Flamingo®

Advanced Training Series

Studio-Quality Rendering

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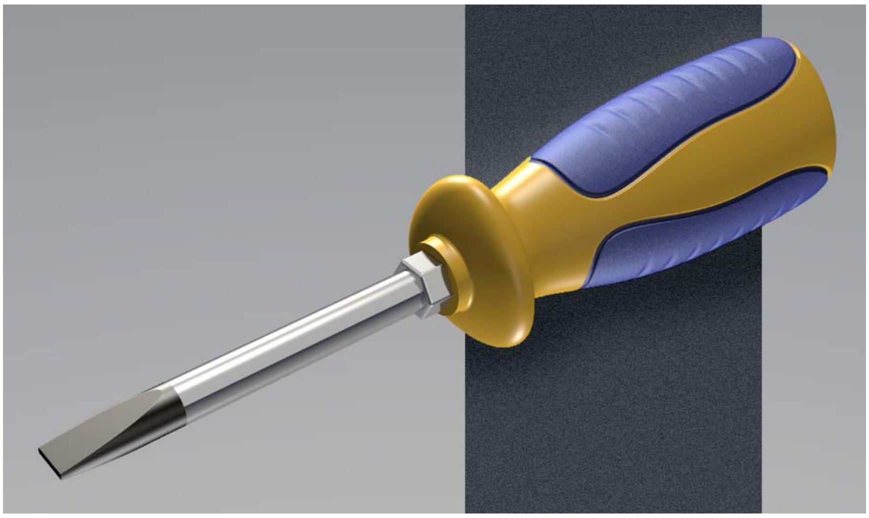
1 Introduction

This training material focuses on studio-quality product rendering. Although all images have been made with Flamingo, a rendering plug-in for Rhinoceros, the information can be applied to other rendering applications as well. The tutorial's main purpose is to provide you with tips and techniques to make product shots of your designs that have a photo studio look.

Before we start, let me explain the term *studio-quality rendering*. A studio-quality product rendering is analogous to a photograph from a professional photography studio. In a photo studio, a product is lighted with artificial lights that have been carefully set up by the photographer or stylist. It is not the kind of spontaneous snapshot photograph that you would take at a party. Everything is set up to get the most out of the subject of the photograph. These are the kinds of shots that are used in advertisements. They have to sell the product. That's exactly the result a designer is after when making a presentation of his work. This type of rendering can sell your design to your boss or client.

This tutorial assumes that you already know the basics of using Rhino, Flamingo, and Photoshop.



Rubber and chrome materials with a background created in Photoshop.

2 Lights and shadows

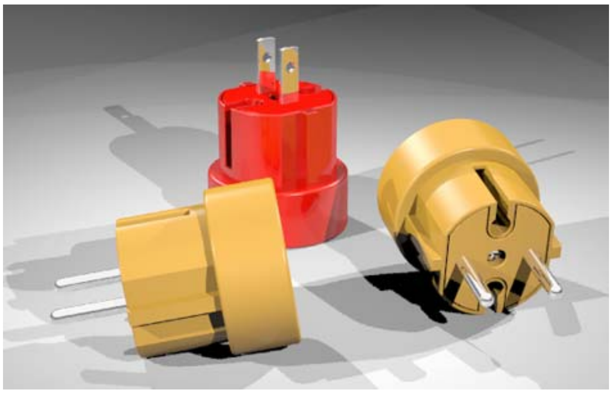
The most important factor in making a good rendering is the proper use of lights and shadows. No matter how well designed and detailed your product is, if the lights and shadows are not placed deliberately, your product won't look its best. In the following examples, I will try to give you some insight into making the right choices for your lighting design. I will use both good and bad lighting examples. It is important not only to recognize these differences, but also to learn why it is qualified as "bad" or "good," so you can adjust your rendering efficiently in the set-up phase.

