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Lighting in the Computer Rendering

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LIGHTING IN THE COMPUTER RENDERING

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Rendering is an art, and it involves views, lights, and the composition of materials. Producing photorealistic digital images involves the critical placement of the above-mentioned components. Several conceptual steps may be involved, not necessarily in the order presented in this list:

* Constructing your 3D scene
* Generating your perspective for rendering
* Creating light for your scene
* Setting up material UVW coordinates for your objects
* Assigning materials to your objects
* Waiting for your 3D program to finish your rendering

Rendering a great image requires time, passion and patience, but the result is quite rewarding. If you are using a slow computer, you will find that rendering is possible but painfully slow. Please read Tips at the end of this section; you will find shortcuts to make your rendering a breeze rather than an annoyance.

LIGHTING

In the 3D world, materials can be modified throughout the design process. Your choices of different materials can be matched to your design ideas, and what can be better than creating your own texture maps? We often take lighting for granted, but lighting plays a vital role in our physical world. In the world of 3D, we have to set up lights to simulate our world. It is a daunting task but makes computer rendering interesting and challenging. This section covers the basic lighting concepts and principles and takes a close look at how lights play an important role in defining space in computer rendering. Different rendering methods will also be discussed.

This section will cover the following:

* Lighting in computer rendering, the difference between sunlight and artificial light;
* Omni lights, target spotlights, and free spotlights;
* Differences between shadow-mapped shadows and ray-traced shadows, volumetric lighting, and volumetric fog;
* Different rendering technologies – differences between ray-tracing, radiosity, direct illumination and High-Dynamic Range (HDR) images.

Types of Lights

The placement of lights and selection of types of lighting is critical to the success of your rendering. Most 3D programs on the market support four kinds of lights. Please consult your owner's manual for more specific types of lights.

- Ambient light
- Point lights
- Distant lights
- Spotlights

Ambient Light

Ambient light is different from other lights in the 3D world because it has no particular physical property. As background light, ambient light provides constant illumination to all the 3D surfaces of your scene. Consider it as the lord of the lights, which controls the intensity and colour of all lights in the main lights dialogue box. The default parameter for the intensity of Ambient Light is 0.30, and the default colour is white (red:1.00, green:1.00, and blue:1.00). It is

not recommended that you modify these parameters unless that you know exactly what you are doing, because it will result in global changes to your lighting's intensity and colour.
Purpose: Global parameters control the intensity and colours of all lights
Appearance: No source, no direction, and no appearance

Point Light
A point light is also known as an Omni light or filler light. This light source radiates light in all 360-degree directions from its source. Point lights are generally used for the purpose of filling up an area quickly, and are preferred over the alteration of the intensity level for ambient light. The group of three Attenuation buttons control the falloff of the point light as the point light intensity decreases when the distance from the light source increases. Select the none button; you do not take the distance from the light source to the surface of the object into consideration. When you choose between the Inverse Linear and the Inverse Square, you can simulate two light sources and choose how they illuminate the same target object. By choosing the latter of the two, you can determine how point light intensity diminishes over distance.

Purpose: Filler light, incandescent light with no shade, or candle light
Appearance: Spherical shape-attenuation determines its intensity diminishes over distance

Distant Light
A distant light is also known as a sun light. This light source has no attenuation; therefore, it cannot attenuate over distance no matter how far the light is from the rendered object. A special sun angle calculator, the sun's position based on the hour of the day and the geographic location, can be chosen in the dialog box of the distant light. Sometime distant lights are used to create a consistent distributed lighting scene. This can make your scene less dimensional, and less focused.
Purpose: Sun
Appearance: Parallel one-directional light – an hour of the day and geographic location determine how it appears in the scene.

Spotlight
A spotlight is also known as a target light because it emits a unidirectional cone of light with a source and target. Both the source and the target of a spotlight can be relocated in 3D space. Hotspot and falloff parameters are distinct features of the spotlight. The hotspot angle defines the brightest area of the spotlight. The falloff angle defines the outermost parameter of the spotlight. The area between the hotspot angle and the falloff angle determines the appearance of the spotlight. A softer edge on the light cone is the result of a greater difference between the hotspot and falloff angles. A sharper edge on the light cone is the result of a small difference between the hotspot and falloff angles, but the hotspot angle can only be equal or less than the falloff angle.
Purpose: Stage lights, halogen lights, projection lights, and any focus lights with shade.
Appearance: Conical shape – the hotspot angle and the falloff angle determine the softness or sharpness of the cone in the spotlight.

Volumetric Light
Volumetric light can simulate a complex environment with shadows and noise, and provide light effects based on the interaction of lights with atmospheric effects such as fog or smoke. Volumetric light is an effect that adds to the light, and not a specific type of light. The disadvantage of the volumetric effect is that it is CPU intensive and therefore time-consuming.

Placement of the Lights

"Inspiration is the feeling at the beginning at the threshold where Silence and Light meet. Silence, the immeasurable desire to be, desire to express, the source of new need, meets Light, the measurable, giver of all present, by will, by law, the measure of thing already made, at a threshold which is inspiration, the sanctuary of art, the treasury of shadow." Louis I. Kahn

Light defines space and creates life. Without light, our world is dark, colourless, cold and lifeless. We cannot live without light; we certainly cannot render without lights. A default light is created if you do not assign any light in your scene, but it is dull, flat, and uninteresting. A good rendering is often placed with many lights to simulate the real world. A carefully placed light with the proper parameters can make your rendering stand out. Lighting in the virtual world is much like lighting in the real world, but there are differences because light (diffuse light) does not bounce back. Features like the radiosity effect can be found in many popular 3D programs, such as Discreet 3D Studio Max/VIZ, Auto.des.sys's Form.z, and Lightscape. Each type of light in the virtual world exists for a purpose, be creative when you use it. It is also important for you to mix up different types of lights in a scene. For example, mixing up spotlights with point lights in a living room scene can enhance your rendering greatly. Experiment with different types of lights and modify parameters to see the difference. We often take lighting for granted but lighting plays a vital role in our physical world. In the world of 3D, we have to set up lights to simulate our world. It is a daunting task, but it makes computer rendering interesting and challenging.

