Using 3ds Max 2018 and the Arnold Renderer with Revit Models

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Learning Objectives

- Understand when to use the ART Renderer and when it would be better to use Arnold.
- Convert Revit models and scenes for compatibility with the Arnold Renderer
- Work with Arnold lights, HDR images and physical materials
- Create 360 degree Virtual Reality Stereo Panorama Images

Description

3ds Max 2018 introduces the Arnold 5.0 rendering engine as one of the default rendering engines, replacing the mental ray engine that many Revit users are used to using. This has ramifications for workflow, materials and lighting when linking or importing Revit models into 3ds Max. You might be tempted to stick to the ART renderer to avoid the change, however the Arnold renderer can provide stunning still images, as well as 360 virtual reality stereo panorama images, when configured properly. This class will provide you with the tips and tricks you'll need to successfully pair your Revit model with the new features of 3ds Max. Come get acquainted with Arnold!

Speaker

Having been a registered architect, Matt Dillon has nearly 30 years of experience in Autodesk Architectural applications, and is an Autodesk Certified Instructor at an Autodesk Authorized Training Center. In addition to assisting customers implement Building Information Modeling (BIM) and Revit Platform products, Dillon has also consulted with Autodesk, Inc., development staff in product design and usability for AutoCAD Architecture software. A published author, Dillon was one of the recipients of Autodesk's Distinguished Speaker Award in 2010, and he has been a highly-rated instructor at Autodesk University since he first began presenting in 2000.
Introduction

One of the major changes to be introduced with 3ds Max 2018 is the inclusion of the Arnold rendering engine, which replaces the NVIDIA mental ray engine. This is significant because many traditional rendering workflows involving Revit and 3ds Max were previously centered around the mental ray engine.

Revit 2017 replaced the mental ray engine with the Advanced Ray Trace (ART) renderer, which was also made available in 3ds Max, however mental ray was still supported in 3ds Max. Now Revit 2018 still utilizes the ART renderer, which is also supported by 3ds Max. So, where your choice for rendering Revit models in the 2017 releases was between ART and mental ray, in the 2018 releases is between ART and Arnold. (ART only in Revit, ART or Arnold in 3ds Max).

If you choose to use the Arnold renderer, there will be changes to your workflow, and that is the focus of this document. It will impact how you work with materials and lighting, primarily, however the Arnold renderer introduces a new VR Camera, which will allow you to create a stereoscopic virtual reality image directly from your 3ds Max scene. We will explore this new capability at the end of this document.

**Note:** It assumed in this class that you are already familiar with the 3ds Max interface and general workflow, as well as the process of linking a Revit project into a 3ds Max scene.

ART or Arnold? Which Renderer Should You Use?

The choice as to whether or not you should use the ART renderer or Arnold is fairly simple. If you are doing an exterior rendering, ART will most likely be sufficient (however you should experiment with Arnold once you have become more proficient with it – you will probably find that your image quality will improve). If you are doing an interior rendering then you should use the Arnold renderer.

The ART renderer is easier to use and configure than other renderers. However in order to be easier to use, it sacrifices the indirect lighting controls that are necessary to properly light interior scenes. The figure below illustrates the problem.

![Examples of an interior rendering with the ART renderer, using different exposure levels.](image)

The image on the left was rendered with the exposure set to a value that is appropriate for an exterior scene. As a result, the interior of the scene is poorly lit. The image on the right lights the interior much better, however this can only be accomplished by setting the exposure to a value more appropriate for an interior scene, which causes the exterior and any areas in direct sunlight to be washed out. Because there are few controls for indirect lighting, it is difficult, if not impossible to achieve proper interior lighting without washing out parts of a scene like this.
The image below was created using the Arnold renderer, using Arnold lights - a *Distant Light* to simulate the sun, a *Skydome* light to provide indirect lighting, a *Quad* light to remove some of the noise associated with the indirect lighting, and an *HDR image* for the background image. HDR’s can also be used to affect light intensity and color, however that functionality was not used in this example.

There is a price to pay should you choose to take advantage of Arnold’s more robust lighting controls. You will most likely need to spend more time perfecting your settings before generating your final image. You will also need to make some modifications to some of the materials that were imported with the Revit model, since they are based on the old mental ray rendering engine, and while still compatible with the ART renderer, will need to be converted and modified to work with Arnold.

Assuming, however, that you’re willing to trade a little time for better renderings, then read on!

