What is a Render Engine?

As you make your 3D models in Blender, your goal will probably be to generate (render) an image or a movie as a final result. The software that determines how your scene will look is the render engine. The render engine will need to know how to handle materials on your objects, how the lighting in your scene should react with reflections, refraction, bounced ambient lighting, shadows, etc. While there are several 3rd party engines out there that can work with Blender, there are actually two engines built into the program: the classic internal renderer and the newer cycles renderer. Every render engine will generate different results depending on how it calculates the scene. Some render engines will take a lot longer to generate an image than others. Cycles handles lighting much better than the internal renderer, providing more realistic results.

So which one do you use?

That will depend on what you want for results. The classic internal engine will give you faster results, but with less realism. The cycles engine will give you more realistic results, but requires more set up time and much longer render times, depending on your computer and graphics card (possibly minutes as opposed to hours). Because this book is written for use in the classroom, all of the activities here use the classic render engine. Time is a valuable commodity in school and we need to render as quickly as possible to meet deadlines. Like most schools, we do not have the best video cards on the market, making cycles a tough choice for us. Cycles is a work in progress and getting improvements with every new release. Some students do choose to use cycles. In this chapter and the next, we will discuss the basics of the cycles renderer and how to set up basic materials. With that knowledge, you can decide which render engine you would like to use for the activities. Both render engine will give you great results!

The Classic Render Engine:

Currently, by default, the classic “Blender Render” is active when you launch Blender. You can change this in the top header to “Cycles Render” or “Blender Game”. The Blender Game engine rendering will be discussed in a later chapter. For now, stay in “Blender Render”. We will discuss “Cycles Render” later.
Chapter 1- The Blender Interface

Materials and textures are what change your model from being gray to brilliant. We will only discuss some basic material settings in this chapter so you can experiment with the render engines. Materials will be detailed in the next chapter. Remember, we are focusing on the classic internal renderer right now.

Basic Material Settings

To add a material, first select the object you want to work with, then go to the Materials panel in the Properties window. Click the “New” button (unless you are working with the initial cube- that has a material on it by default). You will see more options open up. Right now, we are only interested in changing color and glossiness.

Diffuse:
Diffuse is actually the color that is given off by the object- the color you see. If you want the object to be red, set it here. You will also see settings for the way the material is calculated (default-Lambert) and the intensity slider. The Ramp button will allow diversity of color.

By clicking on the color sample in diffuse (or in any other block dealing with a color), the color wheel will pop up. You can set the color using the wheel and light/dark slider, setting in manually using RGB, HSV, or Hex numbers. You'll also see an eyedropper for picking a color elsewhere.

Specular:
Specular settings control the glossiness of the object (is it flat or shiny?) You will see a color sample, calculation model and ramp as in Diffuse. The color sample indicates the color reflected back (usually kept white). Intensity controls the amount of glossiness while the hardness slider controls the hardness and softness of the glow. Check the sample as you change these settings to see how it changes appearance.

RoboDude Asks: How can I see all the panels on the screen?
It is impossible to see all of the panels at once, but you can scale the by pressing the “+” and “-” keys on the number pad and pan with the mouse wheel.

Chapter 4- Blender Render Engines
The Cycles Render Engine:

As mentioned before, you have a second option for rendering your projects. While the classic render engine is still the default in Blender, Cycles continues to receive most of the recent development and will likely become the default renderer in the near future. Since cycles can produce more accurate results with reflected light and other effects, it is more memory and is processor intensive. This is where your computer hardware makes a big difference and a place where many high school labs can fall short. In our lab, we have fast dual-core computers, loaded with RAM, but with integrated video cards. Due to school district budgets, I think many schools are in the same boat. Because of this factor, we can render simple scenes in Cycles, but as scenes become more complex, we experience problems and need to rely on the classic renderer. Render farms, or Network Rendering, (discussed in Chapter 8) can help you get through larger projects as well. Expect detailed project in either render engine to take minutes to hours to render a single image as you add more detail.

To access the Cycles render engine, switch from “Blender Render” to “Cycles Render” at the top of the screen.

CPU or GPU?