Improper lighting

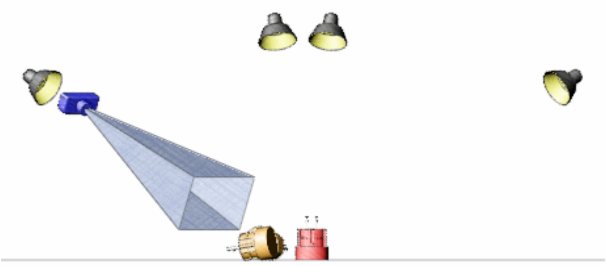
The two most common lighting mistakes are using too many lights and using a single light that is near the camera location.

Mistake: Too many lights

The real problem with using too many lights is that there are too many shadows. As you can clearly see in the image below, these shadows compete with each other and what is worse, they compete with the product.



Rendered image with too many lights.



Lights used to render this image.

The overlapping shadows form several dark and light shapes. These shapes are irrelevant to the image and thus qualify as *noise*, since they distract the viewer from the real subject: the collection of plugs. An important part of your attention, which should go to the product, is distracted because the image is out of balance.

In product advertisements, you will never see shadows like this. The same thing should be true in our virtual photo studio. Shadows are meaningful when they tell the viewer something about the shape or location of the objects, as we will see later in this chapter.

This example teaches us an important aspect of a studio-quality rendering: The viewer should not be distracted by visual noise. The *product* must take the central place in the rendering.

Mistake: Headlight

A second lighting problem is using a headlight. This is the same kind of lighting that you get when you take a photograph using a compact camera with built-in flash. The headlight casts a thin shadow and totally lights up the product from the viewing angle.

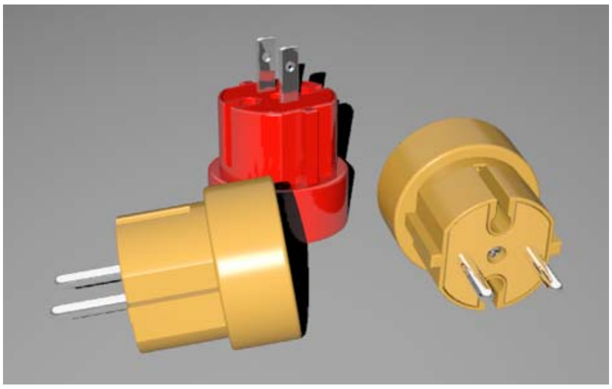
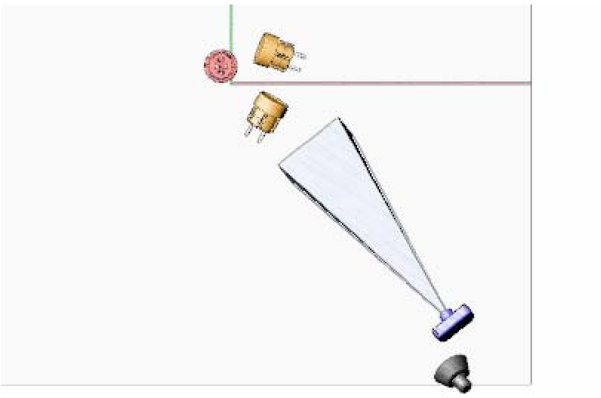


Image rendered with headlight lighting.



The headlight is very close to the camera location and angle.

Because this type of shot has very low contrast in the lighted parts, the result is an image that gives a poor sense of depth. The image loses a lot of its three-dimensional quality. It is, however, a great lighting method for making "before" photographs for beauty products.

This example teaches us a second aspect of our studio-quality rendering: Proper lighting helps the viewer to correctly perceive the object's shape and three-dimensional form.

When comparing these exaggerated examples, you will see that you perceive the object differently when the lighting changes. I think that in both renderings you are being misled. Your perception is not "correct."

The product must take a central place in the rendering. The viewer must not be distracted by visual noise.

When does the viewer make the right perception of the object's shape and three-dimensional form? Since there are many factors that influence your perception, the answer is not simple, but using the right lighting is certainly the most important aspect. In the following lesson, I will show you how this simple scene can be build up efficiently to create a final image that is correctly lit with regard to tonal range, shadows, and presentation.