**Converting Revit Models for Compatibility with Arnold**

Once you’ve imported or linked your Revit model into your 3ds Max scene, you need to do some conversion before rendering with the Arnold Rendering Engine. There are several components of a Revit model that may be incompatible with the Arnold renderer:

- **Materials** – Revit models include materials that are based on the old mental ray rendering engine and, while somewhat compatible with the ART renderer, are not compatible at all with the Arnold rendering engine.
- **Maps** – Likewise, you should convert all of the maps being used in your Revit model’s materials to Arnold-compatible maps.
- **Cameras** – Arnold requires a Physical Camera for proper exposure control. If you have imported any cameras from Revit they are most likely Target Cameras. These will need to be converted.
- **Lights** – Revit uses Photometric Lights. While these are somewhat compatible with Arnold and will work satisfactorily, you will probably have better results and more control of lighting if you convert them to Arnold Lights.
- **Exposure Control** – Since Arnold utilizes Physical Cameras, you need to make sure that you are using *Physical Camera Exposure Control* in your environment settings as well. Frequently scenes created from Revit projects are using mental ray exposure control, and will need to be converted.
• **Others** - If you import the sun settings from Revit into your 3ds Max scene, you will need to convert the resulting Daylight System to a *Sun Positioner*. The Daylight System is based on the old mental ray engine, however the Sun Positioner is compatible with ART and again, to some extent the Arnold renderer as well. However, as we will see, you may decide not to use either for simulating sunlight.

Fortunately, 3ds Max 2018 includes a *Scene Converter*, which will automate a large part of the process of converting your Revit geometry to Arnold-compatible elements.

The following images show some comparisons between a rendering done with the ART renderer, and some examples done with the Arnold renderer. All render quality settings are left at their default levels for both rendering engines. Note the reflectivity of the glazing in the original ART rendering. This is actually not correct; the same rendering done in Revit or with the mental ray engine would not show as much reflectivity. The resulting *converted* material in the Arnold examples is actually closer to the original glazing material used in Revit.

![ART Rendering with default settings](image)

![Arnold Rendering with no conversion](image)
![Arnold Rendering with materials converted](image)
![Arnold Rendering with materials and lights converted](image)

In the image above, all renderings were created using the same Physical Camera and with the same exposure values. Obviously, without any conversion being done, the resulting image is of extremely poor quality. Even after conversion, however, you should expect to do some touching up on materials and lights.

Once the scene has been converted, you will find that there is still some work to be done with the materials, and possibly with the lighting, however the Scene Converter will give you a good head start toward making your scene compatible with Arnold.

**Using the Scene Converter:**

The Scene Converter is located on the “Render” pull-down menu. The first time you use it, you should configure a conversion for the Arnold renderer.

1. Launch the Scene Converter from the “Render” pull-down menu.
2. Choose the “Editor” tab.
3. For each item in the “Source” list, choose what to do, if anything, to convert it to an Arnold-compatible element in the “Destination” list. Note that there are multiple material types and light types. You should account for everything in the “Source” list with something in the “Destination” list.
4. Once you have accounted for everything in the “Source” list, choose the option to change the renderer to the Arnold renderer, provide a description for the conversion settings, and save them to a file.

5. To run the conversion, go to the “Options” tab and make sure the correct conversion is loaded, then click the Convert Scene button in the lower right corner of the dialog.
Running the pre-saved conversion.

**Note:** A pre-configured Scene Conversion File has been provided with this class – make sure you have downloaded it from the “Additional Materials” link for this class on the Autodesk University web site and save it to “C:\Users\<username>\Autodesk\3ds Max 2018\Scene Converter\ConversionPresets\”. 
Working with Physical Materials, Arnold Lights and HDR Images

Once you have run the conversion routine, you will still need to do some work to get your scene ready to render. You will find that even after conversion many materials need some editing; in particular, some of them will be too reflective. Additionally, you may wish to substitute them entirely, replacing them with new materials that you’ve created in 3ds Max. You will also want to spend a little time adjusting your lights.

Physical Materials

There a variety of material types unique to the Arnold renderer, and you will find them in the Material/Map Browser under the “Arnold” node.

![The Arnold and Physical material types in the Material/Map browser.](image)

While these will certainly work, you will probably find it easier to work with the “Physical Material” type, found under the “General” node. Physical Materials were developed for the ART renderer, however they are perfectly compatible with the Arnold renderer and are much easier to work with in most cases.

**Note:** The topic of materials in general is a wide ranging and complex one. It is assumed for the purposes of this document that you are already familiar with basic material editing concepts, the 3ds Max Material Editor, and how to use bitmaps when editing and creating material definitions.

