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.

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
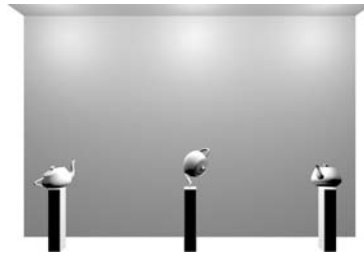
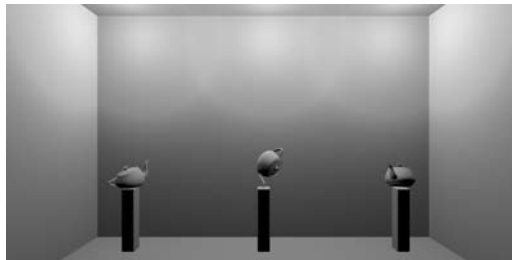**FIG 1.1** Light Source without Decrease in Illuminance.

FIG 1.2 Light Source with Natural Decrease in Illuminance.

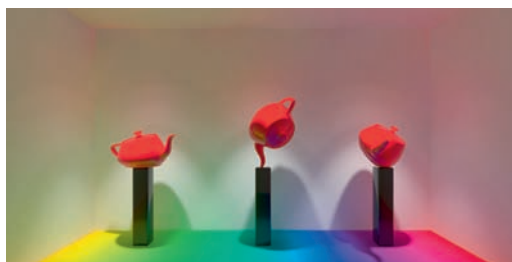**FIG 1.3** The Blue Floor Makes the Entire Scene Look Blue.

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.
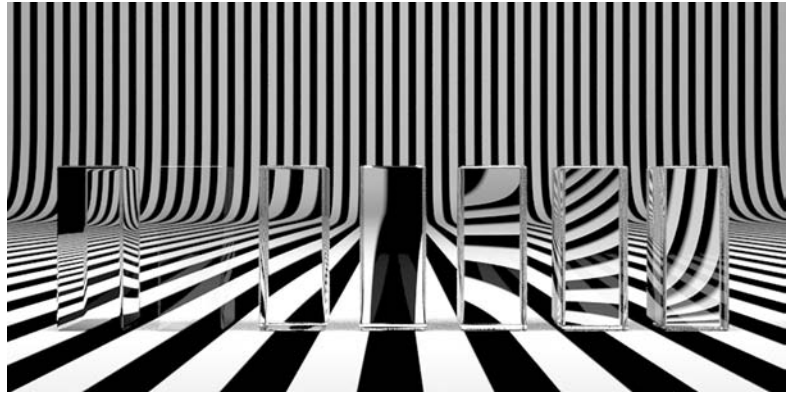
The following table contains some examples.

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.

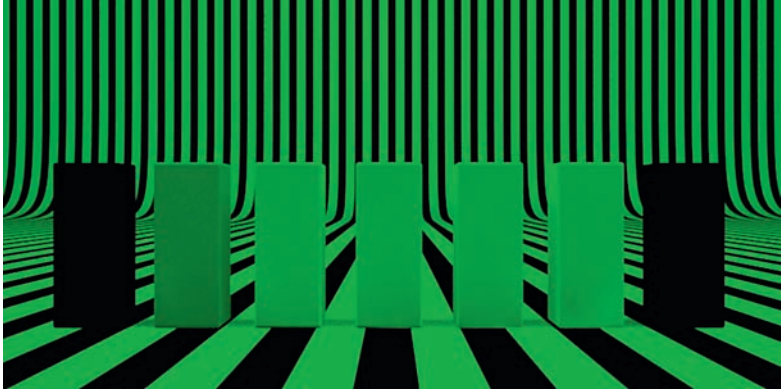**FIG 1.7** The Same Cuboids, Red Light (R:255; G:0; B:0).

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.
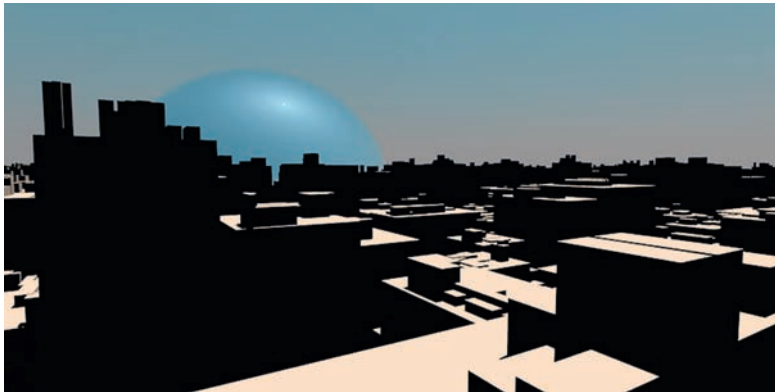
FIG 1.10 Rendering without Global Illumination.
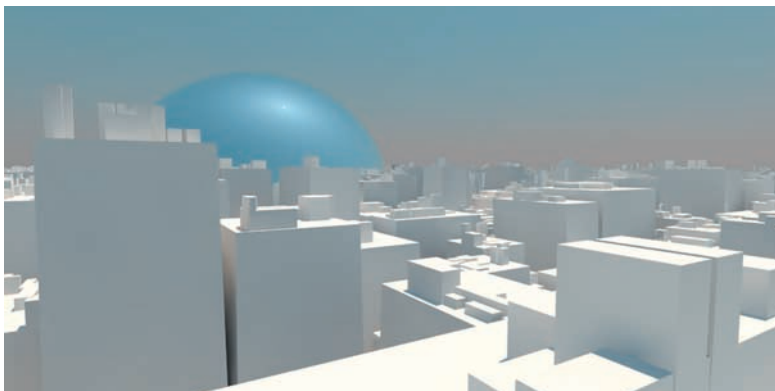
FIG 1.11 Rendering with Global Illumination.

• 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.

- Very complex setting options.
- The light solution is dependent on the location—only the visible portion of the scene is calculated.

Photon Map

For the Photon map algorithm, photons are emitted from all light sources in the scene and then bounced around between objects until their energy is used up. Only true light sources are taken into consideration, not surrounding illumination or luminous materials. The algorithm is useful for interior scenes with many light sources and achieves good results with short rendering times when used in combination with irradiance map.

Advantages:

- Very fast algorithm.
- Location-independent.
- The photon map can be saved, but changes in material, light, and position of objects are not possible.

Disadvantages:

- Very imprecise calculation; usage under primary bounces is not recommended.
- High memory requirements.
- Restrictions in selecting light sources.

Light Cache

This algorithm functions in a similar way to the photon map, but the photons are emitted into the scene from the camera and the algorithm can be used for any kind of scene.

Advantages:

- Simple setup.
- Very quick calculation.
- Very fast, good results in combination with the irradiance map.
- Very precise calculation of contact shadow and shadows in corners.
- Preview during calculation process; therefore, serious mistakes can be spotted quickly.

Disadvantages:

- Location-dependent; has to be recalculated every time.
- Problems in calculating *bump maps*, but this has no effects when used for secondary bounces.

Finally, we would like to offer you some guidance by comparing the most sensible combinations for an interior scene and an outdoor scene. For the first comparison, we refer only to the quality of the result; for the second

comparison, we relate the quality to the rendering time. We are analyzing only stationary images—these comparisons are not necessarily applicable to animations.

Interior Scene

Criteria: Quality

The best quality is produced by a combination of the algorithms Bʀᴜᴛᴇ ꜰᴏʀᴄᴇ (primary bounces) and Lɪɢʜᴛ Cᴀᴄʜᴇ (secondary bounces). Hardly any artifacts occur, and even in detailed image areas, the accuracy remains high. A clear disadvantage, however, is the long rendering time.

Criteria: Time invested in relation to quality

In this case, we recommend a combination of Iʀʀᴀᴅɪᴀɴᴄᴇ ᴍᴀᴘ (Pʀɪᴍᴀʀʏ ʙᴏᴜɴᴄᴇꜱ) and Lɪɢʜᴛ Cᴀᴄʜᴇ (Sᴇᴄᴏɴᴅᴀʀʏ ʙᴏᴜɴᴄᴇꜱ). The calculation is very quick and exact, even in detailed image areas. Possible errors can usually be fixed by selecting a better preset. This combination is the better choice for everyday work.

Exterior Scene

For the exterior scene, the same applies as for the interior scene. The calculation can potentially take even longer in this case, as the scene has a higher number of polygons due to trees, bushes, and lawn, and therefore more detailed areas.

We can therefore conclude that the combination of Iʀʀᴀᴅɪᴀɴᴄᴇ ᴍᴀᴘ and Lɪɢʜᴛ Cᴀᴄʜᴇ is the most appropriate. As there is an exception to every rule and sometimes the rendering time is irrelevant, you should not completely disregard the other algorithms.