Build a correct light set

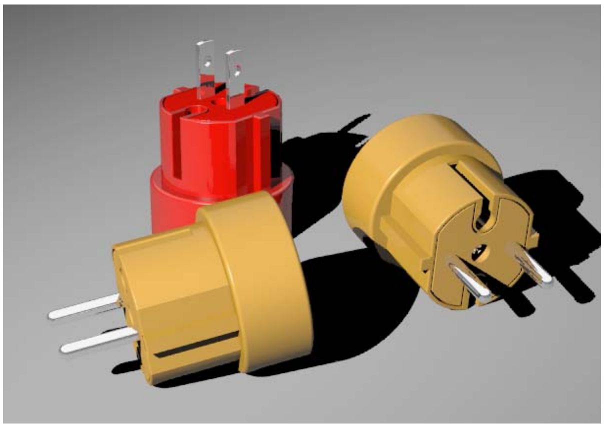
Lots of people start making renderings by throwing in some lights and hitting the render button. Then they will most likely try to adjust one or more lights between test renderings to improve the image. However, in order to know how each individual light is influencing your scene, it is better to work systematically and consistently. That is why I always start lighting the product with a single light. The first light that is placed is called the *key light*. When we have determined the right location and brightness of our key light, additional lights will be added depending on the state of the scene. These additional lights will be used to fill in the darker parts of our scene.

You can follow the steps in this lesson in the **Models and Images\Lights and Shadows\Plugs\plugs.3dm** file installed in the folder *My Documents\Studio-Quality Rendering* on your computer. Each step is on a separate layer. Make the default layer and the appropriate step layer visible.

Note For all of the examples in this tutorial, open the model file provided and spend some time examining it to learn about the setup, materials, and lighting.

Step 1: Place the key light

In this example, you see the plugs scene again lit by one spotlight. If you adjust the spotlight hardness to about 30 (default value is 50) you can prevent unrealistic spotlight edges.



Initial placement of the key light.

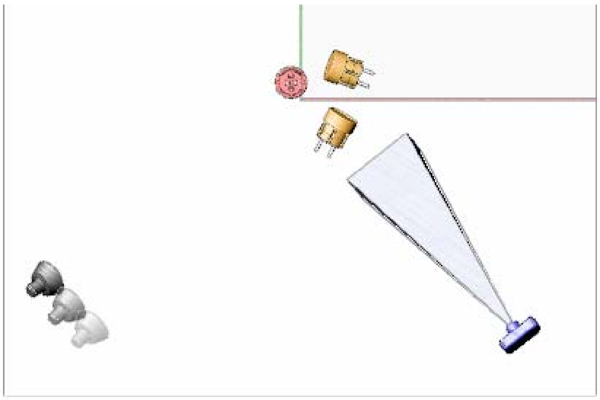
Starting with this single test render, you should ask yourself these questions:

- Do I like the direction of the light?
- Do the shadows make sense?
- Is there enough depth in the scene?
- Do I have enough contrast in the image?

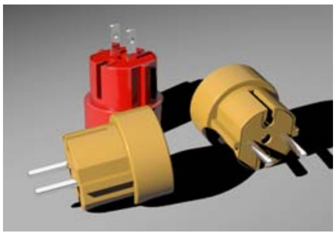
The first thing I noticed after making this test is that the image does not have enough contrast. I want to show a distinct lighting direction in the scene, but the plugs are lit too evenly.

Step 2: Rotate the light into place

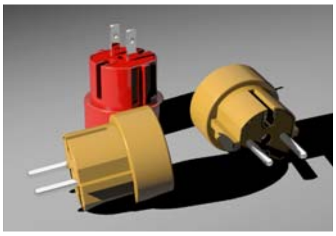
In these next images, I rotate the key light a little at a time. Render a test to check the position of the shadows. In the final position, I have a good balance between lit parts and dark parts.



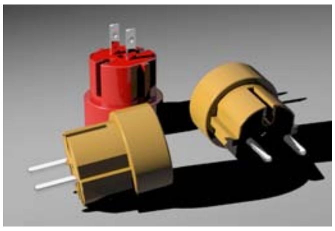
Rotate the key light into position.



