependent on the viewing angle of the

surface following the Fresnel equations (which depends on the IOR value).

I have no idea what this is used for… "turning it up has less of a fresnel effect -- that means that the faces facing away from us are reflective but also the faces facing towards us"
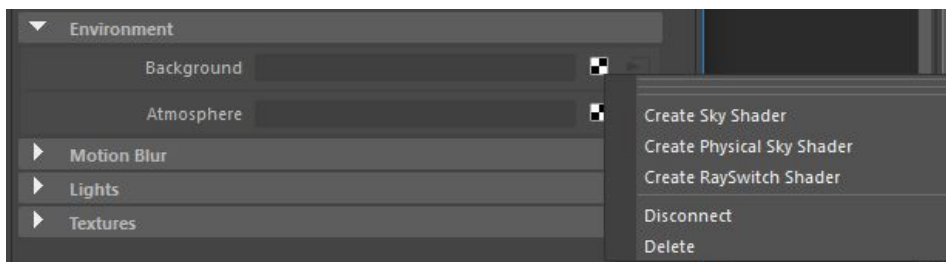
Arnold Environments

You can fiddle with your "environment" by going to Render Settings. Under the Arnold Renderer tab, there should be a Environment section.
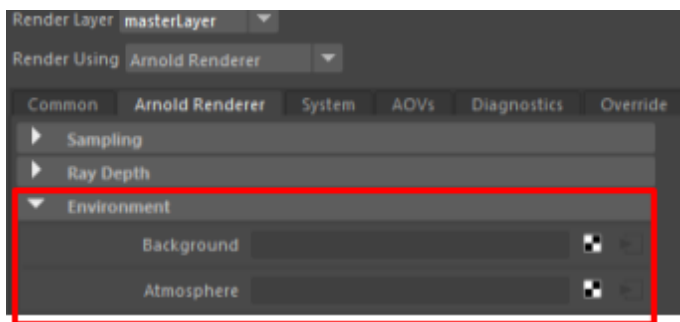
Background

Background selects a "background" shader.

Sky Shader

This looks very similar to a skydome light, but it renders as well as gives off light? Here's what the website says…

This shader is intended to be used as a global environment shader (or a background shader in Arnold terms), thus affecting all objects in the scene. By default it has a simple white color, and will illuminate the whole scene evenly using this color. For image based lighting, use the Skydome light node instead.

> **NOTE**: This doesn't show in reflections/refractions by default -- check out the render stats section of the attributes and enable if needed.

Physical Sky Shader

Simulates a sky? Apparently there's something like this with pretty much every renderer. I don't know what all the options mean, but you can look them up individually if needed. Here's what the website says…

This shader implements a variation of the [Hosek-Wilkie](#) sky radiance model, including the direct solar radiance function. You can plug it into the environment, or to the color input of a Skydome light (which benefits from efficient importance sampling, sending more rays to bright areas around the sun) or add it directly as an environment shader. Currently this shader is invisible to GI diffuse and glossy rays. To use it as a light source you must attach it to a [skydome_light](#) with sufficient resolution to capture the small solar disk.
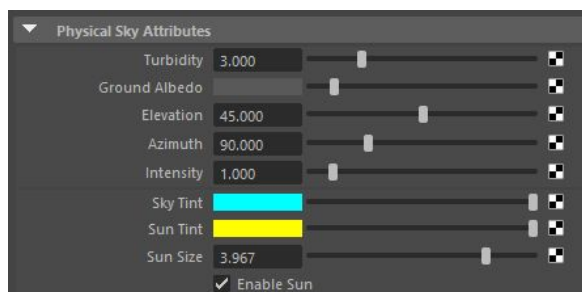
> **NOTE**: Setting this under environment in the render settings did nothing. I had to link it to a skydome light to get what I wanted.

RaySwitch Shader

Unclear on what this is actually used for. Apparently it allows you to set what type of shader gets applied to what type of ray. For example, you can make reflections red (or link to some shader).

This is useful for "optimizing a scene". For example, if you have a complex shader but you don't want that shader being calculated for thing like reflections, you can link reflections in here to a simple version of that shader.