Physical Materials have the typical controls for color, reflectivity, transparency and emission, along with the ability to assign bitmaps to control those and other properties, such as bump, anisotropy, etc. They also have the ability to specify subsurface scattering, which provides for more realistic transparent and translucent materials. You can base them on a material template, which will establish the base settings for a particular type of material, which you can then modify to suit your specific needs.
Two examples of Physical Materials: the material on the left is a “raw” material – the base definition before any modifications have been made. The material on the right is based on a material template, which pre-assigns texture maps to critical nodes in the material and pre-assigns values for reflectivity, IOR (index of refraction), transparency, etc. These values can be further edited and the texture maps edited or replaced with something else to achieve the specific results you need.

After converting your scene using the Scene Converter using the preset provided with this class, all materials that were imported with the Revit model should be converted to Physical Materials, and will be compatible with the Arnold rendering engine, however you will find that in some cases, they have reflective values that are too high. These will need to be edited. Additionally in some cases, the texture maps that some Revit materials use will not be retained and you will have to re-assign them or find other suitable maps to use.

Example of Revit materials after conversion using the Scene Convertor.

In the preceding image, while the converted Revit materials will work with Arnold, they still need some editing. Note the reflectivity of the ceiling and sofa materials in particular. That is
common result when mental ray materials are converted to Physical Materials and is easy to deal with. Additionally, while the wood materials look satisfactory, they can be improved using the more robust features of 3ds Max materials.

**Note:** Not all objects in the image above originated in Revit. The ceiling fan, rug and wall painting were modeled in 3ds Max and had materials assigned to them, then stored in a “resource” scene file. When needed in a scene they can be easily accessed using the ability of 3ds Max to merge elements from one scene into another. The camera and lights were also merged from another file as well.

The image below shows the problem with the GWB material that is the result of scene conversion. “Reflections” is set far too high, and the “Roughness” values are far too low on the right, which is the state immediately after running scene conversion. By editing those values, the material becomes much more appropriate for the scene.

![Editing a converted material to remove unwanted reflectivity.](image)

The following image shows the same scene after materials have been edited to reduce unwanted reflectivity and specular highlights. Some Revit materials have also be replaced with Physical Materials created in 3ds Max.

![The scene after editing materials to reduce reflectivity and specular highlights.](image)

**3ds Max Asset Library**

If you need to work with texture maps, you will find that the 3ds Max Asset Library can help you locate and keep track of your maps. It replaces the old Asset Browser that was included with earlier versions of 3ds Max. It can be found by going to the “Content” pull down menu and
clicking **Launch 3ds Max Asset Library**. The first time you do this you will be taken to the **Autodesk App Store** – the application needs to be downloaded and installed, however it is free. Subsequent clicks will launch the application, which is actually a stand-alone program and can be run independently of 3ds Max.

![Launch 3ds Max Asset Library](image)

You can add your own folders to the “Locations” panel. In particular, you will find the library of texture maps that Revit uses in C:\Program Files (x86)\Common Files\Autodesk Shared\Materials\Textures.

**Lighting**

Lighting can be the most complex aspect of any rendered image, regardless of the software being used to create it. Lighting scenarios and workflows will differ greatly depending upon whether you are rendering an exterior scene or an interior scene or rendering a night-time scene or daylight scene.

**Exposure Control**

Before looking at the various lighting scenarios, it is important to understand how Arnold works with exposure control. Prior to Arnold, there were several options for exposure control, with the most viable choices for mental ray being either mental ray Exposure Control or Physical Camera Exposure Control. With Arnold, the choice is simple – **use Physical Camera Exposure Control, combined, of course, with Physical Cameras** (again, as a part of the Scene Conversion process, you should make sure that any Target Cameras are converted to Physical Cameras).

With Physical Camera Exposure Control, you are passing all exposure settings off to the camera itself, which allows for you to have multiple cameras in your scene with different exposure settings. This means that you can have an exterior camera that is set for a value that is appropriate for exterior lighting and an interior camera that is set for interior lighting, which is usually significantly different, in the same scene.
Using Physical Camera Exposure Control

In the image above, the Exposure Control has been set to Physical Camera Exposure Control in the Environment and Effects dialog. On the right side of the image are the settings applied to the actual Physical Camera in the Modify Command Panel.

Render Setup

In addition to understanding Exposure Control, you need to understand the unique Render Setup options that Arnold has, many of which have a direct impact on lighting. In the following image, the most important settings on the “Arnold Renderer” tab are shown.

Critical settings for overall image quality and indirect lighting for the Arnold Renderer.
These settings will have a direct impact on both the quality of the image (amount of noise) and the level of indirect lighting. In general, the larger the number for any value, the longer the rendering time.

- **Diffuse Samples** – increasing this number will reduce noise in the image, increasing overall quality.

- **Diffuse Ray Depth** – increasing this value will increase the amount of indirect light in the image (must be used in conjunction with a source of indirect light, such as a Skydome).