Lighting Concept

Setting up lighting in AutoCAD is similar to setting up lighting in a stage or a photographic studio. The stage lighting of a traditional theater simulates the reality of the world in a limited stage space. In a short period of time and a flat stage, it creates convincing spaces of the play. The stage brings the audience closer to the story. In a photographic studio, the photographer has to set up lights to depict the story of the subject with or without a background. In rendering, the lighting is crucial to the presentation of the image. The brightness, contrast, and color of the lights can tell the viewer a lot more about your rendering. Before you set up lights, ask yourself the following questions:

- What is the time and day of my rendering?
- What kind of atmosphere do I want to create (a rainy day, a cloudy day?) This can be a very important question because it can help you plan a strategy for your lighting.
- What is the story behind my rendering? It is OK, if you don't have a story for your image yet. You can always make up a story for your rendering because later it will help you to conceptualize your lighting scenario.
- What kind of lights do I have in my rendering – direct light (sunlight) or indirect light (diffuse light)?

These questions should be thought out in the initial stage before you do any rendering. The time and day of your rendering will make you decide the angle, colour, and intensity of your lights. An early morning sun will cast a different shade, shadow, and colour than a late afternoon sun. We will take a closer look at how to simulate these conditions in the next section. The atmosphere of your scene can help you better plan your lighting. A rendering of a Gothic church is very different from a rendering of a modem house in terms of lighting. In a Gothic church, the atmosphere of awe reflects the presence of God, and the windows emit low, diffuse rays of sunlight. In a quite different scene, a modern house needs to embrace the warm sentiment of greeting. Everything needs a story or concept behind it, whether it is a photograph, a design, a painting or a rendering. What do you want to tell the viewer about your image? An image without a concept or a story is like a cat without its night vision eyes – soulless.

Direct Light and Indirect Light

The insight of a space is defined by the illumination of the sun or artificial lights through how it is perceived. When light reflects off walls, floors, and ceilings, it is called diffused light or indirect light. Most of the light we see in an interior room is indirect light. Direct light is most often sunlight and is also known as natural light. Sunlight is usually sharp, luminous and passive on a sunny day. It can change its quality according to the time of day, the weather, and the season. Diffuse light comes from many directions and from many sources and bounces off multiple surfaces. It produces uniform illumination with soft shadows. The colour of an object will reflect and be absorbed by surrounding surfaces. For example, if a light strikes a red object next to a white wall, it will bounce some red colour onto the white wall. This process can often be simulated in a radiosity calculation, but not every 3D program has this capability. A fake radiosity technique can be used to make up for the absence of a radiosity program. You are advised to lay out your lighting plan with lighting fixtures. Do not render a scene where the light comes from nowhere, especially not an interior one. I often refer to this type of light as ghost light – it comes from nowhere and goes nowhere. Setting up lighting is an important process in computer rendering, and it should be done vigilantly.

Directing Your Lights

Most people tend to look at the brightest area of an image, its focus area. If you direct your lights well, you can hide an incomplete model or difficulties in a model's texture. Most beginners in rendering can determine whether an image is illuminated, but fail to detect an over-illuminated image. This is my explanation of why many AutoCAD renderings are over-illuminated. Anyway, both images that are too dark and images that are too bright should be limited to achieve balance. Consequently, ambient lights should be kept at the default level, because they tend to light up your entire scene uniformly, disrupting your ability to select individual areas to illuminate.

Key and Fill lights

The principle of the key/fill approach is that the key light is used as the primary source to light up a scene, and the fill light is used to fill the dark area left by the key light. A key light is the main light, the brightest. Fill light is much dimmer, and it softens shadows and adds colour and depth left by the key light. More variations involve complex multiple lights. For an outdoor scene, the sun or a distant light is the key light, and there will be multiple fill lights (both spotlight and point light) to add color, depth, and subtleness to the scene. In an interior scene, the spotlight is one of the key lights, and the fill lights will fill up the darkness of the rest of the scene. For a simple scene, you can use the three-lights principle. This is especially effective when you have a main object with a simple background. To add more realism to your rendering, multiple lights can be used to achieve better results. Two front lights and a backlight will be used to effectively illuminate the scene. In digital rendering, you might need at least five light sources – one top light, one backlight, two sidelights, and a front light. One will be named a key light, and the rest of the lights will be filler lights. These principles are revealed by Stanley McCandless in A Method of Lighting the Stage.

Light is perceived as white colour, but in real life it is hardly white. Little as you may believe it, it comes in different colours. It is not a bad idea to add some colour to enhance your image. Adding a little colour to your lights will dramatically add life to your scene. Colour can also give mood to your rendered scene, and it can also mark subtle time differences (for example, between morning and sunset). Early morning light tends to be yellowish, and sunset light tends to be orange.

Composing an interesting scene with effective lighting will greatly add extra realism to your presentation. Lights are required in your 3D rendering. To avoid light coming from nowhere,

you must model a lighting fixture when you are in an interior hall that requires artificial lighting. One way to learn about lighting is to learn from real life. Pay attention to lighting in your room with your desk lamp on, or when you are walking in your neighbourhood park in the sunset. A careful lighting plan will help you to achieve the effect that you want to create in your rendering.