Here's what the website says…

This shader makes it possible to evaluate different shader trees per ray. This decreases the shading complexity of a scene and thus the render times, and increases artistic control. It can be used to remove unnecessary secondary rays (specular/sss), make speculars even more

glossy in specular rays, control the color of opacity in shadow rays to fake light scattering through a tissue or add a second specular lobe in camera rays only.
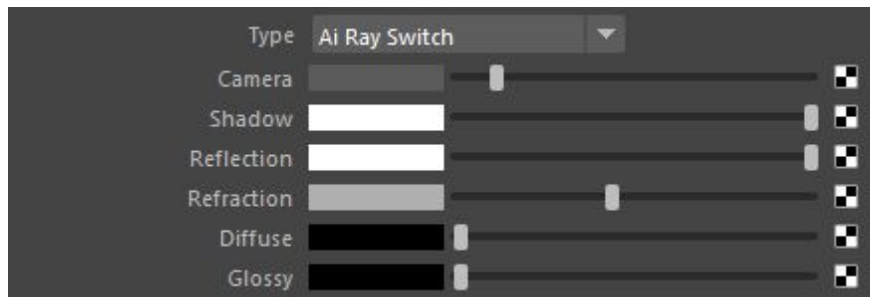
Atmosphere

There are two types of Atmosphere in Arnold, Fog and Volume Scattering. Fog simulates the effect of light scattering, which causes more distant objects to appear lower in contrast, especially in outdoor environments. Volumetric Scattering simulates light scattered by a thin, uniform atmosphere. It produces shafts of light and volumetric shadows cast from geometric objects.
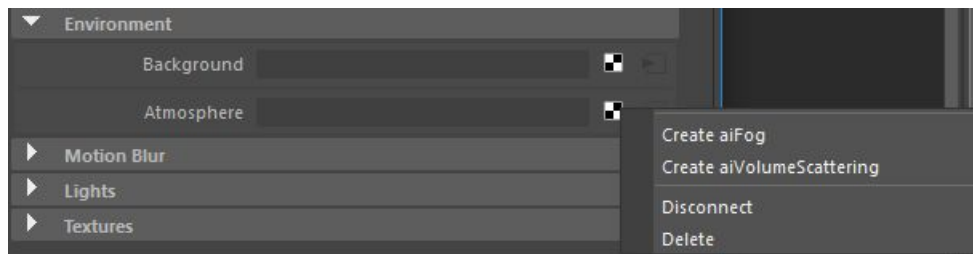
Fog used for underwater effect vs volume scattering used to simulate rays of sunlight…
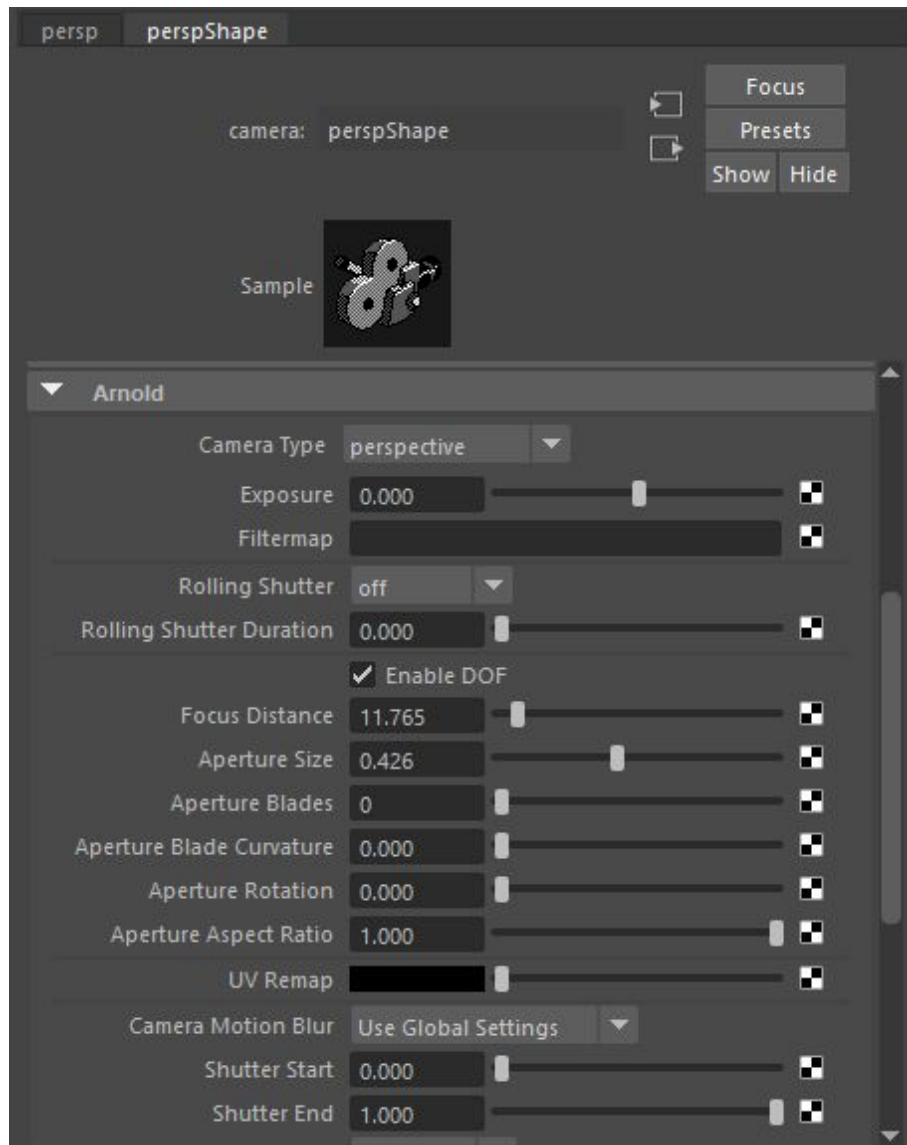