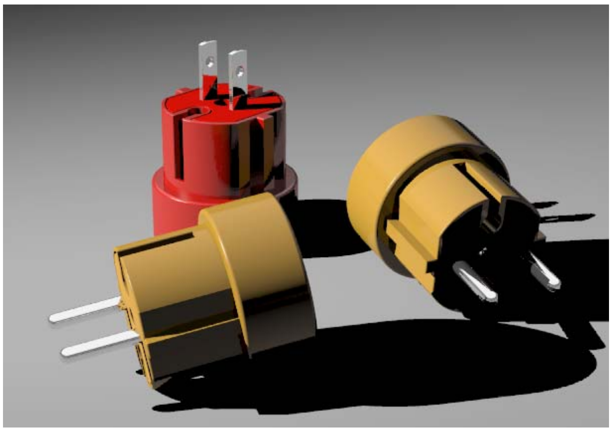
Position 1.



Position 2.



Position 3.

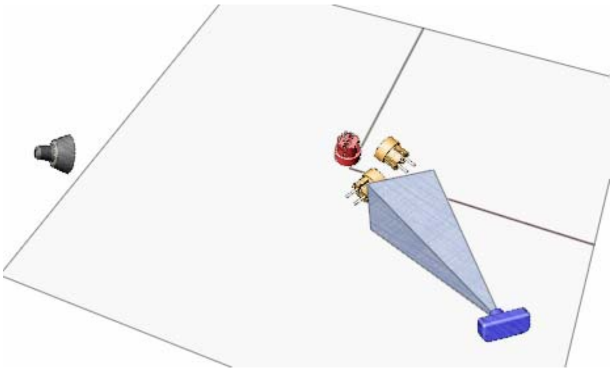


Final position.

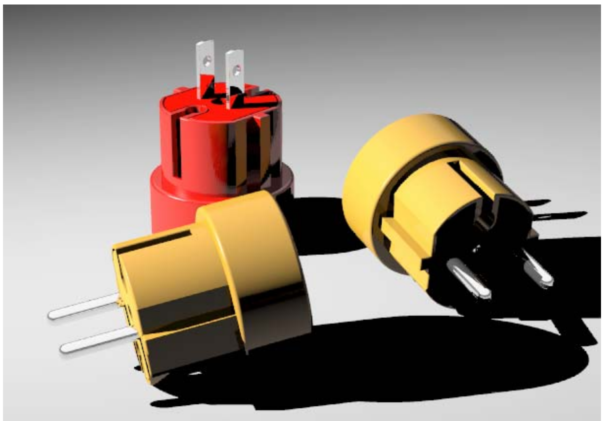
You will probably have noticed that the darker parts of the rendering are far too dark, and you are absolutely right. Don't worry. As you will see, this problem will be solved when we add our additional lights in a later stage.

Step 3: Adjust the light's brightness

Now that we have determined the right location for our key light, we can adjust the brightness to enhance the contrast. I did this by increasing the spotlight intensity to 40, thereby doubling its value. Notice that when you lower the spotlight hardness (hotspot size) while maintaining the same falloff angle, you will likely need to increase the spotlight intensity to get a similar amount of light in your scene.



Key light final setup.



Rendering of key light only.

For now I am satisfied with the position and brightness of the key light. Of course, the shadow is very hard and dark, but this will be handled after we have introduced the additional light (the *fill light*) in the following step.

Step 4: Add fill light and adjust brightness

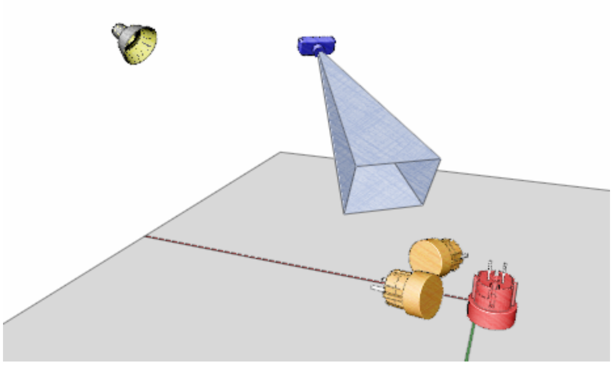
Now it is time to work on the unlit part of the image. Again, we start working with one light only to see what the light's influence is on the scene. Turn off the key light you just placed. In this case, the location of the light will be more or less on the opposite side of the objects from our key light. The elevation of the fill light is slightly lower than the key light. This light is actually a helper light to fill in the dark parts that would have been naturally lit by bouncing light (diffused light) in a real-life situation.