- **Camera (AA)** – serves as a global multiplier for all values in the “Samples” column and will improve overall image quality with larger numbers – however it can have a pronounced impact on rendering time since it affects all sampling values.

- **Preview (AA)** – Turn Preview on when performing test renderings. Frequently it will provide a quick idea of the quality of your lighting and you can cancel the rendering without waiting for it to finish. Turning this off will slightly decrease the rendering time, however you will get no preview, and will have to wait for the entire rendering to complete before seeing all of the results.

**Simulating Sunlight**

Whether you are rendering an exterior scene or an interior scene with exterior lighting contributing at least part of the light, you will need to simulate sunlight and sky as well as a background.

**Sun Positioner**

The Advanced Ray Trace (ART) Sun Positioner that can be imported with the Revit model or be created in 3ds Max is perfectly compatible with Arnold, and has the advantage of being able to be configured by location, date and time of day, similar to the mental ray Daylight System. (Daylight Systems can be converted to Sun Positioners as a part of the Scene Conversion process). The Sun Positioner includes a Physical Sun and Sky Environment that is automatically applied as the Background Environment Map.

![Using a Sun Positioner to simulate sunlight and sky.](image-url)
An interior scene using exterior light provided by a Sun Positioner.

The image above shows a scene using a Sun Positioner as the primary light source for an interior scene. Additional lighting enhancements have been made to provide indirect lighting.

**Arnold Distant Light**

You can also use an *Arnold Distant Light* in place of a Sun Positioner. The end result is initially much the same, however you will need to provide a background environment or image in addition to the Distant Light source, since it does not include one of its own. Arnold Distant Lights have at least two primary advantages over the Sun Positioner:

- There is more artistic freedom to adjust intensity and color than with a Sun Positioner.
- Arnold lights have Sampling settings which will help to decrease noise in a rendering, improving overall quality of the image.

An Arnold Distant Light and the resulting image. No indirect lighting has been added yet, so a good portion of the image is dark.

In the preceding image, an Arnold Distant Light has been placed to simulate the sun, using the default settings:
• **Color**: Overall color of the light
• **Exposure**: Higher values provide more light, lower values dim the light
• **Samples**: Higher values reduce noise in shadows affected by the light, and will increase rendering time slightly.

*Indirect Lighting*

When rendering interior scenes, indirect lighting becomes an important part of your overall lighting scheme. There are a number of tools available to achieve believable lighting effects and they should be used in conjunction with each other.

**Arnold Skydome**

With the mental ray rendering engine, global illumination (a part of indirect lighting) was achieved in large part by using something called “Final Gather”. This is no longer available with Arnold. Instead, you can use one of the new Arnold light types, a *Skydome*.

![Using an Arnold Skydome light to provide indirect lighting.](image)

In the image on the right above, an Arnold Skydome Light is being created. Once created, on the “Modify” panel shown on the right, the light has been named and the “Portal Mode” has been set to “Interior Only”. The “Exposure” value, which, again, essentially controls the strength of Arnold lights, is set initially to 8.0, which is a good starting point. It can be adjusted further from there after some test renders if it needs to be increased or decreased. Note that there is also a setting for “Samples”. This will reduce noise in the shadows created by the light and is normally set to a value of 3 to 5 as opposed to the default 1 shown above.
**Note:** Increasing the “Samples” value will slightly increase rendering times as well, so you should test in a small rendering first to see if it will provide any benefits. Use the RAM Player to compare images if the differences are not clear.

The effect of a Skydome Light on an interior scene.

The image on the right above uses a Distant Light only to simulate the direct light of the sun. The image on the right adds a Skydome light using the settings shown on the previous page. The darker areas are somewhat noisy still, however there is a significant amount of additional indirect lighting in the scene. The amount of indirect lighting can be changed by adjusting the “Exposure” value of the Skydome Light.

**Arnold Quad Light**

Once the Skydome Light has been added to the scene, noise from the Skydome can be reduced significantly by using an *Arnold Quad Light* as a “light portal”.

![Using a Quad Light as a portal.](image)

In the preceding image, a Quad Light is being placed, with the “Portal” option turned on. The Quad Light, which is of a rectangular planar shape, is placed just outside any window or other types of openings through which a significant amount of exterior light is coming, with the size adjusted to provide coverage over the full extent of the opening width and height.

**Note:** When a Quad Light is set to “Portal” mode, sampling and exposure (intensity) are disabled.
Effect of a Quad light used as a portal on a scene.

In the image on the right above is the result of putting a Skydome Light in the scene. The image on the right adds the Quad Light as a portal. While there is not an increase in the amount of light in the scene, the noise is substantially reduced.