Fog

Don't know enough about fog to write here. Look up as needed.

Volume Scattering

Don't know enough about volume scattering to write here. Look up as needed.

Arnold Depth of Field

You can create a depth of field effect for your render through the camera you're rendering from. Select the camera and go down to the Arnold section of the attribute settings.


Click Enable DOF.

- Focus Distance controls the distance in which things will remain in focus.
- Aperture Size controls how blurry things will be for stuff that's out of the focus distance.
- Aperture Blades is bokeh related -- not sure what this has to do with blur? But setting this to 5 will give you a pentagon-ish lensflare bokeh type thing?
- Aperture Curves is bokeh related -- not sure what this has to do with blur? But setting this higher will make straight edges of the bokeh more curved?
- Aperture Rotation is bokeh related -- not sure what this has to do with blur? But sets the rotation of the bokeh lensflare pattern artifacts that show up?

The first 2 options are the main ones. Not sure about the rest.
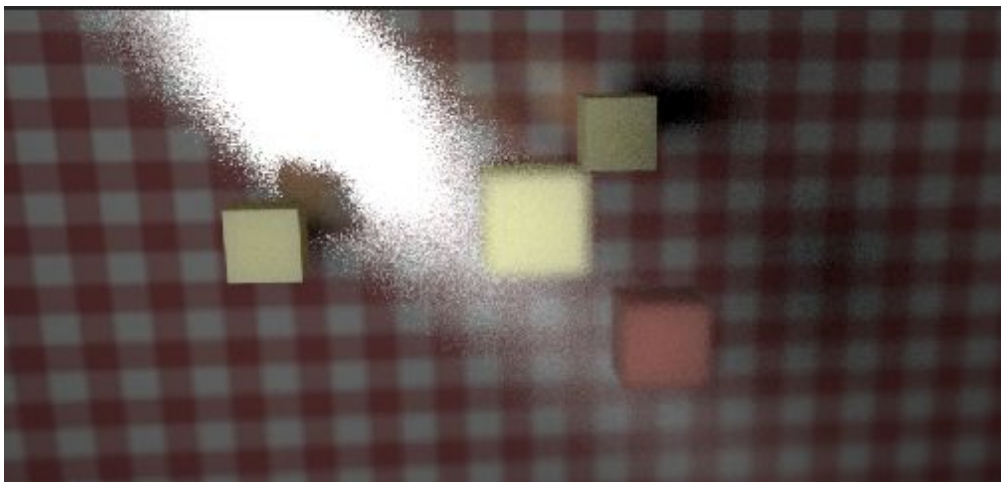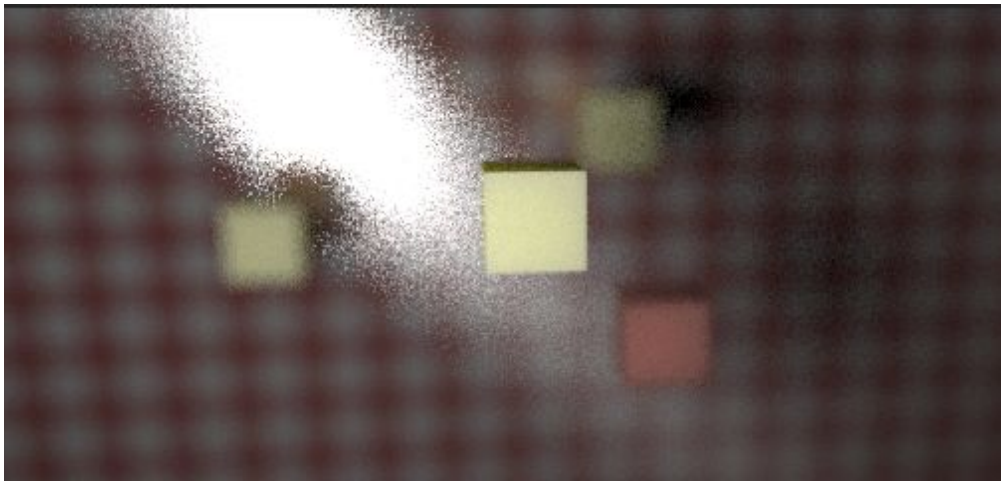
HINT: Want to know the distance between your camera and an object? Use the heads up display by going to Display -> Heads Up Display -> Object Details. When you select an object in your viewport, you should now see how far it is from the camera. You can put this value in for Focus Distance to focus in on that object.
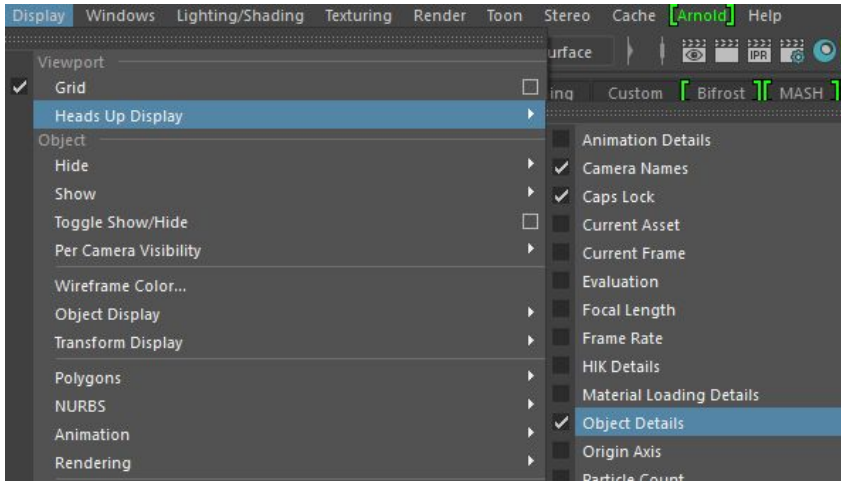
NOTE: You'll notice a lot of grain in the blurry parts. There's no way to fix that other than increasing the main Camera (AA) samples in the render settings.
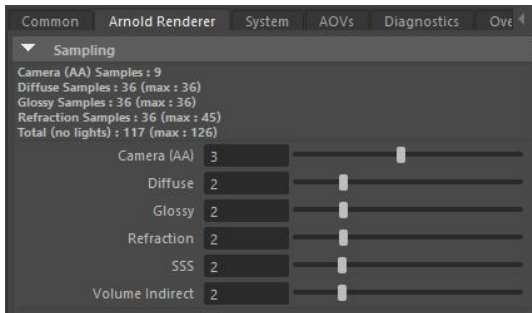

Arnold AOVs

AOVs stand for Arbitrary Output Variables. You can use them to segment off specific parts of the render (e.g. the specular portion of a material) and save that as its own image. AOVs don't add much to the render time because Arnold needs to calculate these details anyways for doing the full render.