By default, Blender and Cycles use the CPU (the computer processor) to render your project. Because the CPU is doing everything to run your computer, the amount of memory and the processor speed of your computer will determine how fast your projects render. Newer computers have fast video cards, or GPU (the graphics processor) and Cycles can be set to use the GPU instead of the CPU. If your computer supports GPU, you can experiment to see which one works best for you.

To see if you have a choice between the two, go to the “File” menu- “User Preferences”. Under the “System” tab, find the “Compute Device” options. If you see an option of CUDA or OpenCL, the you have GPU rendering. If not, you are limited to CPU rendering. You can try to update drivers, update your video card, or live with CPU rendering. You will also need to select CPU or GPU under “Device” in “Properties”. 

System option in Preferences menu with CPU support only.

System option in Preferences menu with CUDA GPU support.

Render settings for Cycles in the Properties window. No option for “Device” when GPU is unsupported by your computer.

Render settings for Cycles in the Properties window. There is a “Device” option for you to select between CPU and GPU when your computer support GPU rendering.
Chapter 4- Blender Render Engines

Node-Based Rendering:

Cycles rendering is entirely different than classic rendering in that Cycles is node-based, or rather blocks, designed to be connected together to produce your results. Nodes can be confusing to work with, but you can set up your basic materials and textures in the Properties window, similar to the way we construct them with the classic renderer to make life easier. You can then adjust your results by adding and adjusting nodes in the Nodes window. As you work with Cycles, this will become easier. With a little research on the internet, you will find a lot of tutorials for creating specific effects with nodes.

In-Viewport Rendering:

A nice feature of Cycles is that you can view your render results in the viewport without the need for pressing F12. While this feature also works to some degree in the classic rendered, you can control the results better in Cycles. If you press the shading button at the bottom of the 3D View window, you can select “Rendered” from the list of options.

Cycles Render Quality Control- Samples:

Cycles renders will look grainy by default. While the complete explanation is complex, what is essentially happening in Cycles is that the image quality will continue to improve over time with each sample and you can control the number of samples (found in the Render Properties menu) in the viewport and in the final render (F12). Usually you want a lower “Preview” sample number for faster work in the viewport and a higher number for the final “Render”. Depending on your computer speed and the complexity of the scene, the higher the better, but you need to find a balance of quality and time. Professionals may render samples in the thousands.

RoboDude Asks: Why is Blender running so slow in Cycles?

If you have your viewport in “Rendered” view instead of “Solid” view and the “Preview” samples set too high, you will be limited in what you can do as it process the samples. Try a lower sample rate.
Lighting in Cycles:

We will look at lighting settings more in chapter 7, but basically, to illuminate your scene correctly in Cycles, you will not be able to use traditional Blender lamps adequately. Cycles uses mesh objects, set to “Emission” in the material settings. This is because traditional Blender lamps project from a pin-point location where real lamps project from larger areas, like a light bulb would project more from a spherical object. Planes work great to light Cycles scenes.

Basic Material Settings in Cycles:

As mentioned before, Cycles is a node-based render engine, but we can use the Materials properties panel to do some basic setup, similar to the classic render engine. After switching to the Cycles renderer, adjusting your processor (CPU or GPU), and setting the Samples, you are now ready to apply some basic materials.

With the object selected, go to the Materials property panel. You will notice settings are presented differently than in the classic renderer. Start by pressing the “Use Nodes” button.

By default, you will see “Diffuse BSDF” as the default node setting under the Surface panel. BSDF stands for “Bidirectional Scattering Distribution Function”. An elaborate term that basically means what happens to the light when it hits an object. Is it reflected, absorbed, or transmitted through the material for transparency or refraction. Diffuse is used exactly like it is in the classic render engine- the light reflected, with no glossiness. Below the surface setting you will see a color swatch, roughness (smooth or rough) and default normal mapping. Clicking on the Diffuse block, more options are displayed.

While we we look at more details in the next chapter, we will examine 4 surface options here: Diffuse, Glossy, Emission, and the Mix Shader.
**Chapter 4- Blender Render Engines**

**Emission:**
Remember we mentioned earlier that we do not use lights in cycles as we normally do in the classic render engine. In real life, we see the light emitting from our lamps. In the classic render engine type lights, we never see the actual lamp. If you create a sphere or pane to represent your light source, you would place an Emission shader on the object and adjust the strength of the emission.

