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Architectural Rendering with 3ds Max and V-Ray

Photorealistic Visualization

ROUTLEDGE

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Contents

Supplementary Resources Disclaimer

Additional resources were previously made available for this title on CD. However, as CD has become a less accessible format, all resources have been moved to a more convenient online download option.

You can find these resources available here: www.routledge.com/9781138400757

Please note: Where this title mentions the associated disc, please use the downloadable resources instead.

CHAPTER 1

Introduction and Theory

Preface

We are glad that you have decided to purchase this book on architectural renderings with 3ds Max and V-Ray. We hope that you will enjoy reading the book and the opportunity to learn new things while working through the lessons. We trust that you will be able to apply this information in your future projects. The book is divided into six chapters. The first chapter focuses on theoretical knowledge. The information provided in this section spans a range, from light in real life via computer graphics to its significance in architecture. We will discuss sources of light specific to V-Ray, as well as materials and cameras. Different render algorithms and their advantages and disadvantages will be introduced. The other five chapters show you how to proceed with 3D Studio Max and V-Ray, workshop-style. Architectural scenes and lighting scenarios are described, from opening the file to the final rendering settings. We decided to use V-Ray as the rendering plug-in, because it is a very fast, high-quality renderer and is available for all commonly used 3D software solutions.

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V-Ray is now available for Cinema 4D, SketchUp, Rhinoceros, and 3ds Max, to name a few. There is also a current beta version of V-Ray for Maya. The parameters and theories that the settings are based on are the same in all applications, which makes this book interesting for many users, not just users of 3ds Max.

Have fun and enjoy working with V-Ray!

Acknowledgments

From Markus

I want to thank my family and my wonderful fiancé Rili, who always supported me. I also want to thank the team at ScanlineVFX for allowing me to learn so much and being able to see new tricks there.

From Enrico

I am grateful to my family for their moral support. To them and to my closest friends, I owe thanks for being so understanding about how I was able to spend so little time with them. My good friend Anja deserves special mention for her great support in every respect during the last few weeks before completion.

I owe special thanks to Dr. Marcus Kalusche of archlab.de, who always supported me and provided valuable advice. Many thanks also to our technical editor Florian Trüstedt. He readily supported us with his technical expertise. We also wish to thank our publishing editor at Pearson, Brigitte Bauer-Schiewek, for assisting us throughout the creation of this book.

Who Is This Book Intended For?

The book is mainly intended for computer graphics artists, enthusiastic users, and students of all disciplines who want to present their drafts, products, and ideas in three dimensions. Primarily, it obviously addresses students of architecture and interior design, where ideas are often conveyed through the medium of renderings. Furthermore, this book is meant to offer experienced architects and creative people access to the world of three-dimensional computer graphics. We hope to accomplish this through clear and straightforward presentation of the basics and by offering various problem-solving strategies as well as helpful tips for daily production tasks. You should already have a basic understanding of the user interface and operation of 3ds Max. As we focus primarily on light, materials, and settings for V-Ray rendering, it would be beyond the scope of this book to explain the basic elements of 3ds Max. It would also be helpful if you have previous experience with AutoCAD. Some of the models on which the scenes are based have been constructed in AutoCAD and are linked with 3ds Max. Here, emphasis is placed on using AutoCAD layers.

Basics of Architectural Visualization

The primary purpose of every picture is to impart an idea, concept, or draft. Sketches and templates for image formation are not necessarily required but can be very helpful. In architectural visualizations, photorealistic pictures are not in great demand. Instead, abstracted renderings are sought after in order to elaborate the idea and eliminate unimportant elements. Good communication with your client is therefore very important: you have to be speaking the same language, so to speak. It is also helpful to have a certain amount of background knowledge about your client's trade.

More concrete basics are a three-dimensional, digital model, reference photos of the surroundings, and materials or even mood pictures. You should build a well-structured database of fixtures and fittings, textures, background images, and other accessories. This database will grow rather large over time, so it needs to be properly arranged.