Ambient Occlusion

In areas where two or more objects are touching, there is insufficient light, and these areas appear darker in comparison to the surroundings. These darker areas are called *contact shadows* (*ambient occlusion* or *AO*). Ambient occlusion is always calculated without direct light, and with only a diffuse surrounding light. In V-Ray, there are several options for calculating the ambient occlusion. For example, you can output it as a separate rendering channel, resulting in a grayscale image. In an image editing program, you can multiply this image with the actual rendering. Only certain image areas are darkened, as the image consists of color values between one and zero. In this book, we use a VRᴀʏDɪʀᴛ material for objects that are to have a contact shadow. In this case, the ambient occlusion is already saved in the output image. As you can adapt the parameters for each material, you have good control over the contact shadow.
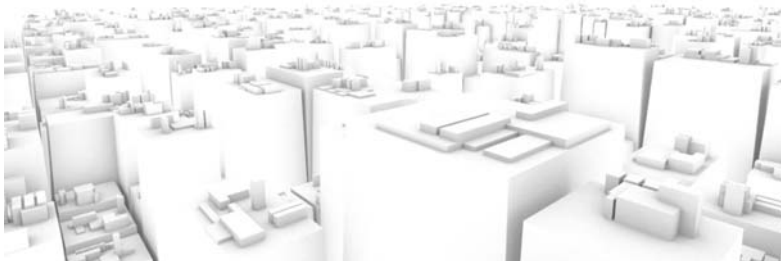
FIG 1.12 Ambient Occlusion Channel.

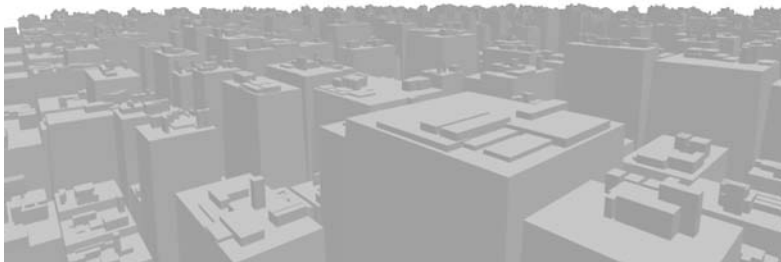FIG 1.13 Diffuse Channel, Rendered without a Light Source.



FIG 1.14 Result of Overlaying Both Channels.

VRayLight

Using V-Ray light sources (VRayLights) is the best choice when working with V-Ray. These light sources behave with physical correctness. Unlike standard light sources, the light is emitted by a three-dimensional source, not by one point. VRayLights require shorter rendering times, have integrated falloff as the standard, and always produce a realistic-looking area shadow. There is a choice of four light sources:

1. Plane
   • The light is emitted by an area (i.e., from the light flux direction of the plane object only).
   • The bigger the light source, the more light is emitted and the softer the shadows it produces.

FIG 1.15 VRayLight, Type Plane.
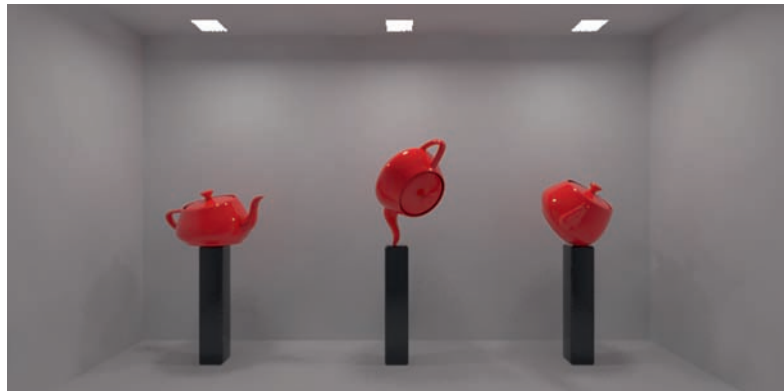
2. Sphere
   • The light is emitted by a three-dimensional sphere.
   • The bigger the light source, the more light is emitted and the softer the shadows it produces.

FIG 1.16 VRayLight, Type Sphere.
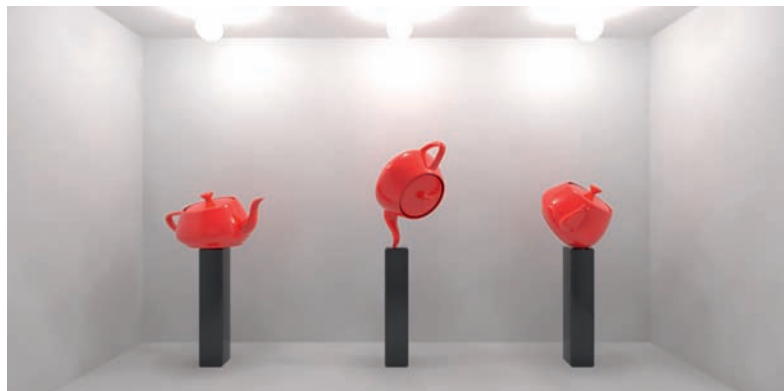
3. Mesh
- The light source can be linked to a three-dimensional object and emits light from its geometry.
- The bigger the light source (the object), the more light is emitted and the softer the shadows it produces.

FIG 1.17 VRayLight, Type Mesh.

4. Dome
- The light is emitted evenly into the scene in order to achieve diffuse illumination without applying GI, especially for exterior visualizations.
- The position and size of the light source have no effect; it should not be rotated in direction x or y.
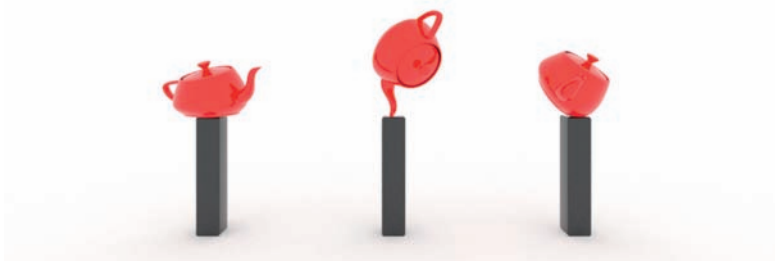
FIG 1.18 VRayLight, Type Dome.
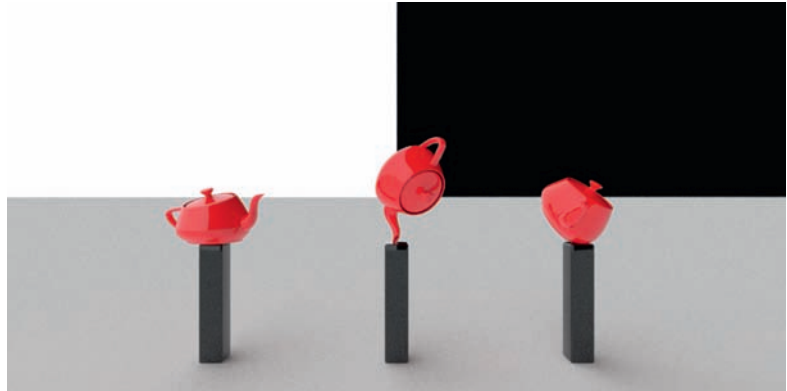
The V-Ray light sources have almost the same parameters as standard light sources. A big difference is the option to be able to work with different units of light intensity. Here is an overview of these units:

- Default (image)
    - No relation to physical values; this is based on the multiplication system internal to 3ds Max.
    - Light intensity and shadows depend on size of light source.
- Luminous power (lm)
    - Is measured in lumen (luminous flux).
    - Physically correct unit, size of light source has no impact.
- Luminance (lm/m^2)
    - Physically correct values for light intensity can be looked up in catalogs provided by lighting manufacturers.
    - The size of the light source has decisive impact.
- Radiant power (W)
    - Measured in watts, describes the total energy that is emitted from a light source.
    - During application, it is important to remember that a light-bulb, for example, transforms most of its energy into heat, which means the value of 100 watts for a lightbulb cannot be directly transferred.
    - The size of the light source has no impact.
- Radiance (W/sr/m^2)
    - Indicates the total energy of a light source per solid angle per square meter.
    - The size of the light source influences the total energy emitted by the light source.

VRayIES

Companies that produce luminaires and lamps can provide so-called IES files. These enable you to simulate real luminaires with physical correctness. Their behavior corresponds to a three-dimensional object that emits light,

just as in reality. The emission properties of the lamps and the effects of built-in reflectors are taken into account. The light distribution within the room and on the walls appears more realistic than using standard light sources. It is important to activate the option Use Light Shape in order to calculate soft shadows as they appear when using a three-dimensional light source in reality. The rendering time is longer, but this is compensated for by increased realism.

FIG 1.20 VRayIES, IES File by Company Erco.