The final results with even less noise and more indirect light coming from the Skydome can be achieved by adjusting the Arnold rendering settings. Wait until you are ready for your final rendering, however, before doing so, because adjusting these settings, while dramatically improving the quality of the rendering, will also significantly increase rendering times.

**Tip:** Use a very small rendering output size, combined with the RAM Player to make adjustments to the Arnold Rendering settings until you find the combination of values that you like, then increase the output size to the desired final image size.

The Render Output size on the “Common” tab of the **Render Setup Dialog** has been set to a very small value to speed up renderings. On the “Arnold Renderer” tab, the default values are shown. The most important values to pay attention to for interior renderings with exterior lighting are shown:

- **Diffuse Samples** – increasing this value further decreases noise.
- **Diffuse Ray Depth** – increasing this value will increase the amount of indirect light from the Skydome and Quad lights. You will want to experiment with this, because eventually
you will reach the point of “diminishing returns” as the number gets set to a higher and higher value. A value of 4 is usually sufficient.

- **Camera (AA)** – This is a global multiplier value for all of the values in the “Sample” and “Ray Depth” columns.

- **Preview (AA)** – This is the quality of the Preview image (what is shown in low quality before the actual rendering starts. Leave this checked on while you are adjusting settings, but leave it set to a low negative value such as the default shown. When you are ready with your settings and want to perform a final render, you can uncheck it – it will slightly improve rendering times without impacting quality.

![Arnold Renderer settings configured for a more high-quality image.](image)

In the preceding image, note that only the “Diffuse Samples” and “Ray Depths”, along with the “Camera (AA)” settings have been adjusted. This is usually the only thing you’ll need to adjust for a daylight interior rendering, and while it will significantly increase rendering time, it will result in a high-quality rendering without having to increase the other values (and some that are further down in the dialog box), which would further increase rendering time for little or no gain.
Sample Interior Rendering Sequence Using Exterior Light

To put all of the pieces together to this point, it might be helpful to summarize a typical setup process for an interior scene using exterior light with the Arnold Renderer from the beginning. Refer to the previous pages for explicit details on each step.


2. In the **Render Setup dialog** box, set the current rendering engine to “Arnold” if it is not already current. Set the “Render Output” to the desired size (a small size is recommended until you are ready for the final rendering).

3. Link the Revit model(s) into your scene. Consider using a preset that does not import lights, cameras or daylight systems, unless you intend to use the sun from the Revit model to provide exterior light (They will have to be converted using the Scene Convertor). For this example, we will use all Arnold lights.

4. Use the Scene Convertor to convert all materials and any other non-Arnold-compatible elements to be Arnold-compatible. Consider using the preset that is provided with this class.

5. Place a Physical Camera in the scene and change one of the Viewport points of view to that camera.

6. Place a Distant Light source to simulate the Sun. (You could also use a Sun Positioner, which is supported by Arnold, but again, we are using all Arnold lights for this example). Set the initial Exposure value to 8.0. (Samples may need to be set higher if the shadows are noisy.)

7. In **Environment and Effects** dialog, set the “Exposure Control” to “Physical Camera Exposure Control” and set the “Target Exposure Gain (EV)” value of the camera to 12 as a starting point. Click **Render Preview** in the **Environment and Effects** dialog. Adjust the Distant Light and camera exposure values as necessary.
8. Add a Background Environment. There are multiple options for backgrounds, which we will look at later, but for this example, we’ll use a “Physical Sun and Sky” Arnold Environment Map. Instructions for exactly how to do this will come in the next section.

9. Place an Arnold Skydome Light to provide indirect illumination. Make sure the “Portal” value is set to “Interior Only” and set the Exposure “Target” value to 8.0 initially.

10. Adjust the Exposure “Target” value of the Physical camera if necessary to make sure the exterior background is not washed out. Click Render Preview in the Environment and Effects dialog, and then observe the changes as you adjust the camera exposure control.

11. Perform a test render.
12. Adjust the “Exposure” values of the Distant and Skydome lights if necessary, increase the “Sample” value of the Skydome light (5.0 is a good initial value) and test again.

After adjusting the Distant and Skydome lights, the scene looks better, but there is a significant amount of noise and the materials need work. Many are too reflective.

13. Now that you have enough light, modify the materials in the scene to reduce unwanted reflectivity. You can also take this opportunity to replace some of them as well.
14. Place a Quad Light just outside any windows in the scene with “Portal” checked on.

15. Make any final adjustments to exposure and lighting necessary, then change the “Arnold Render” settings, rendering to a small output size initially, and adjusting the settings if necessary. Use the RAM Player to compare results as you adjust.

16. Generate your final rendering at the final desired output size.
The final rendering with noise removed. Due to the output size and the Diffuse sample and ray depth settings, it will take dramatically longer.