We do not want to comment in great detail on technical equipment, as it constantly needs to be updated. We recommend that you have at least two computers. One should be a workstation with an up-to-date, powerful processor; a lot of RAM; a good graphics card; and two monitors. Ideally, one monitor should be at least 24 inches (diagonally) to allow comfortable working. You are going to be working on this computer, while the other one calculates your pictures. The second computer does not require a powerful graphics card or monitors. If possible, you should use processors of the same type.

In addition to your knowledge and your equipment, you will need a lot of patience and of course a great deal of inspiration for creative computer work.

Considerations Regarding Light

In this section, we are going to approach the topic of light from three angles: its observation in real life, its translation within computer graphics, and its significance in architecture.

Light in the Real World

Perception and Mood

First, it must be said that the topic of "light" is far too complex for us to sufficiently explore here. We are going to comment on only a few aspects regarding atmosphere and phenomenology.

In everyday life, we rarely think about light in the real world, although it is present everywhere. But we are so used to the conditions of reality that we notice immediately if something is not real. Consequently, we would almost always notice a difference between a computer-generated picture and a photograph. This is mainly due to differences or errors in computer-generated presentations of light. Almost anyone can notice that these diverge from reality, but only a trained eye can actually specify the differences.

Light has a subconscious influence on our feelings; it can stimulate emotions and create atmosphere. For example, when we are watching a sunset, we might feel romantic. Depending on its color, light can have a calming effect or make us feel uncomfortable. Think of the difference between warm candlelight and a corridor with the cold light from fluorescent tubes. Creating moods therefore requires conscious and deliberate observation of our surroundings.

In the real world, there are three lighting scenarios. The first one is natural light, which means sunlight shining directly or indirectly onto Earth, such as moonlight or through a layer of clouds. Natural and weather phenomena provide an exception—for example, lightning and fire. The second scenario is artificial light: any light that is not of natural origin, but manmade. This includes electric light, but also candlelight. The third and most common scenario is a simultaneous occurrence of both natural and artificial light.

One of the first discussions you should therefore have with your client is determining which of these scenarios is present in the picture you are going to create.

Some units of measurement in dealing with light:

- *Luminous flux (lumen):* Describes the radiated output of a light source per second
- *Luminous intensity (candela):* Describes the luminous flux which is emitted in a certain direction
- *Illuminance (lux):* Describes the luminous flux which arrives at a certain surface
- *Luminance (candelas per square meter):* Describes the luminous flux which is emitted from a certain surface

Illuminance

Light is subject to a series of rules. Three of these are of great importance in computer graphics. The first rule is that the illuminance decreases with the square of the distance from the light source. This means that a surface of one meter square that is one meter away from the light source is illuminated with the full assumed luminous intensity of the light source. If you increase the distance by another meter so that it is now two meters, the illuminance is only a quarter of the luminous intensity. At a distance of three meters, the illuminance is only a ninth of the luminous intensity. The luminous intensity always remains constant.

The two other important qualities are the reflection and refraction of light. If light hits a surface, a certain amount of it is absorbed and the

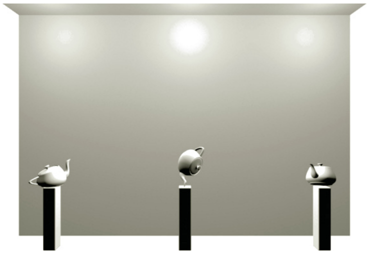

FIG 1.1 Light Source without Decrease in Illuminance.

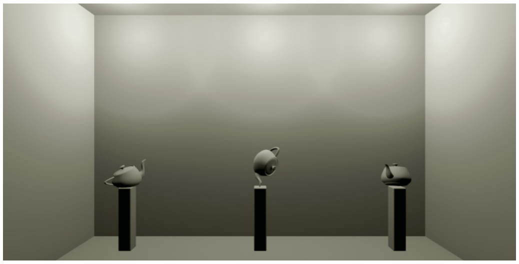

FIG 1.2 Light Source with Natural Decrease in Illuminance.