**Diffuse:**
The cube to the left is using a Diffuse surface material with some roughness applied. The roughness may not be very apparent depending on how many samples you are rendering at. Try a higher sample rate for better quality (discussed on page 4-4).

**Glossy:**
A sphere has been added to the scene on the right with a Glossy surface material added with a blue color. A glossy surface by itself will be a perfect mirror. This is where it is important to mix your surface shaders.

**Mix Shader:**
A Mix Shader was selected on the left. You will notice that when a Mix Shader is used, you can now add two more shaders below to combine effects and the balance of the two effects is controlled by the “Fac” slider directly below the Mix Shader (the percentage to use of each). In this example, Diffuse and Glossy shaders were used on the cube, which gives the cube color and reflection. A Mix Shader could also be added to the 2nd slot to mix even more together.
Your Material Setting in Node View:

Now that you have some basic materials set in Cycles, in order to see them in a Node view, change your 3D View window to the Node Editor window (found at the bottom-left corner of your viewport).

Here are some of the basic parts of the Node Editor window. More details will be discussed throughout the manual and activities.

With experience, many people set all of their material properties in the Node Editor window. We will also examine times in future chapters where you can start in the material properties panel and then add additional features in the node editor window.

Working with nodes can be confusing and knowing how to connect them can be more of a challenge. While we will examine the basics of Cycles in this book, the internet is an excellent resource for additional learning.
Chapter 4- Blender Render Engines

Tweaking Cycles for Speed & Quality:

So what can you do to speed up renders in Cycles? We already talked about adjusting the sample rates on page 4-4, but what else can you do to speed things up? Ken Murphy from Southwest Minnesota State University shared some setting options he uses with his class to speed up the rendering times while giving results similar to the Blender internal render engine. Here are some setting options:

In the **Render** property settings, change the following in the “Light Paths” panel:

**Transparency:** Set the minimum and maximum settings to zero, unless you have transparent objects in your scene. If you need this, try a low number (2-3). The default settings are 8 for both minimum and maximum.

**Bounces:** Set the minimum and maximum settings to zero, unless you have transparent objects in your scene. If you need this, try a low number (2-3). The default settings are 3 minimum and 12 for maximum.

Uncheck **Shadows** and both **Caustic** settings.

In the **World** property settings, change the following:

Uncheck all option in the “Ray Visibility” panel except **Camera**.

In the “**Settings**” panel, uncheck the **Multiple importance** setting.

The type of lamps you use will also contribute to your results. While using meshes with an emission shader is ideal in Cycles, a traditional Hemi lamp may provide sharp shadows.
Create a simple scene similar to the one below. Place the camera and lamp in good locations to get a render similar to the one shown below. You will start in the classic "Blender Render" engine. Use only one lamp to light your scene. Save this Blender file as "Test Render 1", then use the "save as" command to save a second file called Test Render 2. You will be experimenting with color and glossiness in this activity.

For your "Test Render 1" file using the classic renderer, press "F12" to render an image, then immediately press "F3" to save a .png image file of your render. Check your saving location and title it "Test Render 1.png. (do not forget the .png at the end)

Now open your “Test Render 2” file and switch to the "Cycles Render". Replace the lamp with a UV Sphere and put an “Emission” surface shader on it. Adjust the strength for a good output. Add appropriate material shaders to your other objects in Cycles. Set your render samples as high as your computer will allow for an appropriate render time. Press “F12” to render this new image, then press “F3” to save the image as "Test Render 2.png". (do not forget the .png at the end)

**Call the instructor when finished**
Chapter 4 Reflection and Wrap-up:

Both render engines have their pros and cons and both can be difficult to master. Compare your two render results and answer the following questions:

1. Look at the lighting effects in both images. You used one light in each, but have different results. Which one looks more realistic? Why?

2. In Cycles, graininess is determined by the number of samples. Why does the image improve with higher samples? Research and explain why.

3. Which render engine do you like the best and why?

4. You have had a comparison of Blender’s two render engines in this chapter, but how does Cycles compare to another program’s render engine? Conduct an internet research of another render engine that can be used with other commercial animation programs. Explain your findings.