**Backgrounds**

There are several options available for image backgrounds in addition to using simple image files as a background, depending upon the circumstances and your needs.

**Sun Positioner**

The Sun Positioner is used by the ART renderer in place of the legacy mental ray Daylight System, and functions essentially the same way, allowing you to control it by date, time and location. It includes a *Physical Sun and Sky Environment Map* as the background. *If you use the Sun Positioner to create your background, use it in place of the Arnold Distant Light.*

A sample image using a Sun Positioner to create the background.

**Arnold Environment maps**

While Sun Positioners are supported by Arnold, they have fewer controls for color, intensity, etc. If you choose to use an Arnold Distant Light to simulate sunlight instead, as was done in the Sample Scene Setup on the previous pages, you can still use a Physical Sun and Sky
Environment for the background. It will add to the exterior light of the scene, even without including the actual “Sun”, which is being simulated separately by the Arnold Distant light.

1. In the Material Editor's Material/Map Browser, find the “Physical Sun and Sky Environment” map and drag it into the Material Viewer.

2. Connect the output node from the map to the “Environment Map” button in the Environment and Effects dialog, making sure that “Use Map” is checked on.

Establishing the “Physical Sun and Sky Environment” as the background for the render image.

**Note:** Make sure not to click the “Create” button for the “Sun Position Widget” in the Map Properties dialog box. This will create a Sun object to go with the map, essentially creating a Sun Positioner, which will add its own light to the scene in competition with the Distant light that is already present.

HDR Images

An HDR (High Definition Resolution) image can also be used as a background. Using an HDR image you can allow the image to contribute to the global illumination or keep it completely independent, depending upon the effect that you want to get. You can also use color correction maps to control the image intensity and the amount of light it contributes for global illumination independently.

HDR Images can be found from a variety of on-line resources, and some of them are available at no charge. Some useful links are:

To use an HDR image as a background, perform the following steps:

1. Drag the image file from Windows Explorer into the viewer in the 3ds Max Material Editor.

2. In the Properties dialog, set the coordinates to “Environ” and the “Mapping” value to either “Screen” or “Spherical” (you can experiment with these to see which effect you like the best).

![Setting up the HDR image for use as a background.](image)

Frequently, HDR images will need their intensity adjusted to look good as a background image. You can use a Color Correction Map to do that.

3. From the Material/Map Browser, expand the “Arnold” node under “Maps”, then expand “Color”. Drag the “Color Correct” map into the viewer and connect the output node from the HDR image to the “Input” node of the Color Correct Map as shown in the following image. Editing the properties of the Color Correction Map, set the “Exposure” value to 1 as a starting point.
Attaching an HDR image to a Color Correction Map to allow for adjustments to intensity.

4. In the *Render Setup* dialog, under the “Arnold Renderer” settings, change the “Background (Backplate)” source from “Scene Environment” to “Custom Map”, then connect the output node from the Color Correction Map to the “Custom Map” button as an instance.

Specifying the Background as part of the Arnold rendering settings

5. Perform a series of test renders, adjusting the “Exposure” value of the Color Correction Map to lighten or darken the background.
You can also use an HDR image to contribute to the indirect lighting of the scene by attaching it to the Skydome. This is best done by using a separate Color Correction Map to allow you to control the lighting intensity separately from the background intensity. It is a good idea to name the maps that you are using according to what they are controlling to avoid confusion later on.

6. Edit the properties of the Color Correction Map that is already attached to the HDR image and change its name to indicate it is for the background.

7. Add another Color Correction Map to the viewer in the Material Editor, and attach the output node from the HDR image to the “Input” node of the new Color Correction Map. Rename the map and give it an initial “Exposure” value of 1.0.

8. Make one more change to the HDR image itself – if it is not already set “Spherical” mapping, do so now. (This usually works best, however for some images, you might still find “Screen” to be better – again, you can experiment for best results).
Adjusting the mapping coordinates of the HDR image.

**Note:** If you want to use different mapping coordinates for the background and indirect lighting images, use two copies of the same HDR image.

9. Finally, select the Skydome light that is currently providing your indirect lighting and change the “Resolution” value to match the resolution of the HDR image if known (it is usually indicated in the file name), and change the “Color/Intensity” settings to “Texture”. Connect the output node from the Color Correction Map to the box next to “Texture” as an instance as shown in the following image.
Assigning the HDR image Color Correction Map to the Sundome.

10. Perform test renders until you get the desired appearance, adjusting the “Exposure” value of the Color Correction Map. You may find also that depending upon the image the color effect is more pronounced than you’d like. You can lower the “Saturation” value of the Color Correction Map until you get the desired effect.