VRaySun

The VRaySun is a V-Ray-specific light source, and its way of functioning differs from that of other light sources. It simulates a daylight system, composed of sun (direct light) and sky (diffuse light). When creating a VRaySun, a VRaySky shader is automatically placed into the channel of the environment map. The VRaySun has the same intensity as the real sun. The color and the light intensity of the VRaySun are determined by its position, just as with the real sun.

FIG 1.21 VRaySun, Time 06:00.

FIG 1.22 VRaySun, Time 08:00.

FIG 1.23 VRaySun, Time 10:00.

FIG 1.24 VRaySun, Time 12:00.

FIG 1.25 VRaySun, Time 14:00.

FIG 1.26 VRaySun, Time 16:00.

FIG 1.27 VRaySun, Time 18:00.

FIG 1.28 VRaySun, Time 20:00.

For example, the lower the sun, the softer the shadows. In this respect, the value Intensity Multiplier —which sets the intensity—cannot be compared to other light sources. There are two possibilities of working with the sun system. For one, you can set the intensity in the multiplier to *0.001* in order to be able to use it with other light sources without exposure compensation. This is not recommended, however, as the result is not physically correct. The better method is using the physical camera, VRayPhysicalCam.

FIG 1.29 VRaySun, without VRayPhysicalCam.

Here is a brief introduction to the main parameters of VRaySun:

- Turbidity
  - Haziness, degree of air pollution
  - The higher the value, the lower the amount of sun that gets through, the softer the shadows become, and the redder the picture is tinged.
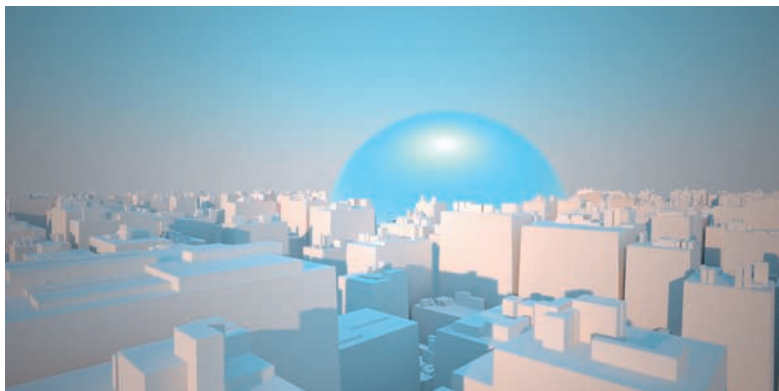
FIG 1.30 VRaySun, with VRayPhysicalCam.
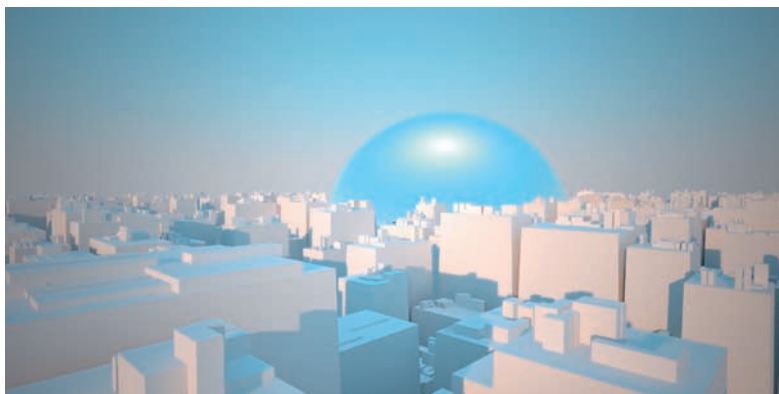
FIG 1.31 Turbidity 3.

FIG 1.32 Turbidity 10.

- Ozone
  - Affects the color of the light, yellow for a value around *0,* blue for a value near *1*
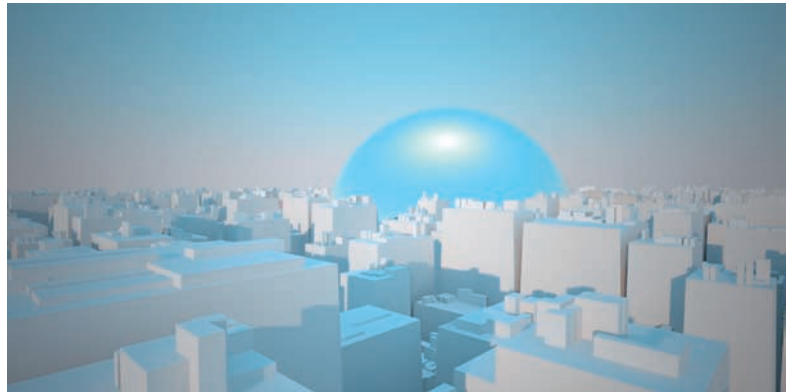
- Intensity multiplier
  - Light intensity of the sun, the value *1.0* is physically correct, but only to be used in combination with the VRayPhysicalCam.
- Size multiplier
  - Affects the size of the sun.
  - The larger the sun, the softer the resulting shadows.
  - We recommend values between *0.5* and *5*.
- Shadow subdivs
  - The higher the value, the better the resolution of the shadows and the quality, but the rendering time will also be longer.
  - We recommend values between *8* and *64*, depending on distance between observer and shadow.
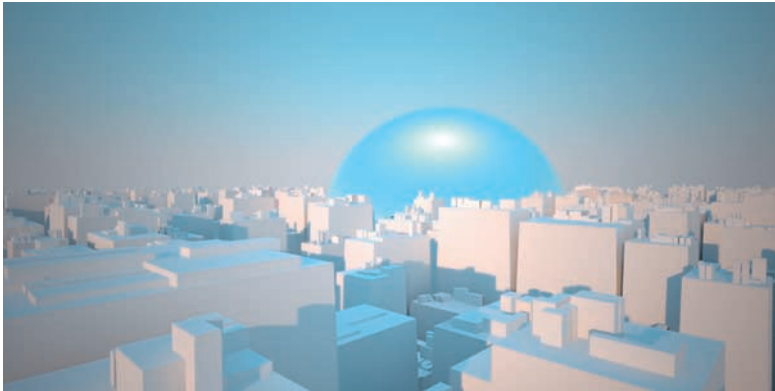
FIG 1.35 Size Multiplier 1.
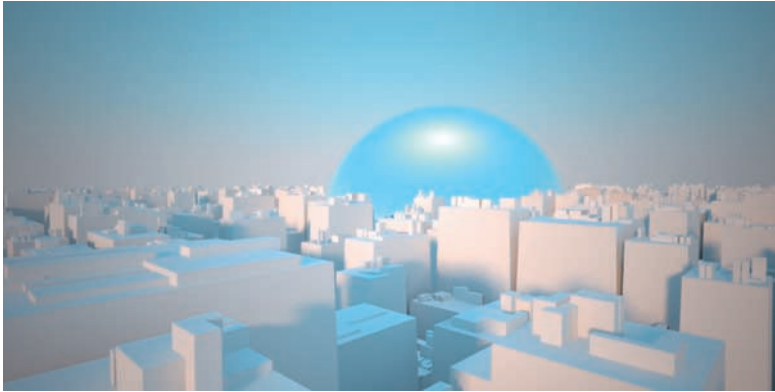
FIG 1.36 Size Multiplier 10.

- Shadow bias
  - Moving an object's shadow away from the object.
  - Values below *0* move the shadow away from the object; values above *0* pull the shadow closer to the object.
  - Choose values slightly above *0* in order to obtain realistic results and avoid errors in calculation.
- Photon emit radius
  - Within this radius, photons are emitted that can be used for calculating caustics.

VRaySky

VRaySky offers the same setting options as the sun and is by default linked to the sun. It influences the diffuse light incidence within the scene. The shader with which the parameters can be set is located in the Environment Map channel in the Environment and Effects dialog box. The sky can therefore be accessed independently from the sun's position, and each can be adjusted on its own by enabling the manual sun node function.

