PBR Materials for Revit: What These Materials Mean and How You Can Use Them

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Learning Objectives

- Learn what physically based rendering is and discover the science behind it
- Learn about the specific material channels that make up Revit software’s physically accurate materials
- Learn about creating the different texture channels that make up a PBR material
- Learn how to use Revit software’s cloud-rendering service to create a photorealistic render

Description:

There is no question that technology is growing at an unimaginable pace. With the addition of Revit 2019 software’s Physically Accurate Materials comes the opportunity to push our renderings to the next level. This class is designed to take attendees on a deep dive of what physically based rendering (PBR) is, and how to use the enhanced materials to achieve a photorealistic render. We’ll cover how to create each of the different textures that are needed to develop a physically accurate material and where to apply them inside Revit. When our model is textured, we’ll look at Revit software’s cloud rendering service, and how it can utilize the PBR materials to enhance our renderings.

Speaker:

Josh Radle is a Technical Specialist in visualization programs at ATG USA. Josh is responsible for all levels of assistance, training, and consultation to Architectural, Engineering and Contractor firms across the world.
What is Physically Based Rendering?

Physically Based Rendering is a way of creating materials that will accurately respond to light just as if they were in the real world. It is a theory based on measured surface values.

What are the benefits?

Physically Based rendering removes the guess work of wonder what my materials are going to look like in a certain lighting condition. We can have comfort in knowing that if we have to make a change to the lighting in our scene the materials will follow along and act how they would in real life.

It requires fewer textures to make a PBR material and thus saving on computing memory.

It will help develop a texturing standard for your company knowing every material that is created will have all of the texture maps that make up a Physically Accurate material.

Physics behind PBR:

How does light work?

To help us better build our texture materials we should have a basic understanding of how light works and interacts with the materials around us. When a light wave encounters an object, they are either transmitted, reflected, absorbed, refracted, polarized, diffracted, or scattered depending on the composition of the object and the wavelength of the light.

Reflection:

Reflection is when incident light (*incoming light*) hits an object and bounces off. Very smooth surfaces such as mirrors reflect almost all incident light. Mostly every material around us has some form of surface roughness that will
light interacting with a smooth surface

Energy Conservation:

When the light ray meets the surface, some of the light ray is absorbed by the object, the light intensity will decrease as it changes into another form of energy, usually heat. And the rest of the light ray being reflected off the object
Refraction:

Refraction is when the light waves change direction as they pass from one medium to another. Light travels faster in air, than it does in water. As light travels into a different medium, the change in speed bends the light. The *Index of Refraction (IOR)* is used to determine how much the light will be bent when it is traveling from one medium to the next.

https://medium.com/@grahamte/physically-based-rendering-simplified-d01ec18667d1
Fresnel:
Fresnel is everywhere! The most common place we see it is when looking at water. When we look straight down, we can see to the bottom, but when we look at an angle, we cannot see to the bottom anymore. This will be rendered when we set the Reflectance value in our Revit material. *The rougher the material ie rocks the less Fresnel there will be*
Revit Base Materials explained:

Revit comes with a variety of pre-built materials for you to use. The materials with a yellow triangle in the bottom left corner (see image below) will indicate it is a legacy material and are not setup to be Physically Accurate. Materials that do not have the yellow triangle are setup to be Physically Accurate. If you wanted to start from scratch with your own materials, Revit has included 4 base materials that you can start with. *(5 in Revit 2020 Glazing)* Found in the Asset Browser > Appearance Library> Base Materials is where the base materials are located, they have the characteristics of a standard PBR material such as albedo/diffuse, roughness, bump/normal. Revit values are displayed like this 0.04 which translates to 4%
Opaque material:

The Opaque material is setup to be used for materials that are non-metallic or transparent. Typical examples of this are: Plastic, wood, stone, ceramics etc etc.
Transparent material:

The Transparent material is used for all materials where most of the light rays can pass through the material without any scattering.

*Types of materials that would normally be used for this are glass, water, acrylic, etc etc.*
Metal material:

The Metal Material is setup to be used for all Metal materials.
Layered material

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Layered Material is used to represent materials that have a bottom specular surface and a top clear coat.

Typical uses for this material are, carbon fibers panels, metallic paints, and surfaces that might have reflective specks like granite and car paint.

Example of the new material maps that make up a wood floor material:
Materials Maps:

PBR materials in Revit have a typically 2-4 different texture maps per material that define its characteristics. Below are the names of the materials and the descriptions of what they do.