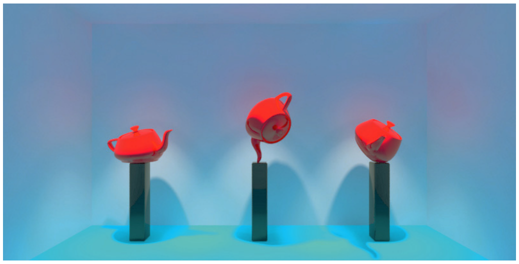

FIG 1.3 The Blue Floor Makes the Entire Scene Look Blue.

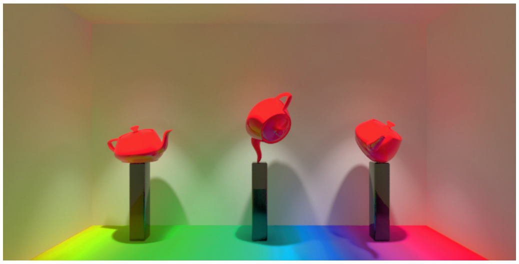

FIG 1.4 The Multicolored Floor Affects the Coloration of the Surrounding Objects, Depending on its Surface Color.

rest reflected. The reflected part is the determining factor that enables us to perceive objects. An object that absorbs 100 percent of light appears completely black to us. White surfaces reflect most of the light. The darker and rougher the surface, the less light it will reflect and the more it will absorb. An object always reflects light in its object color, which can lead to what is called *color bleeding*, or the bleeding or overlapping of colors onto other objects.

The refraction of light occurs if light travels through a translucent medium with a different density than that of the medium in which the light was before. Again, the light will take on the color of the material.

Light travels at the speed of light, which is measured inside a vacuum. If the light's speed is decelerated by a change in density, there will be refraction. The refractive index or *index of refraction* (*IOR*) can be determined for each material. It measures how much the speed of light is reduced when passing from air into the medium.

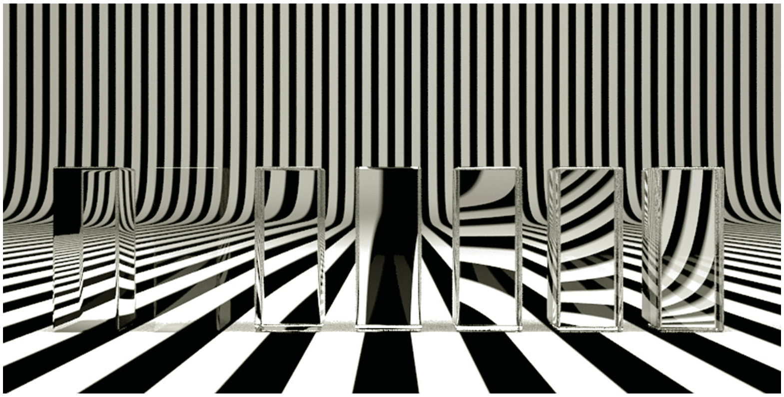

FIG 1.5 Refraction; Glass Cuboids with Varying IOR.

The following table contains some examples.

TABLE 1.1 Overview of Refractive Indices

Medium	IOR	Medium	IOR	Medium	IOR
vacuum	1	quartz	1.46	flint glass	1.56–1.93
air (near the ground)	1	Plexiglas®	1.49	glass	1.45–2.14
plasma	0–1	crown glass	1.46–1.65	lead crystal	Up to 1.93
ice	1.31	polycarbonate	1.59	zircon	1.92
water	1.33	epoxy	1.55–1.63	diamond	2.42

The Color Temperature of Light

The color temperature of light has been measured in Kelvins since William Thompson Kelvin realized that carbon emits different colors depending on its temperature. In blue light, the red and green components of the light source are lower or nonexistent. Under these circumstances, all red and green objects would appear black. When using colored light sources, you therefore need to make sure to always mix a certain proportion of all colors to avoid black objects.

FIG 1.6 Cuboids with the Three Primary Colors and their Combinations, White Light.