FIG 1.37 Rendering with Sky and Sun Linked.
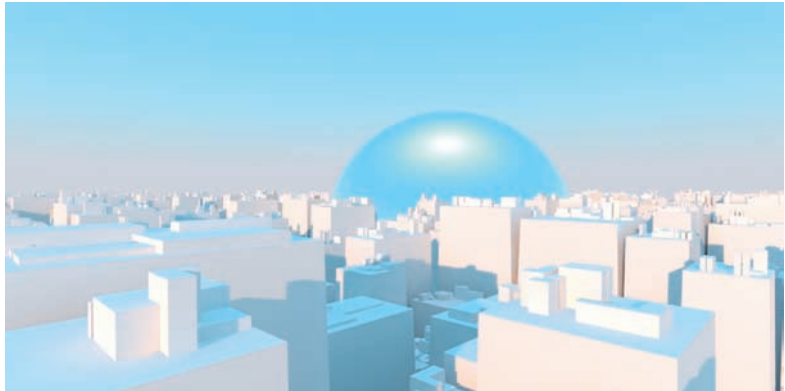
FIG 1.38 Rendering with Separate Sky; the Shadows Remain the Same, but the Sky's Ambient Light Changes.
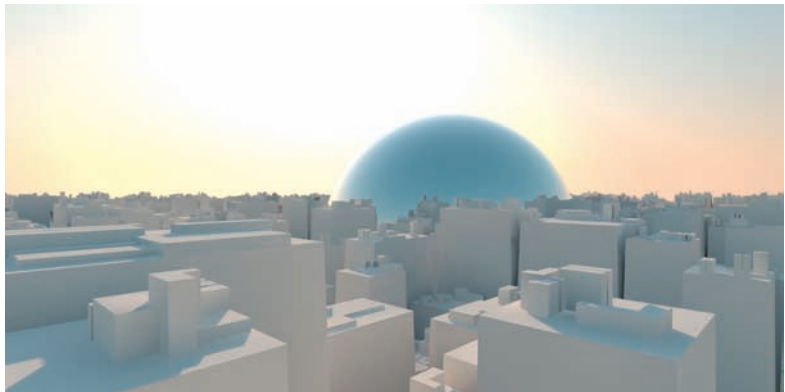
Here we offer a brief overview of the advantages and disadvantages of VRAYSUN and VRAYSKY (the daylight system).

Advantages:

- Easy to set up and modify.
- Good results with little effort.
- Physically correct.
- Well suited for daylight situations.

Disadvantages:

- Longer rendering times in comparison with standard light sources.
- Limited adjustment options.
- Additional light sources in the scene have to work with photometrical data.
- Working with VRAYPHYSICALCAM requires knowledge of photography.

VRayPhysicalCam

The application of the VRAYPHYSICALCAM enables working in V-Ray with physically correct values. In combination with VRAYSUN and VRAYSKY, it can be used to perfection. Using physically correct light sources is a requirement. The advantages in comparison to the standard camera are physically correct calculation of depth of field blur, motion blur, and bokeh effect (explained later in this section). The parameters, such as the exposure time, are equivalent to those of a real camera. The disadvantage is a comparatively long rendering time.

Here once again an overview of the most important parameters.

Basic Parameters
- Type
  - Selection of different camera types, camera (STILL CAM), film camera (MOVIE CAM), digital video camera (VIDEO CAM).
  - Affects aperture and therefore appearance of blur.
- Targeted
  - If activated, the camera has a target point.
  - Very helpful for working with depth of field blur.
- Filmgate (mm)
  - The camera's sensor size.
  - Important for matching the camera to the photograph (camera match).
- Focal length (mm)
  - The camera's focal length.
- Zoom factor
  - The camera's zoom factor.
- F-number
  - Relative aperture of the camera, analog to photography.
  - Affects brightness if the EXPOSURE option is activated.
  - Affects depth of field blur.
- Guess vert./Guess horiz. shift
  - Camera correction, removes perspective distortion; at times you may have to tweak its parameters.
- Exposure
  - If activated, parameters such as F-NUMBER, FILM SPEED (ISO) affect the image brightness.
  - If deactivated, the camera behaves like a standard camera except for DISTORTION, MOTION BLUR, and DEPTH-OF-FIELD.
- Vignetting
  - Simulation of the reduction of the image brightness in the periphery when using a real lens.
- White balance
  - Regulates the white balance.
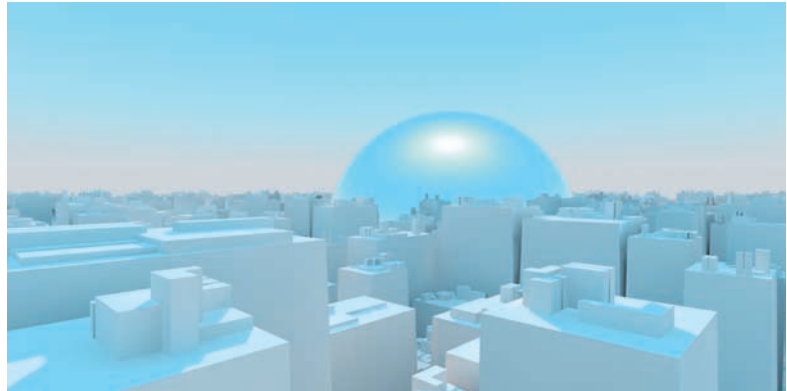
FIG 1.39 Rendering, without Vignetting.

FIG 1.40 Rendering, with Vignetting.
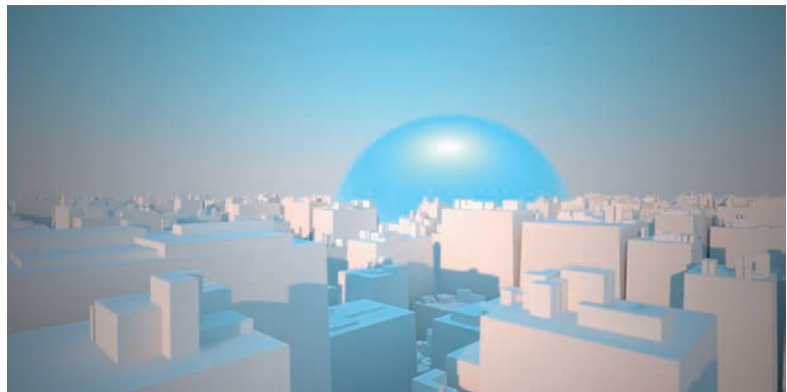

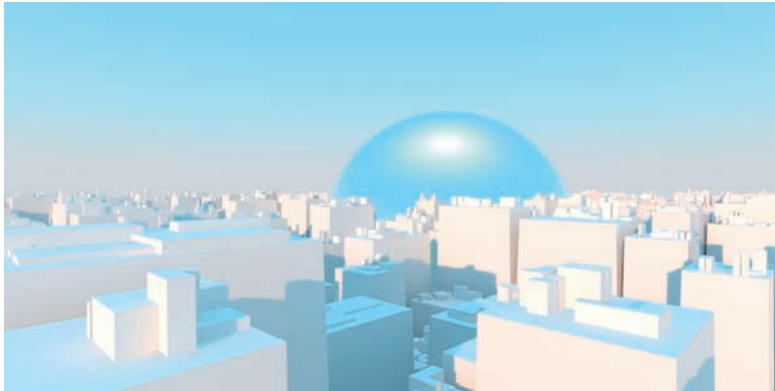**FIG 1.41** Neutral White Balance.

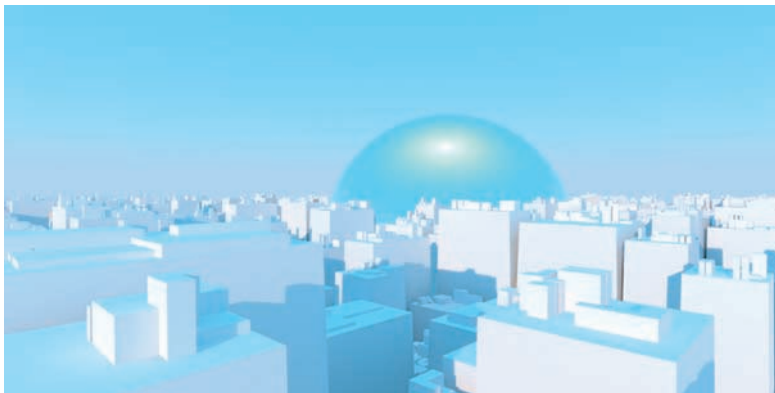**FIG 1.42** Daylight, Optimized White Balance.

FIG 1.43 User-Defined White Balance.

- Shutter speed
  - Exposure time or shutter speed, analog to photography.
  - Values are given in s^{-1}: the higher the value, the shorter the exposure time and the darker the picture.
- Shutter offset
  - Direction of the motion blur when using a Movie Cam.
- Latency
  - Latency, influences motion blur when using the Video Cam.
- Film speed (ISO)
  - Simulates the light sensitivity of an analog film.
  - The higher the value, the more light-sensitive the film and the lighter the image.

Bokeh Effects

The term *bokeh* describes the appearance or quality of blurred areas in a photo. It depends on the lens used; for example, blurred image areas appear softer if the aperture has many sides. The effect only applies if Depth of Field is activated, and it is very calculation intensive.

- Blades
  - Number of blades of the aperture. If the option is deactivated, a circular blur is calculated; if activated, the blur appears polygonal, depending on the number of blades.
- Rotation (deg)
  - Alignment of blades.
- Center bias
  - Determines which areas of the blur appear lighter. Values above *0* make the outside appear brighter.
- Anisotropy
  - Simulation of amorphous lenses, the bokeh is stretched horizontally or vertically.