AOVs can be used for debugging your renders (e.g. checking out how the specular highlights look on their own) or for compositing (e.g. splitting out the indirect and direct lighting and combining in nuke).
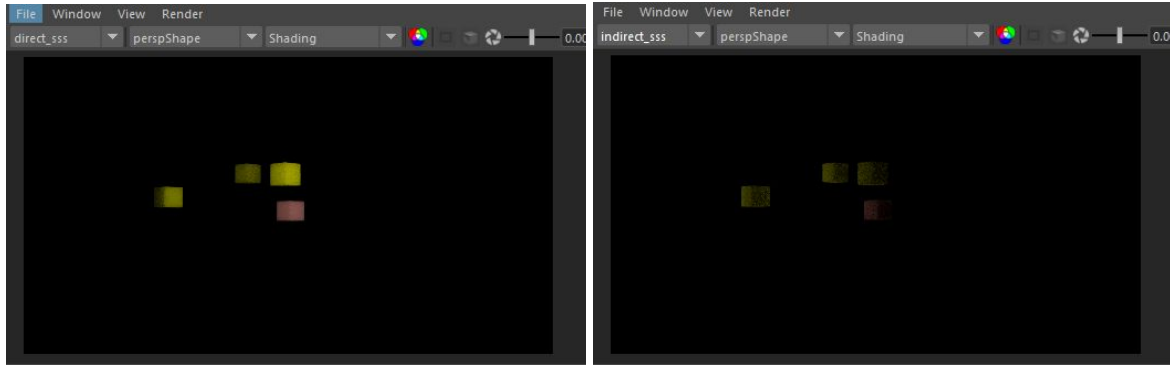
To set up an AOV, go to the AOV tab in the render settings.
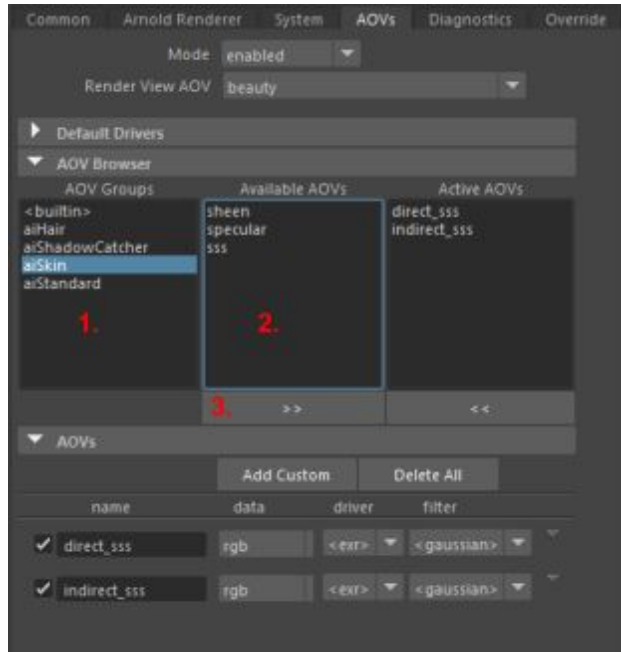
1. Select the material type in the 'AOV Groups'
2. Select what part of material to segment out into its own render in 'Available AOVs'
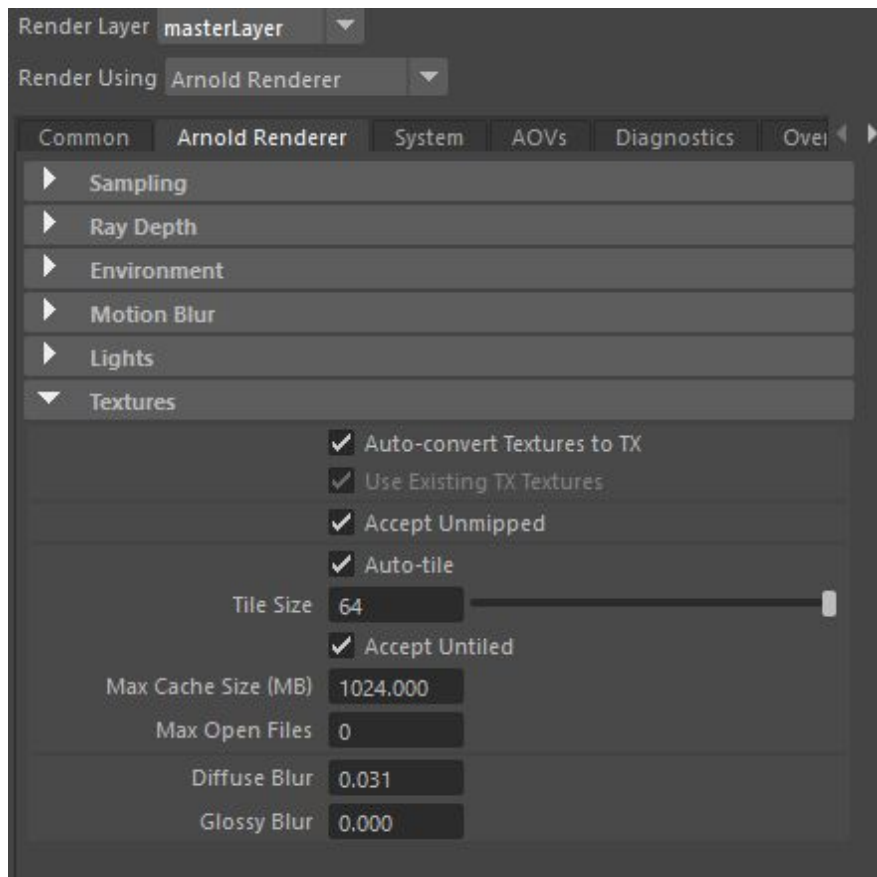3. Click the >> button to move them over to 'Active AOVs'