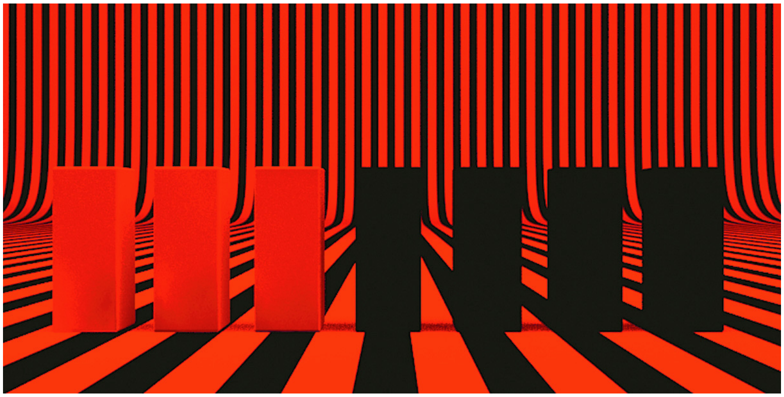

FIG 1.7 The Same Cuboids, Red Light (R:255; G:0; B:0).

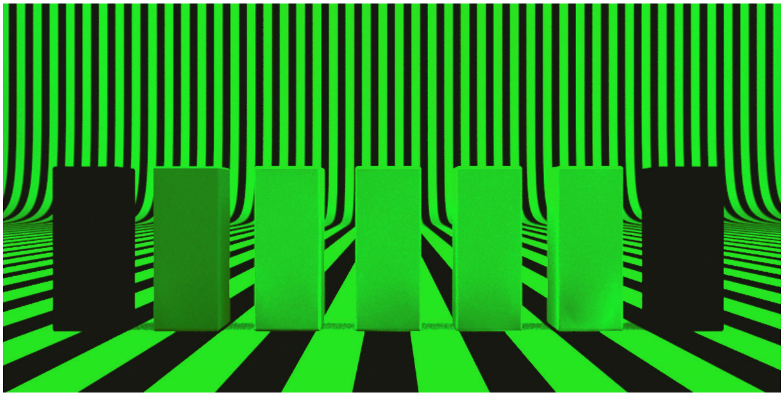

FIG 1.8 Cuboids, Green Light (R:0; G:255; B:0); Here You Can See Clearly that the Green Portion is the Largest in Our Color Spectrum.

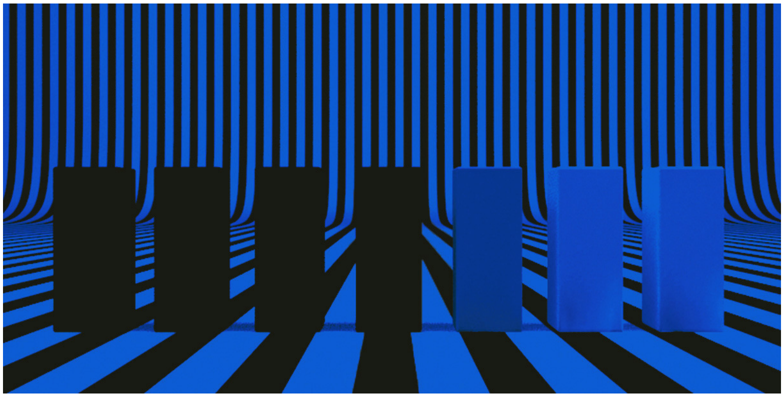

FIG 1.9 The Same Scene, Blue Light (R:0; G:0; G:255).

The following table contains an overview of several color temperatures.

TABLE 1.2 Overview of Color Temperatures

Type of light	Kelvin	Type of light	Kelvin	Type of light	Kelvin
Candle light	up to 1900	Neutral white	5000	Cloudy north sky	6500
Warm white	Up to 3300	Sun at noon (summer)	5100–5400	Daylight white	5000–6800
Light bulbs	2200–3400	Cloudy sky (January)	5900–6400	Blue sky at noon (December)	9900–11500
Fluorescent tubes	Over 3900	Xenon lamp	6500		

Color Temperature and Its Effect

Colored light is very important, for example, to express the time of day. The color of the light in the morning has a different proportion of red than the light of the setting sun. The color of daylight also depends on the place, the time of year, and the weather conditions while you observe it.