Sampling
- Depth of field
  - Activates the depth of field blur.

FIG 1.44 Depth of Field Blur with Near Focus.
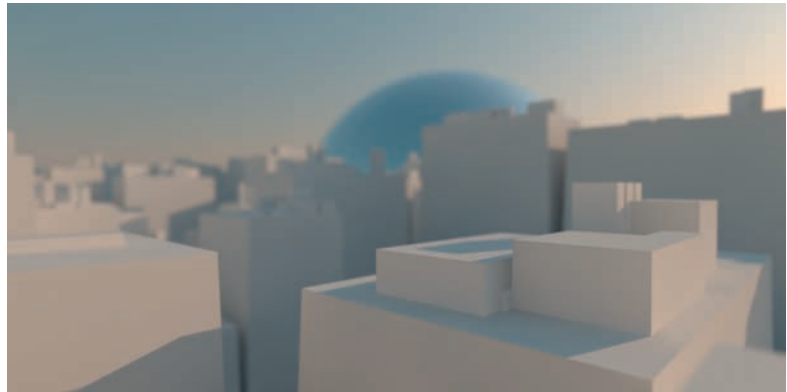
FIG 1.45 Depth of Field Blur with Focus Far Away.
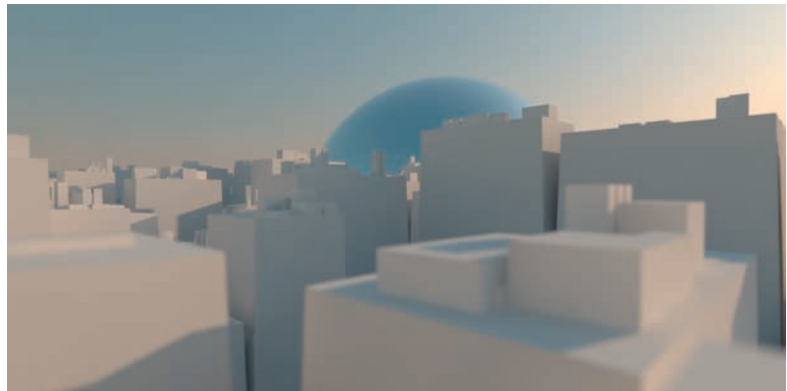
- • Motion blur
  - • Activates the depth of field blur.
- • Subdivs
  - • Determines the amount of subdivision during calculation, also referred to as *resolution*.
  - • The higher the value, the higher the quality of the effects and the bigger the expenditure of time required for the calculation.

V-Ray Materials

In this section, we discuss the V-Ray materials. These are installed together with the plug-ins and are naturally optimized for V-Ray.

VRayMtl

The advantage of this material is that it has been optimized for the renderer and therefore enables it to calculate a physically correct result. It behaves physically correct with regard to absorption, reflection, and refraction of light. The material is based closely on the standard material and has similar parameters. For example, within the material you can set and change the diffuse color channel, the reflection, refraction, bump mapping, displacement mapping, and other qualities of the desired material. If possible, you should work with this material, as it has been optimized for V-Ray, and—if used in combination with V-Ray—it requires less time for rendering than other materials.

VRay2SidedMtl

The VRRAY2SIDEDMTL enables creating translucent materials. Amongst other things, it is suited very well for the representation of leaves, curtains, and paper screens.

VRayOverrideMtl

The VRAYOVERRIDEMTL enables you to override certain behaviors such as global illumination (GI), reflection, refraction, and shadow of a material independently from one another.

VRayLightMtl

With the VRAYLIGHTMTL, you can create self-luminous objects. Unlike a light source, the material does not emit photons and does not create caustics. The rendering time is shorter than if using a standard material with self-illumination, and it can be used to illuminate a scene. In combination with a VRAYDIRT map, you can create an ambient occlusion channel very easily. The material cannot be used if you are working with motion blur.

VRayMtlWrapper

This material applies the V-Ray Object Properties to a material. You can create matte objects via materials already present in the scene.

VRayFastSSS

With this material, you can simulate the so-called subsurface scattering surface effect. The light within an object is transported on to the object. Materials such as wax or skin have this property. The VRayFastSSS material has a shorter rendering time and can be controlled easily.

VRayFastSSS2

This material is also used primarily for the simulation of skin, marble, and wax-like structures. It has more parameters than the VRayFastSSS material. You can use it for example to influence reflection and shine.

VRayBlendMtl

This material offers the option of placing several materials on top of one another, to blend them. In each case, you can choose another material for masking. The rendering time is shorter than with 3ds Max standard materials such as Shellac, Blend, or Composite. This material is used for creating complex surfaces, such as car paint.

VRaySimbiontMtl

This is a special material that you can use with procedural shaders by the company Darkling Simulations. It enables you to create very complex shaders that are built completely procedurally and represented in full quality, independently from the representation distance.

V-Ray Image Sampler (Antialiasing)

"Sampling" here refers to the sampling or resolution of an image. It influences the relation between sharpness of edges and avoiding aliasing (jaggies, or stair-like lines instead of smooth lines).

Antialiasing

Antialiasing is used to reduce aliasing when converting a vector graphic into a raster picture. This method is usually achieved with smoothing of edges and occurs mostly with angled lines. In V-Ray there are two methods of antialiasing. We are going to give you a brief introduction to both.

Oversampling (Supersampling)

A rendering consists of several pixels created when converting the vector-based graphic to a raster image. The number of pixels determines

the resolution of an image and therefore its quality. Each pixel can again be subdivided into subpixels. The number of subpixels is the square of the number of subdivisions. For example, with a subdivision of 1, the pixel is divided once. There is only one subpixel. With a subdivision of 2, the pixel is divided into 4 subpixels. The finer the subdivision into several subpixels, the higher the resolution and therefore the quality of antialiasing. However, the required rendering time also increases sharply.

Undersampling

In undersampling, the opposite occurs. Pixels are not subdivided, but combined. Again, the relation is square. To keep the required rendering time low, this method is suitable for preview renderings.

V-Ray offers three antialias algorithms. Oversampling and undersampling are used differently in each. Again, we will give you a brief introduction. Choose the algorithm in the RENDER SETUP dialog box, the V-RAY tab in the V-RAY: IMAGE SAMPLER (ANTIALIASING) rollout:

- Fixed image sampler
  - Simplest antialiasing algorithm.
  - Each pixel is divided into an equal amount of subpixels.
  - The number of subpixels is always the square of the SUBDIVS value.
  - The higher the value, the better the quality.
  - The required rendering time increases rapidly with higher values.
  - Used for highly detailed scenes, high amount of motion blur, blurred reflections, detailed textures.
- Adaptive DMC
  - Number of subdivisions calculated for each individual pixel.
  - Subdivisions depend on the difference between a pixel and neighboring pixels.
  - Undersampling not possible.
  - MIN SUBDIVS: number of minimum subdivisions per pixel.
  - MAX SUBDIVS: number of maximum subdivisions per pixel.
  - CLR TRESH: influences the decision about which pixels are divided into how many subpixels; the smaller the value, the higher the quality and the required rendering time.
  - USE DMC SAMPLER TRESH: also influences the subdivision, different method.
- Adaptive subdivision
  - Complex image sampler, can also do undersampling.
  - CLR TRESH: influences the subdivision, smaller values produce a better result with longer rendering time.
  - RANDOMIZE SAMPLES: better antialiasing for approximately horizontal or vertical lines.
  - OBJECT OUTLINE: undersampling of edges for all objects.
  - NORMAL TRESH: objects in which the normals differ greatly are always subdivided more.

33

Summary

For scenes with sharp reflections and soft, blurry textures, always use the ADAPTIVE IMAGE SAMPLER. Scenes with highly detailed textures and lots of geometry or blurry reflections should be rendered with the ADAPTIVE DMC SAMPLER. It gives the best result with relatively short rendering times. Depending on the circumstances, the ADAPTIVE SUBDIVISION IMAGE SAMPLER may yield a lower quality, despite longer rendering times. For highly complex scenes with a great number of details and effects, apply the FIXED IMAGE SAMPLER. The required rendering time may be very long, however.

Linear Workflow (LWF)

Put simply, the linear workflow describes a method of governing the input, processing, and output of image material in 3ds Max. The monitor is not able to display an image in the same brightness as we see it in reality. Each image has a gamma correction curve in order to be displayed on the monitor in such a way that our eyes see it correctly. This is usually a gamma correction value of 2.2. Because 3ds Max works internally in a linear way—that is, with a gamma of 1.0—this correction has to be reversed. To do this, choose the following settings in 3ds Max and V-Ray.

