AUTODESK UNIVERSITY

AS118916

Visualization Using the Arnold Renderer in 3ds Max

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Learning Objectives

- Learn how to create high-quality renderings in Arnold
- Learn how to use Arnold's advanced lighting features
- Learn how to optimize Arnold for efficient rendering
- Understand workflow differences with older renderers

Description

The Arnold renderer is a high-quality, production-ready renderer that is now a core part of 3ds Max software. This course will show you how to get the most out of this renderer for visualization and design. We'll cover Arnold rendering workflow, as well as how to set up scenes for maximum speed and quality. This includes sections on materials, physical sun and sky, and image-based lighting workflows.

Speaker(s)

George Maestri is an animation industry professional with extensive experience as a writer, director, and producer, working on a number of hit television shows, including South Park and Rocko's Modern Life. As an entrepreneur, he built a successful studio that produced several hundred cartoons for broadcast, education, and film. George has written over a dozen books on computer graphics. As an educator, he has taught at several top animation schools, including California Institute of the Arts. He currently authors and develops CAD and 3D content for LinkedIn Learning and Lynda.com

About Arnold

Arnold is an advanced Monte Carlo ray tracing renderer built for the demands of feature-length animation and visual effects. Originally co-developed with Sony Pictures Imageworks and now their main renderer, Arnold is used at over 300 studios.

Autodesk bought Next Limit and Arnold in 2015, the software has now been integrated in the Media and Entertainment packages (Maya, 3ds Max, Softimage)

Arnold Replaces Mental Ray as the new Production Renderer for 3ds Max.

Arnold Advantages –

Quick photorealism
Used in many productions, there is a strong user base.
Easy to use
Cross-platform support (Maya, Max, etc…)
Configurable/Flexible
Reliability for production

Outstanding Issues –

Arnold is aimed primarily at Media and Entertainment, though it can certainly be used for visualization. Currently supports Maya, 3ds Max, Softimage, Houdini, Cinema 4D and Katana.

CAD and BIM files will have to be run through one of these for rendering. Other plug-ins are planned.

No bake to texture (game artists may want to hold off for now)

Network render requires license

Transmissive Caustics (light bending through objects) is not available, though reflective Caustics (light reflection effects) is available.

Arnold Basics

Arnold is a **physically-based unbiased rendering engine**. This generally creates greater realism with less effort, though artistic/stylized effects can be achieved. Unbiased means the renderer is physically accurate and works great out of the box with no additional controls or statistical trickery. "Biased" renderers such as Mental Ray require more controls as a way to adjust the image towards (or away) from reality. Because Arnold is unbiased, it needs far fewer controls than most renderers.

> Arnold uses what is called a **brute force algorithm**

> It does not use GI or irradiance maps. This means it can be slower in that it is not able to do rendering shortcuts using maps (i.e. Mental Ray)

> However, Arnold's brute force algorithm is often faster than optimized algorithms, so generally faster for basic scenes, equivalent for complex scenes. It is faster than ART, for example.

> Arnold is an unbiased renderer. This is not better, necessarily, but probably closer to nature and more accurate.

> Arnold uses a Monte Carlo algorithm. This creates the familiar grainy look that gets less grainy with time. This progressive display provides faster interactivity in Activeshade.

> Lights in Arnold are real world by default. This means lights decay quadratically (but this setting can be changed)

> Global/local control over ray sampling/depth. Every object in Max (lights, materials, etc) can be optimized for speed.

> Non-physical fx can be achieved. (adjust bounce light or color bleed to enhance/change reality, for example)

Setting up Arnold

> One big issue that crops up with Arnold is lack of support for 3ds Max's "Standard" material, which is used in the original Scanline renderer. In order to avoid nasty error messages, you should configure a default UI that avoids this issue by using the supported "Physical Material" as the default.

> Select: Customize -> Custom UI and Defaults Switcher

> Select : "Max.ART" preset . This will use the "Physical Material" as default.