Shadow

The shadow being cast is not really a property of the light, but rather a property of illuminated objects. A shadow in itself is the absence of direct light and mostly refers to a diffusely illuminated area. Shadows always appear behind objects that are positioned in front of a light source. The shadow area does not necessarily have to be darker than the directly illuminated area. Transparent objects, for example, also cast a shadow and can even produce lighter shadows, due to a concentration of rays of light or caustics.

Shadows play a very important role: they indicate the position and type of the light source. Without shadow, a picture cannot have any spatial depth.

An object that does not cast a shadow appears unrealistic, as if it were always floating. Parallel shadows do not occur in nature; they can be created only by artificial light.

Light in Computer Graphics

Unlike in the real world, the light in computer graphics is not subject to any restrictions. You therefore have many options and great freedom, but it becomes more difficult to produce realistic illuminated scenes. A watchful eye is required to achieve a rendering that appears realistic. Sometimes one light source is not enough and you have to resort to tricks in order to achieve a result that appears realistic or expresses the desired idea.

Consider possible scenarios of illumination:

- Location of scene, time of year, and time of day
- Indoors, artificial light, sunshine with clear sky
- Indoors, artificial light, cloudy sky
- Indoors, only artificial light
- Exterior view of a building, sunset, artificial light inside

Ask yourself which atmosphere you want to convey:

- Do I want to create a calm atmosphere or a romantic one?
- Do I want to draw to attention to something in particular?
- Is there a reference that I need to integrate my rendering into?

Get an overview of the light sources and their qualities:

- Standard light sources
- Point light, spot light, parallel light
- Create even illumination
- Are not subject to physical laws
- Photometrical light sources
- Point light, plane light
- Are essential for physically correct illumination
- Can be expanded with IES profiles
- Are based on physical units
- Daylight systems
- Even, diffuse lighting (sky) and direct illumination (sun)
- Light-emitting materials
- For representing luminescent, such as neon tubes or monitors
- Render-engine-specific light sources
- Dependent on the render engine used (V-Ray, Mental Ray, Maxwell, Brazil)

These are some tips when working with light:

- Try to work with surrounding light that corresponds to natural light from the sky to light the scene diffusely.
- The main light should always be clearly noticeable.

- Pay more attention to convincing light setup than physical correctness.
- The shadows are as important as the light.
- Become familiar with materials in reality and their physical properties.
- Hardly any material has a completely smooth surface; the irregularities affect the light distribution on the surface.
- Highlights help the viewer to determine the quality and nature of a material, but not all materials have hard highlights.
- No two materials are the same; the differences in surface appearance create a more realistic effect.

Light in Architecture

Light has always played a decisive role in architecture. Light creates atmosphere, can make rooms appear bigger or smaller, and can emphasize details or hide them. The first great buildings that specifically employed light were religious buildings. Initially, they did not let much natural light in, in order to emphasize the few existing windows. The windows seemed to shine, creating a mystical effect.

Light and architecture are closely linked; light presents good architecture favorably, but can also show mistakes. During the day, the light wanders across the façade, constantly giving it a different appearance. Architects have always used this medium, from the old master builders of temples and churches to famous architects of today, such as Tadao Ando, Jean Nouvell, or Louis I. Kahn. Light can also be used as an effect in architecture, such as the Empire State Building, with its varying illumination for different occasions. The use of artificial light is of particular importance in exhibition architecture, whereas daylight plays an important role when constructing domestic buildings.

V-Ray

Let's now turn our attention to the render engine V-Ray. We will begin with some product specifications that convinced us to work with this product; then we will comment on the methods for light calculation and introduce some features specific to V-Ray. Last, we will discuss linear workflow.

Why V-Ray?

Here is a list of the product features that we particularly appreciate during our daily production tasks:

- V-Ray is platform-independent and available for many 3D programs.
- The parameters are the same for the different applications.
- The product is relatively cheap.

- The quality of the pictures is in good proportion to the render time.
- V-Ray is constantly being updated.
- There is a large worldwide community.
- V-Ray is used widely, also in the film and advertising industry.
- It has excellent displacement.
- It supports IES data, an important factor for architectural visualizations.
- Version 3 and later also support Mental Ray materials.
- V-Ray is very well integrated into the 3D programs.