3ds Max

Open the PREFERENCE SETTINGS dialog box (CUSTOMIZE/PREFERENCES…). Switch to the tab GAMMA AND LUT. Activate the checkbox ENABLE GAMMA/LUT CORRECTION and set GAMMA to a value of *2.2*. This setting defines the monitor's gamma correction. In the BITMAP FILES group, set the INPUT GAMMA and OUTPUT GAMMA also to *2.2*. This tells 3ds Max that all image data has a correction and it can reverse this. The output images (renderings) are saved once more with the gamma correction to ensure that they are displayed correctly. Also activate the two checkboxes in the group MATERIALS AND COLORS. This ensures colors and images display correctly in the material editor.

V-Ray

Open the RENDER SETUP dialog box and switch to the V-RAY tab. In the V-RAY:: COLOR MAPPING rollout, set GAMMA to 1.0.

Here, no correction is applied. In the latest V-Ray version, 1.50 SP3, you have the option to use the value 2.2 in combination with the option DON'T AFFECT COLORS (ADAPTATION ONLY). V-Ray is already working with the corrected brightness internally. The correction is not yet saved into the picture, however, but used only for calculating the sampling. This produces a better quality, as image areas that are too dark are lightened by gamma correction.

In order to have the V-Ray frame buffer display the correct brightness, you must activate the option DISPLAY COLORS IN SRGB SPACE.
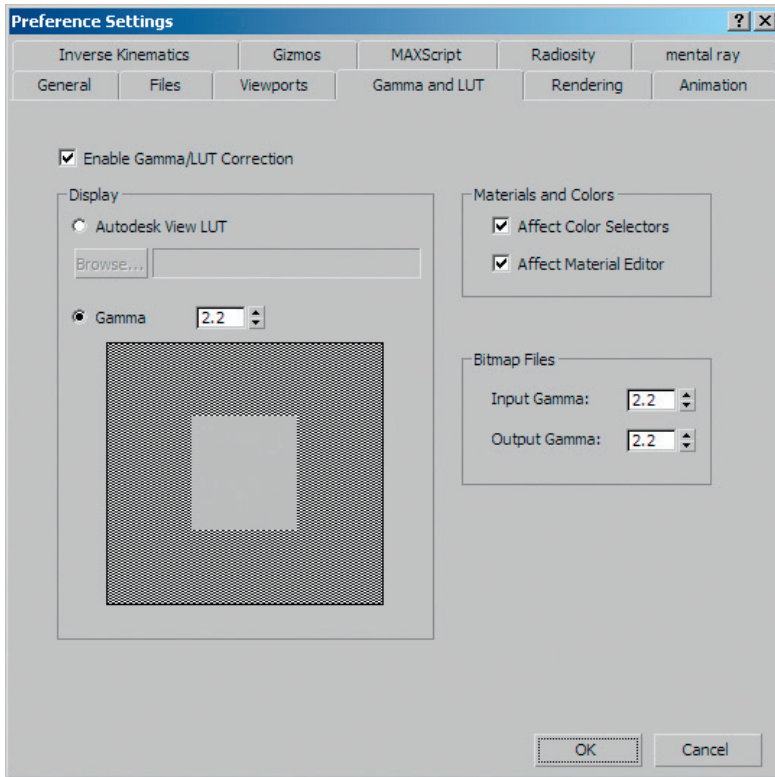
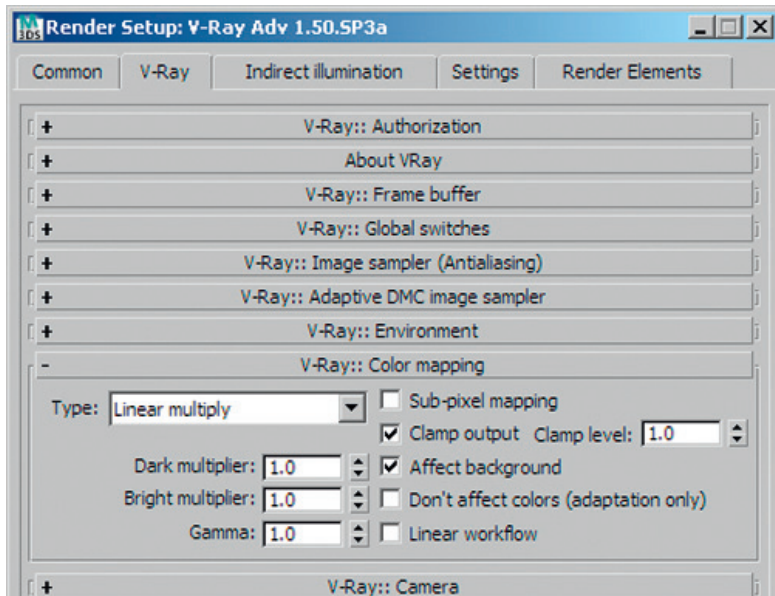**FIG 1.46** Render Setup Dialog Box, Gamma, and LUT.

FIG 1.47 Render Setup, VRay:: Color Mapping, Gamma 1.0.

FIG 1.48 Render Setup, V-Ray: Color Mapping, Gamma 2.2, Don't Affect Colors (Adaptation Only).
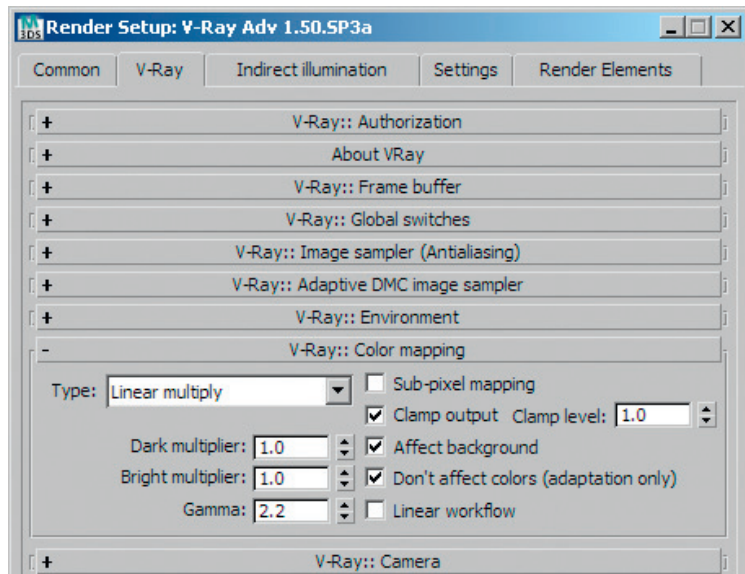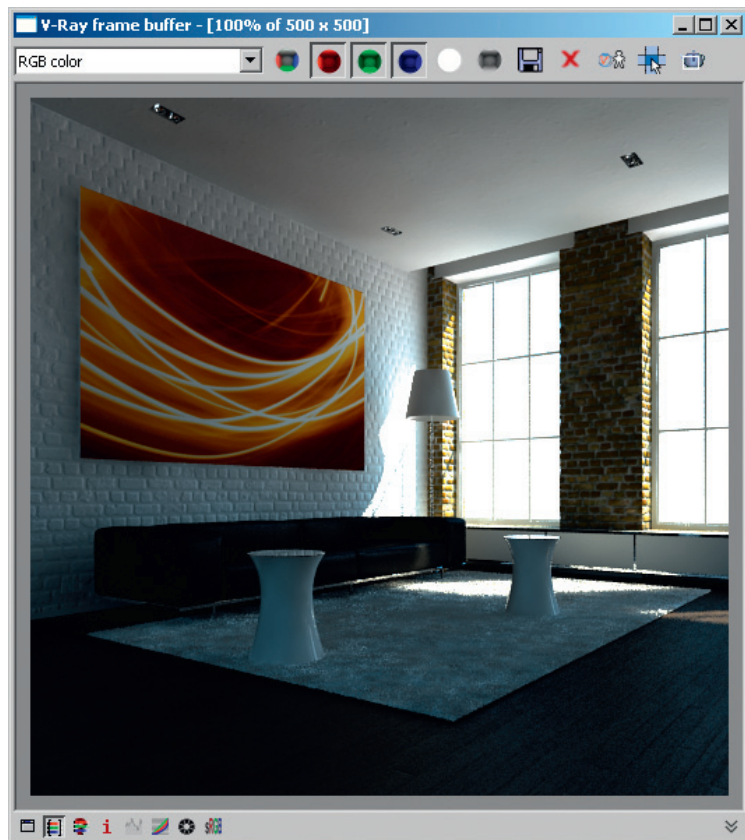