Rendering with HDR image used for the background and also as a control for the Skydome light.

Revit Photometric Lights vs. Arnold Lights

While you can import lights from your Revit model into 3ds Max and have them work with the Arnold renderer, the effect is not always as good as it would be if you invest a little more time replacing them with or converting them to Arnold lights.

In the image below, the scene on the left was rendered in 3ds Max using the ART Renderer with no conversion or other modifications following the initial linking of the Revit model, meaning that photometric lights are being used. The scene on the right is the result of using Scene Convertor to convert all lights to Arnold lights and materials to Physical Materials. Some materials were then edited to remove unwanted reflectivity, and a few “props” were imported from another 3ds Max scene (the rug and the wall art). There are also exposure differences between the two scenes, however the overall quality of the Arnold rendering, with the subtle lighting changes due to indirect illumination in particular, is superior to the ART rendering.
Comparison of the ART renderer and the Arnold renderer with artificial lighting.

**Arnold Lights**

In addition to the Distant Light, Skydome and Quad Light discussed previously, Arnold lights can also be a variety of other types, similar to the light types available with the Photometric lights in Revit and 3ds Max. **Arnold lights can also utilize a photometric web**, so if you have lights in Revit scene that are dependent upon a photometric web file (.ies), you can assign that same IES file to an Arnold light to get the same distribution settings. When you import the lights into your 3ds Max scene, any required IES files are copied to your project's "sceneassets/photometric" web file and the reference to the IES file is maintained. You can then convert the lights to Arnold lights and they will continue to reference the IES file.

In the following image, the settings for a photometric light using a photometric web file in Revit are shown on the left. On the right the same light, after conversion to an Arnold light, maintains the same IES file association.

**Noise Reduction Workflow**

Noise is always an issue with any kind of rendering in 3ds Max, and different rendering engines provide different tools to reduce or eliminate it. Usually you can eliminate noise with the Arnold renderer by increasing the "Diffuse Samples" in the "Arnold Renderer" settings, combined with a Quad Light as shown previously, however sometimes you will have to go a bit further. Interior
scenes will sometimes have “fireflies” (small bright white dots) in the scene, and they can usually be removed by turning on “Clamping” in the Arnold Renderer settings, then setting the “Max Value” to ever-increasingly smaller values until the fireflies are gone.

Adjusting the Clamping values to remove “fireflies”.

For rare, but sometimes extremely challenging noise issues, you can use AOVs to diagnose where the noise is coming from and which setting needs to be adjusted to reduce it. AOVs are images that only show one sampling aspect of the “Arnold Renderer” settings. If you see any noise when you view an AOV for a particular setting, that is one of the settings that needs to be adjusted.

The following image shows the result of using AOVs to diagnose a noise issue. On the left, the rendered image shows a significant amount of noise. The Diffuse Indirect AOV and the Specular Direct AOV are shown below. The Diffuse Indirect AOV is very noisy, and the Specular Direct AOV, while dark, is very crisp and clear in the areas where geometry is visible. That means that you don’t have to waste your time adjusting specular settings in the “Arnold Renderer” tab. Instead, adjust the “Diffuse Samples”. The images on the right show the result after increasing the “Diffuse Samples”. Both the rendered image and the corresponding Diffuse Indirect AOV are far less noisy.
The results of using AOVs to assist in diagnosing noise issues.

To create AOVs, do the following:

1. In the “AOVs” tab of the Render Setup dialog, specify a file type for the AOV images and click Add AOV File.

2. In the next dialog, choose the AOV type from the “Built-Ins” list and click Add. This will cause the AOV type to appear in your list of AOV files.

3. Continue to add AOVs until you have selected all that you need and added them to your list.
4. In the “Common” tab, click the **Files** button under “Render Output” and specify a folder and file name. (The file name will become a prefix for each AOV file name). Make sure “Save File” is checked on.

5. Click **Render**.

When the rendering has finished, you will find all of your AOV image files, along with the rendered image file itself, in the specified folder.
Creating 360 Degree Stereo Panorama Images

In addition to the superior rendering quality of Arnold images, the Arnold renderer also provides the ability to create 360 degree stereo panorama images directly from 3ds Max, without having to use cloud credits, and without having to use some other 3rd party application. The resulting images can be viewed by anyone with an Android or iPhone and a VR headset, such as Google Cardboard, which can be purchased for less than $10.00 US. (There are, of course, more expensive options as well).

Creating a VR Image

Once you have your scene set up with materials and lights using the processes outlined in this document, creating a 360 degree stereo panorama image is remarkably simple.

1. Make sure you have your scene configured for a good quality rendering using a Physical Camera, using the steps outlined in this document.