> Restart Max.

Render settings

You can optimize render speed through Arnold's render settings, found in the Render Setup window.   The main controls involve sampling and ray depth.   Samples/Ray depth should be set high only for those things that are in the scene. No need to direct computing resources towards features that will not be rendered.

Sampling/Ray Depth

> **Sampling -** controls the visual fidelity of the scene and determines the quality of the render. Generally, higher numbers mean better quality, though increased quality means longer render times. The number of elements calculated increases quadratically with the number of samples assigned, so a slight increase in samples means a lot more computing.

>> **Camera AA** – This sampling parameter is the most important setting and determines a global quality of the render. Generally values of 1-3 are grainy, 4 and above can be used for production.

>> **Diffuse** / **Specular** / **Transmission** / **SSS** – These sampling attributes control the amount of quality for each specific feature. You can assign higher quality to diffuse surfaces and less to the specularity, for example.

> **Ray Depth –** controls how many times a ray can bounce through the scene.   These values are important for effects such as relections and refractions as well as bounce lighting (oe global illumination)

>> **Diffuse rays** – more diffuse rays create more bounce light. If you want softer and more realistic lighting, adjust these values upwards. 3-5 are generally good.

>> **Specular rays** – Controls depth of reflectivity in the scene. Usually 2-4 is plenty.

>> **Transmission –** Controls how light passes through transparent surfaces such as glass and fluids. At least 7 rays are required for a glass filled with water, for example.

> **Depth limits** - This determines how many total rays are calculated in the scene. The best way to determine this value is to add up all the rays (Diffuse, Specular, etc…)

Lighting scenes

Lighting scenes is an art into itself.   One bit of advice is to use white-colored stand-ins so you can see lighting effects in your scene without bias caused by materials. Materials can trick the eye into seeing lighting effects that are not there.

> **Global Exposure** : (Located in Rendering -> Environment.) Exposure helps to offset of lighting that is a bit off.   It is very similar to the exposure controls on a camera. Exposure can really help with creating real-world lighting. Because Arnold defaults to real-world lights, you can very easily have too much or too little light. Before setting up any lights, is a good idea to turn on exposure in order to have those controls at your disposal. Start with Automatic or Physical Camera.

Supported Lights -- When rendering in Arnold, it is best to use either the Arnold Light. Photometric Lights can also work. Not advised to use Standard lights.

Arnold Lights -- Arnold has one light that can be reconfigured into any type of light.   The **Type** pulldown controls how the light is emitted.

> **Standard** – Spot, Point, distant. Similar to standard lights in 3ds Max.
>
> **Photometric** – Real world lighting models, can load light profiles from a file.
>
> **Shapes** – Disc, Cylinder, Quad.   Area lighting that simulates light emitted from a surface/shape. Can simulate a soft box, fluorescent lighting, etc.
>
> **Mesh** – Turns geometry into a light.
>
> **Skydome** – Global/Environmental lighting.

Other important Arnold lighting parameters :

> **Radius** – Controls the physical size of the light. A bigger radius creates softer lighting.
>
> **Light Shape Visible** – For Shape/Mesh lights, makes the light source visible
>
> **Intensity/Exposure** – Both control light intensity, there are differences
>
> > **Intensity** – Real world value of the light. Control is linear.
> >
> > **Exposure** – Multiplies intensity by an F-Stop value. Each increase in F-Stop **doubles** the amount of light.
> >
> > Use **exposure** for large changes in lighting, **intensity** to fine-tune lighting.
>
> **Normalize Energy –** Allows you to change the size of the light without affecting brightness. Good for adjusting shadow softness.
>
> **Samples** – Quality of the light, particularly in the shadow areas and spotlight penumbras. If creating soft shadows, this value may need to go up.
>
> **Light Contribution** – Controls by feature (diffuse, specular, etc) how much the light contributes to the scene.
>
> **Max Bounces** – Overrides global render settings for ray depth. Best to keep at 999, unless required for a special effect.