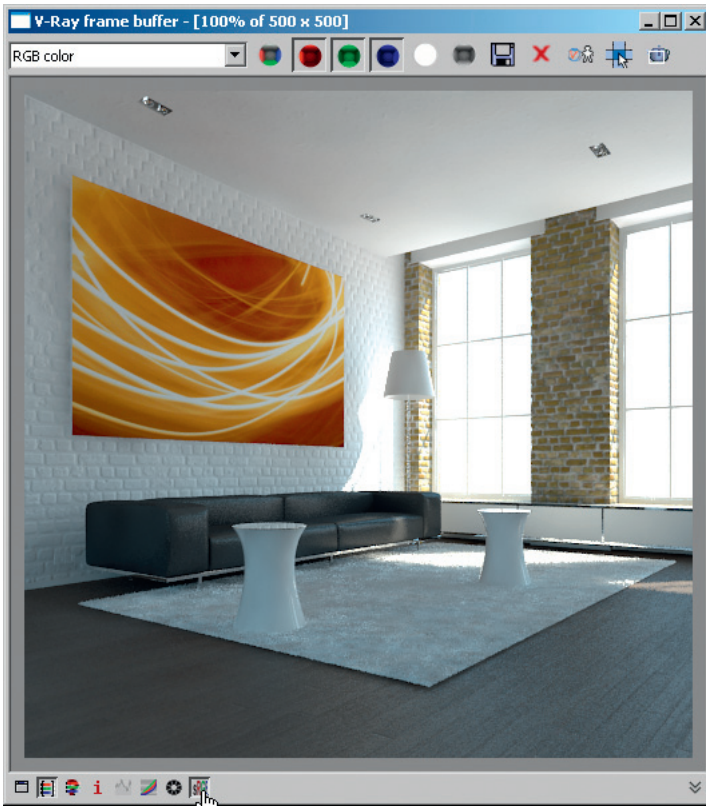**FIG 1.49** V-Ray Frame Buffer, without Gamma Correction.

FIG 1.50 V-Ray Frame Buffer, with Gamma Correction.
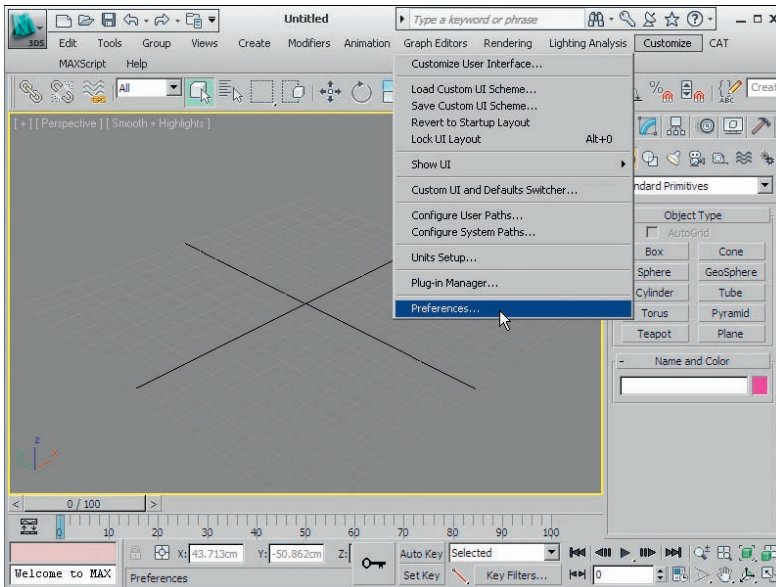
FIG 1.51 Opening the Default Settings of 3D Studio Max.
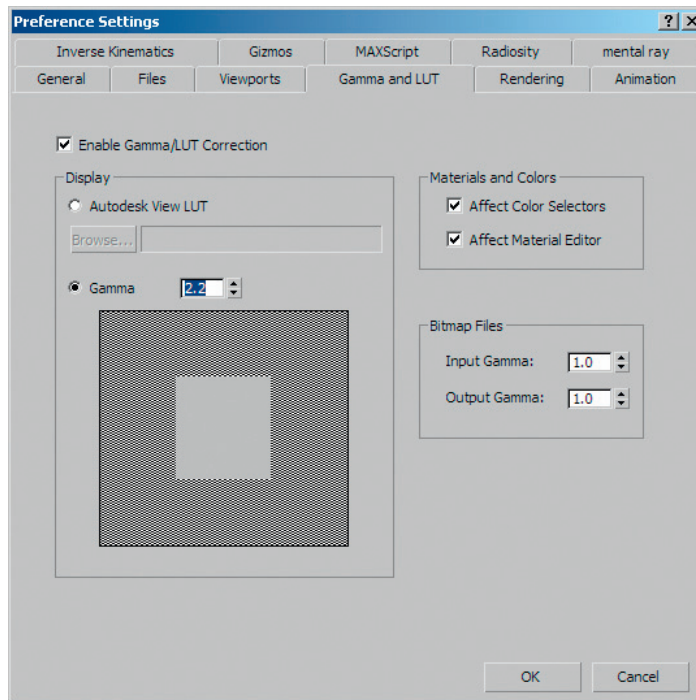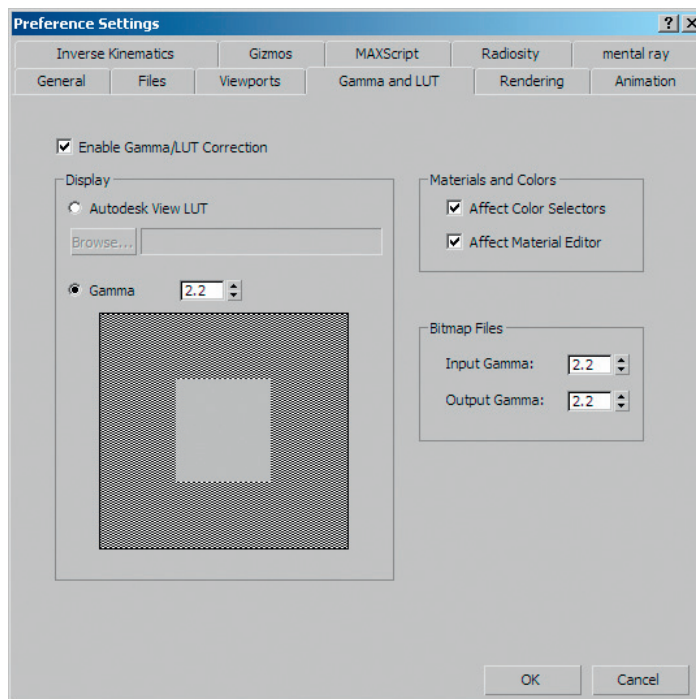
FIG 1.52 Activating and Setting the Correct Gamma Value.

FIG 1.53 Setting the Right Gamma Values for Input and Output of Image Files In 3D Studio Max and the Color Corrections for the Material Editor.
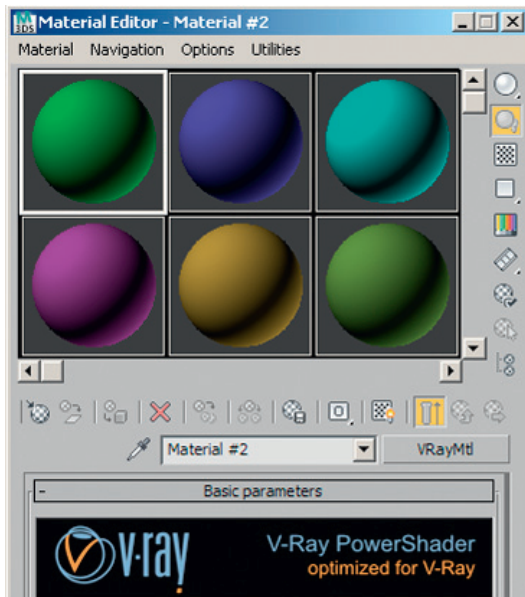
FIG 1.54 Material Editor before Gamma Correction.
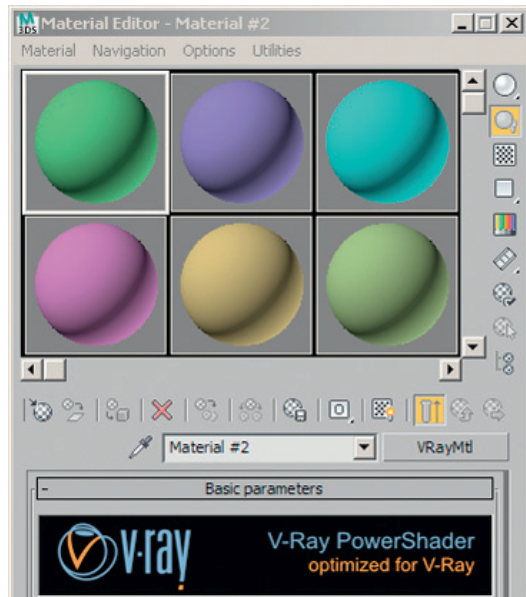
FIG 1.55 Material Editor after Gamma Correction.