2. In the Environment and Effects dialog box, set the Global Exposure “Exposure Value” to the same value as the one currently in effect for your Physical Camera. This is because the VR Camera that you will use to create the panorama has no exposure controls of its own. If you don’t match the Global settings with the Physical Camera that you initially set your scene up for, your results might be a little surprising.

3. Place an Arnold VR Camera. This is not a targeted camera, but a “Free” camera instead, and will be facing directly away from the view that you place it in. Place it in one of the side views so that it will be oriented correctly. Once it is initially placed, adjust the “Focal Length” of the lens – this is the only opportunity to do so. Finally, move it into the center of your scene.
Placing an Arnold VR Camera

4. Adjust the settings for the camera in the “Modify” command panel. These will depend, in large part, on the application that you are planning to view the image in. In particular, pay attention to the “Eye Separation” value, as setting this too large or too small can cause the resulting image to be disorienting. The default value of roughly 2 ½” is usually best, as it is representative of the distance between a typical person’s eyes.

Critical settings for an Arnold VR camera after placement. The “Mode” and “Projection” settings will depend upon the application being used to view the image.

5. Set your camera’s viewport point of view to the Arnold VR Camera. Don’t worry if the image looks extremely distorted. Depending on the “Mode” setting of the camera, this is normal.
VR Cameras can cause the viewport to appear extremely distorted, depending on the mode set for the camera. This is normal.

6. In the Render Setup dialog box on the “Common” tab, change the “Output Size” to “Custom” and set the actual size to something that represents a 2x1 ratio, with the width being twice as big as the height. For the initial test render, keep the size relatively low, as in the image below.

![Setting the Output Size for the initial test render.](image)

1. Still in the Render Setup dialog, in the “Arnold Renderer” tab, set all of the sampling values to their initial low settings so that you don’t have an excessively long render time for your test render.

2. Render the viewport. Again, the results will vary depending upon the “Mode” and “Projection” settings. The following image shows the result of rendering with “Mode” set to “Side by Side” and “Projection” set to “Lat/Long”.

![Initial test render result.](image)
3. Once you are satisfied that the lighting is correct, adjust your render settings for a higher quality rendering. “Diffuse Samples” should be set to a minimum of 6 to remove noise, if not higher. It is recommended that you also set “Specular” and “Transmission Samples” to a medium value such as 3. “Render Output” size should be set to at least 2000 x 1000. Obviously, this will take awhile to render – consider letting it run overnight or transfer it to an unused computer.

**Note:** Autodesk has recently released a new cloud service, “Cloud Rights” for 3ds Max 2018 which allows you to offload your rendering to a remote computer via the cloud. This would be a good application for that service.

### Viewing a VR Image

Once the rendering has completed, you can save it to one of the standard image formats (JPG, PNG, etc.). The choices for viewing are varied, and will depend on the device you have. You will need a pair of VR goggles, however these are relatively inexpensive to purchase. You can use these with your smartphone to view the images using any number of apps that have been developed for the purpose. I personally Mobile VR Station for iPhone, however there are several others available.
Resources for Further Study

There are several resources on line for further study on the Arnold renderer and on Physical Materials:

3ds Max Understanding the Physical Material:  
https://www.youtube.com/watch?v=48YtLmJCPzE

3ds Max 2018 – MAXtoA Plugin – Arnold Basics – Part 1 of 4:  
https://www.youtube.com/watch?v=NYRtiwbhWEg

3ds Max 2018 – MAXtoA Plugin – Arnold Lighting – Part 2 of 4:   
https://www.youtube.com/watch?v=NYRtiwbhWEg

3ds Max 2018 – MAXtoA Plugin – Arnold Interior Lighting – Part 3 of 4:  
https://www.youtube.com/watch?v=8PSOX01MIQM

3ds Max 2018 – MAXtoA Plugin – VR Camera – Part 4 of 4:  
https://www.youtube.com/watch?v=p6RSHoOzrIo&t=195s

SolidAngle Tutorials – Arnold for 3ds Max:  
https://support.solidangle.com/display/A5AF3DSUG/Tutorials

Summary

The Arnold renderer is the most significant change for building visualization in 3ds Max 2018. It completely replaces the mental ray rendering engine and involves a whole new workflow. While you can still use the default ART renderer with little or no modification of your Revit model (lights and materials) after linking or importing into 3ds Max, investing the effort to learn how to use Arnold and taking the extra time to prepare your scene properly for the Arnold renderer will pay off with superior quality renderings, especially when rendering interior scenes, whether they are using exterior or artificial lighting.

Hopefully this class has given you a head start towards implementing Arnold in your rendering workflow and has inspired you to explore further!