Arnold Modifiers

Arnold **does not** respect Max's Properties panel when it comes to lighting. This is true for both lights and geometry. In order to control lighting, we need to use Arnold light filters and Arnold Properties

Arnold Light Filters – These are modifiers that can be added to an Arnold light

Barn Doors Filter – Simulates barn doors on spot lights.

Blocker Filter – Uses a primitive shape (box, sphere, cylinder…) to block or attenuate lighting in the volume controlled by the shape.

Decay Filter – Adds near/far attenuation control to Arnold lights

Gobo Filter – Simulates a gobo (i.e. projector) on a spot light.

Light Filter – Filters the light based on an image map.

Arnold Properties – (This is the most important modifier you will use when rendering with Arnold.)

The Arnold Properties Modifier can be added to both lights and objects, though it is mostly used on objects. It allows you to control how lights interact with the scene on a per-light and per-object basis.

Visibility – Controls whether the object is visible to certain categories of lighting (diffuse, specular, etc…)

Shadows – Allows objects to cast/receive shadows.

General – Double sided, invert normal, **opaque**.

Opaque is very important to transparency effects. If opaque is toggled ON, the object WILL NOT exhibit transparency. Anything that uses transparent materials (glass, fluids, etc) must have opaque toggled OFF.

Displacement – Used for displacement mapping

Subdivision – Can override subdivision on render settings.

Environmental Lighting

For realistic lighting and color, the trend has been towards image-based lighting (IBL) to simulate the light casting into a scene from the environment. This type of lighting is usually accomplished using high bit depth images such as HDRI files and EXR file, which have significantly greater dynamic range than most image types.

Image based lighting can be created with Skydome mode of a standard Arnold Light.

Toggling Light shape visible will create image based lighting (IBL) effects
Resolution controls Reflections
When using environmental lighting alone, you only get soft shadows.

Image Based Lighting can also be created with with 3ds Max's **Environment** feature

Image map in Environment slot will create image-based lighting.
Be sure to toggle environment background in viewport menu so you can see the light.
Comes in as Material -- "Output Amount" – light brightness.

Instead of bitmap images, we can also use Physical Sky as the image map.

Distant lights can add hard shadows to Image Based Environmental Lighting

Portal Mode –
Improves the sampling quality of an Arnold sky dome.
This is most useful when rendering interiors with natural light

Materials –

When creating materials for Arnold rendering, be sure to check the supported material types. This is an evolving list, but currently the Standard 3ds Max material is NOT supported.

Physical Materials

Autodesk Physical materials are supported, so feel free to use these. One benefit of the Physical Material is that the material is used throughout the Autodesk ecosystem. It makes the material a natural choice for projects that may span multiple Autodesk applications. Physical materials also have a number of presets that can make material creation easier.

Arnold Materials

Arnold's own material is called the Arnold Standard Surface. This material has a lot of features and is the preferred material if you are staying within Arnold for the project.

Arnold Standard Surface

All major parameters have a "General" spinner. The effect of these spinners is cumulative, meaning the ratio of the values is most important.

Base Color - Color of surface in direct light.

Roughness determines character of surface. 0=Lambert/100=Oren-Neyar

Caustics – Turns on reflective caustics

Indirect diffuse – Uses environment for shaded areas

Specular Reflections – Controls specularity and reflections

Roughness – Sharpness of the highlight. 0=Mirror,100=OFF

Metalness - 1.0 the surface behaves like a reflective metal

IOR – Index of Refraction for transparency effects

Transparency -

For proper transparency, the OPAQUE flag must be toggled on in the Arnold Properties modifier of the object.

Depth - depth into the volume at which the transmission color is realized

Thin Walled – Rendered as soap film, not solid glass

Extra Roughness – Blurs refractions

Sub Surface Scattering – Allows light to scatter within volume of surface.

Emission – Turns surface into a light source