About the CD Included with This Book

Directory Structure

Before you start reading the next chapter, please take the time to read the following comments. All files in the following chapters can be found in the corresponding subdirectory to that chapter—for example, *chapters/ch_02* for Chapter 2. This directory contains the 3ds Max files. The first file (*ch_02_01.max*) is the introduction to the chapter, and the second file (*ch_02_02.max*) shows the image at the end of the chapter, after applying the changes discussed in the chapter. You can use this file to quickly refer to a material, for example, or if you want to try something without having to work your way through the entire chapter first. Each chapter directory contains subdirectories for textures, AutoCAD files (*dwg*), and so on. **Figure 1.56** shows the directory structure of Chapter 2.


FIG 1.56 Directory Structure of Chapter 2.
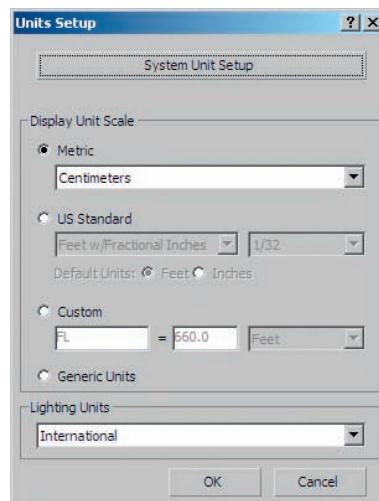
Units

Our AutoCAD and 3ds Max files are all measured in centimeters (cm). This scale lends itself for architectural visualization. All objects or light sources are covered well without an excessive amount of zeros before or after the decimal point. The 3ds Max system unit is set to centimeters as well. If you are using other units, 3ds Max will ask you when opening our files if you want to keep the units or convert to your settings. Please make sure that you adopt the units of measurement from our file to avoid conversion errors. In the FILE LOAD: UNITS MISMATCH dialog box, choose the option ADOPT THE FILE UNIT'S SCALE. Otherwise, you can end up with wrong values, such as for the intensity of light sources.

FIG 1.57 Open File, Adopt File's Unit Scale.
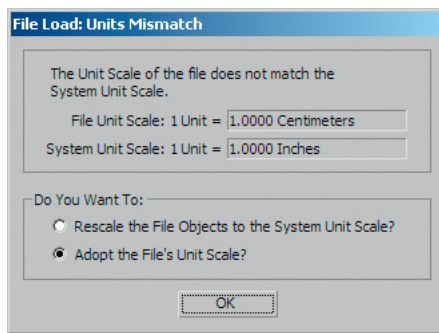
You can view and change your settings in the UNITS SETUP dialog box (CUSTOMIZE/UNITS SETUP…). Make sure that the unit for lighting is also set correctly: under LIGHTING UNITS, you should have the unit INTERNATIONAL selected. You can change the system unit by clicking on the SYSTEM UNIT SETUP button in the UNITS SETUP dialog box.
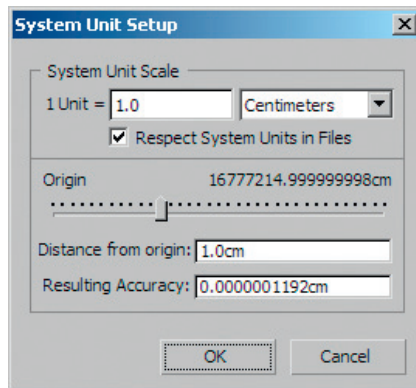
FIG 1.58 Units Setup Dialog Box, Change Units.

FIG 1.59 System Unit Setup Dialog Box, Change System Units.

Gamma Correction

To be able to work correctly with 3ds Max, you should generally adopt the settings described in section 1.3.11. Again, 3ds Max will ask you if other settings should be used. Adopt the settings from our file when loading it by choosing the option ADOPT THE FILE'S GAMMA AND LUT SETTINGS in the FILE LOAD: GAMMA & LUT SETTINGS MISMATCH dialog box.

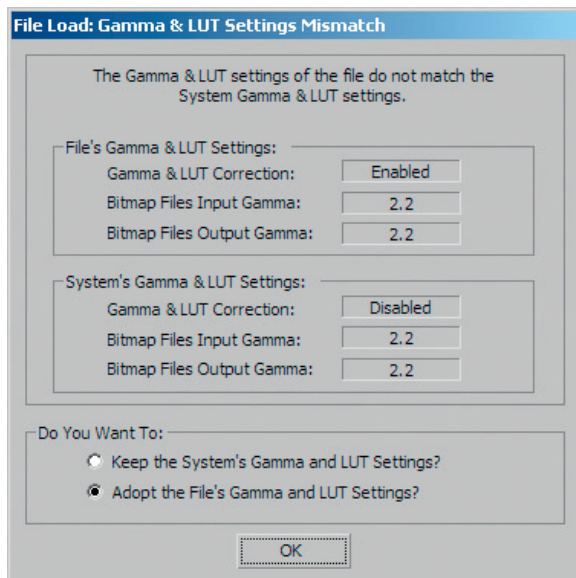**FIG 1.60** File Load: Gamma & LUT Settings Mismatch Dialog Box, Adopt File's Gamma Correction.

Adapt Paths (Asset Tracking)

In our 3ds Max files, all textures, IES profiles, AutoCAD files, and so on are mostly linked. You can therefore copy the CD's folder structure to any folder on your hard drive and 3ds Max should be able to find all used files.

We recommend that you adapt the links to your file system. Open the Asset Tracking dialog box (3DS/Manage/Asset Tracking). Here you can see all file links in the scene. You can change the paths by right-clicking on an entry and choosing Set Path…. Even if 3ds Max displays an error message when opening a file, telling you that a file was not found, you can use this dialog box to assign the correct path to that file.
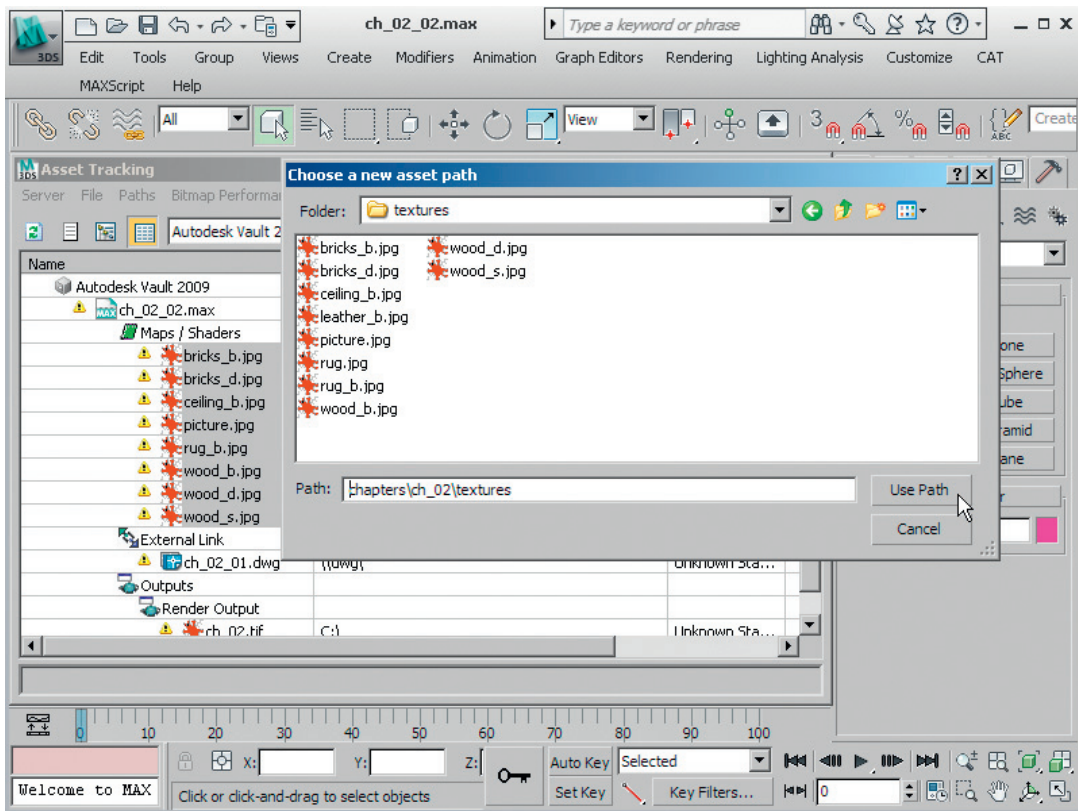

FIG 1.61 Asset Tracking Dialog Box, Assign New Path to Selected Files.

Versions Used

This book refers to the current program versions, 3ds Max 2010 or 3ds Max Design 2010 and V-Ray Advanced 1.50.SP3a. The files included on the CD are also in the most current format. If you are still using older versions of the programs, you can download a trial version of the current products from each manufacturer's web site. You may need to register to do so.

• Autodesk (http://www.autodesk.com)
• Chaos Group (http://www.chaosgroup.com)