Now, in the Arnold Render View, you can view these AOVs by selecting them in the AOV dropdown.
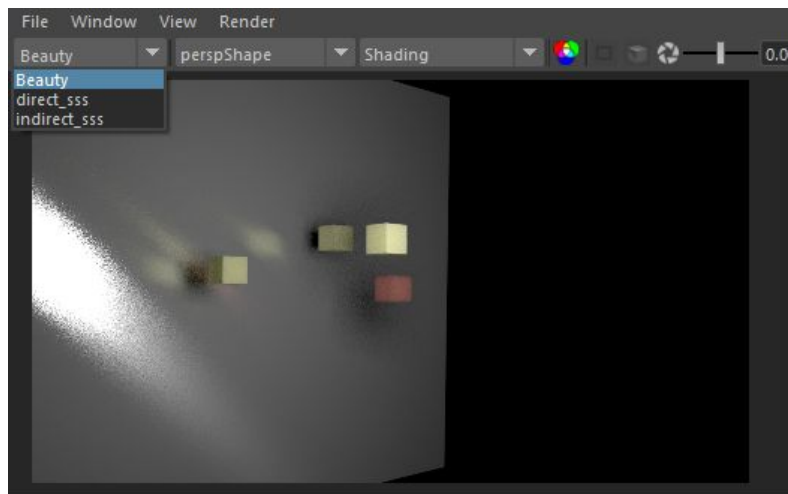
Textures in Arnold

To get to the texture settings, go to the Arnold render setting under the Textures section.

Generally you shouldn't touch these settings. They're mainly knobs for controlling performance. Check out https://support.solidangle.com/display/AFMUG/Textures+-+settings for more information on what each of these parameters are for.

One important thing to note is that textures are automatically mipmapped. If you want to load a less-detailed version of the texture from the mipmap, you can change the mipmap bias attribute of your file node that loads up the texture (why would you ever want to do this?)…