Indirect Illumination

The calculation of indirect illumination in V-Ray is divided into two processes, which can be combined in different ways:

- Primary bounces—The light is emitted from the light source onto the scene until it hits an object. The first complex calculation takes place here, and the light is scattered, absorbed, refracted and reflected.

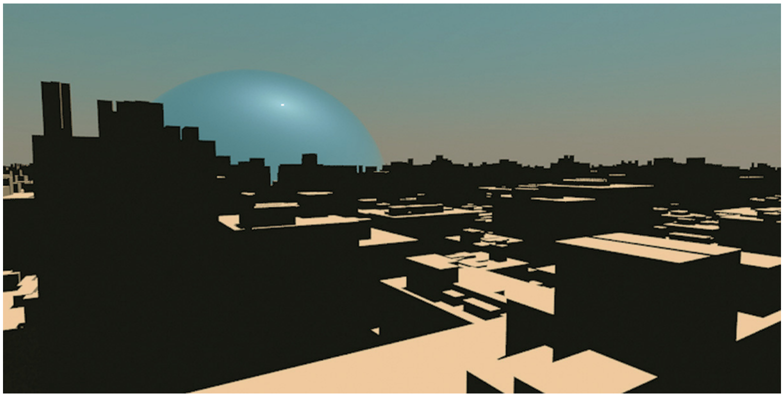

FIG 1.10 Rendering without Global Illumination.

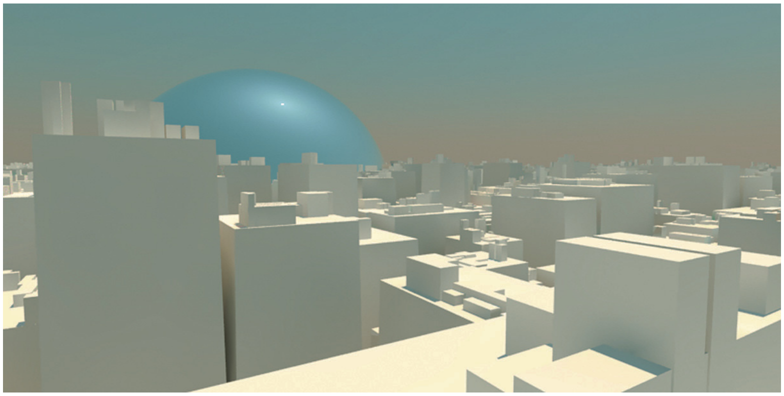

FIG 1.11 Rendering with Global Illumination.

- Secondary bounces—Starting from the point where the primary bounce hits the geometry, the light is spread around the scene once more in this calculation process, achieving diffuse illumination of the scene.

If you did not activate the calculation of global illumination, only the process of primary bounces is applied automatically.

In the following section, we will introduce the various render algorithms with their advantages and disadvantages.

Brute Force

The Brute Force algorithm calculates the GI (global illumination) for each pixel in the picture.

Advantages:

- Few setting options
- Very consistent results
- Reveals even small details
- Only little flickering in animations

Disadvantages:

- Very high render times, especially in complex scenes

Renderings are partly affected by severe noise, especially in darker image areas, which can be remedied only by higher render settings and therefore very long render times.

Irradiance Map

The Irradiance Map algorithm calculates the GI depending on the complexity of the scene with different accuracy. Interpolation takes place between the calculated areas. A multitude of setting options is available and can be managed well with a selection of presets.

Advantages:

- In comparison with the brute force algorithm, this produces shorter rendering times for the same complexity of scene.
- No noise in darker image areas.
- The irradiance map—the result of the calculation—can be saved and reused, which can drastically reduce the render time for animations.

Disadvantages:

- Due to interpolation, fine shadows can be lost in detailed areas.
- Animations can be affected by flickering, which can be remedied by saving the irradiance map as a multiframe incremental map (i.e., provided that the output frame sizes are equal).
- Requires a lot of RAM.