Albedo:

This Albedo map is the base color of the material. The big difference between the Albedo map and the traditional Diffuse map is the Albedo map has the shadows removed from the texture. This is so our materials will look more natural in every lighting condition.
Roughness:

This controls how the surface imperfections that are being displayed. This is an inverted Gloss Map. Black is shiny white is not shiny. The difference between this map and the traditional Gloss Map is it is simply inverted (white is shiny, black is not.) controls how rough or smooth a Material's surface is. Rough Materials scatter reflected light in more directions than smooth Materials, which controls how blurry or sharp a reflection is. A Roughness of 0 results in a mirror reflection and roughness of 1 result in a diffuse surface.
**Bump/Normal:**

New to 2019 found under the Bump map tab, we have the option to add a normal map in. A Normal Map decides about dents and bumps on the object and is like the regular bump map but much more advanced. It will display a more 3d look due to the fact it has information about bumps and dents in the XYZ axes.

**When using a Normal map texture, be sure to switch the Data Type from Height Map to Normal Map, otherwise your material will have black spots on it.**
Advanced Highlights:

This is where we can use an Ambient Occlusion (AO) map to simulate the occlusion of dents and cracks or any other surface imperfections.
If we did not want to use the default Revit textures, we can do 1 of 2 things.

1. Create our own from scratch from photos we have taken or been provided.
2. We can do some looking around on various texturing site and see if we can find some we like. *(there are some links to free texture sites in the resources section)*

We will be using **Substance Alchemist** to create our own materials from scratch and create variations of those materials. Alchemist will allow us to create all the material maps we will need for use in Revit *Substance was used by Autodesk to create the new Physically Accurate materials that come with Revit 2019. [https://www.substance3d.com/blog/autodesk-revit-pbr-material-workflow-architecture](https://www.substance3d.com/blog/autodesk-revit-pbr-material-workflow-architecture)*

Launch Substance Alchemist and click the **Create** tab.
In Substance we can start from scratch or use some of the default materials as a base to start with. For this demo will be starting with a default metal material. Click and drag the Metal Generic model from the Base Materials list. We have some different viewing options for the mesh, I chose to use the Rounded Cube as my preview mesh.
On the right side of your screen you will see the add new layer button. This is where we can start adding effects to our material. I will select the **Metal Finish Layer**.
Once we click on the **Metal Finish Layer**, we can change the type of metal that we want. I will be choosing **Iron**.
I will then change the Finish Type to **Cast** I encourage you to experiment with the different types of finishes.
Once we are happy with our material, we can click **Export Current View** and choose the textures and file format we want.

Or we can create variations of materials from a single image
With the addition of the new materials in Revit 2019 also came an updated rendering engine called **RayTracer**. Revit’s built in rendering engine is the same as the rendering engine as the cloud rendering. What this means is that if you choose to do a render with quality set to **Best** it will be the same as the clouds rendering Best setting. We can start of by doing a draft render to
see get an idea of how our textures are going to look.

Once we like how our image is looking, we can go ahead and send it to the cloud to be rendered.
Before our render begins, we get some render options:
Once the render is sent to the cloud, we can continue working. When the render is complete, we have some post processing features that can help improve our render.
Example of legacy Revit materials:

New Physically Accurate Materials added:
Resource links:

https://www.substance3d.com/pbr-guide
https://marmoset.co/posts/physically-based-rendering-and-you-can-too/
https://marmoset.co/posts/basic-theory-of-physically-based-rendering/
https://www.chaosgroup.com/blog/understanding-metalness
https://www.substance3d.com/blog/autodesk-revit-pbr-material-workflow-architecture
https://www.scratchapixel.com/lessons/3d-basic-rendering/introduction-to-shading/reflection-refraction-fresnel?fbclid=IwAR3AzXPmdK2txPEzAkOJHAgGVXhHFucG3317B6EKPt4TjqRAtpJvLCXVy4

Texture sites:

https://3dtextures.me/
https://source.substance3d.com/allassets?free=true
C:\Program Files (x86)\Common Files\Autodesk Shared\Materials\Textures\3\Mats
https://texturehaven.com/
https://www.polyigon.com/
https://cc0textures.com/
https://www.textures.com/
https://www.cgtrader.com/free-3d-models/textures
https://share.substance3d.com/