Although Flamingo calculates indirect lighting with a radiosity solution, this is generally not suitable for product rendering. In addition, calculating radiosity is a very computationally intensive task. If you are aware of the natural phenomenon of bouncing light and study it, it will be easier to mimic this behavior in your rendering. To study this lighting effect, try darkening a room and then lighting an object with a spotlight while holding a sheet of paper behind the lit object. You will notice that the back of the object will be lit by indirect light bouncing off the paper sheet.

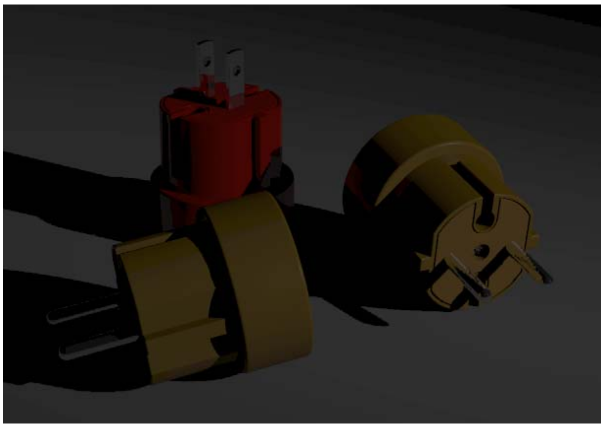
The trick is to make the fill light bright enough to show the details in the unlit areas while maintaining the overall contrast in the image. It should not become an additional key light.

Flamingo offers two options to lower the brightness of a light. You can reduce the light's intensity or make the light's color darker. Light intensity and color are properties of the light object (Rhino File menu: Object Properties > Light page). Since this fill light will be a dim spotlight, I prefer to use a darker color for the light and use the intensity slider to fine-tune the spotlight brightness.

The initial test rendering was too dark.

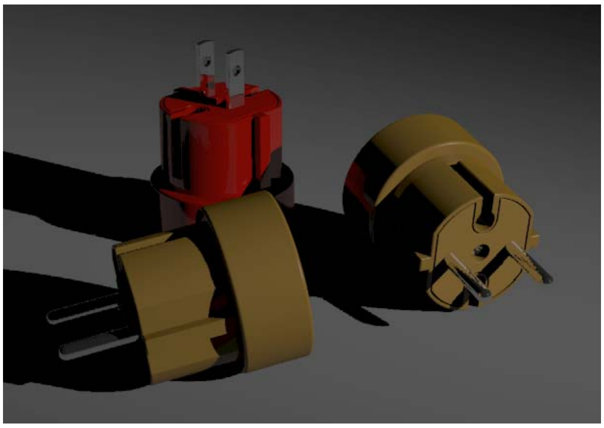


Setup of fill light.



Rendering of fill light only.

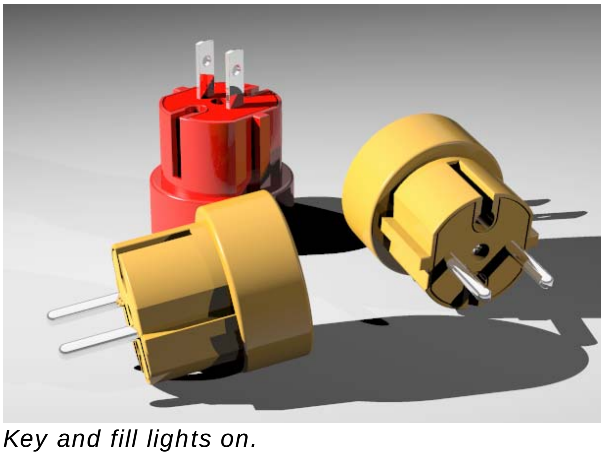
The second rendered image shows enough detail and is still dark enough to avoid visible shadows later on. The goal is to lighten up the part that is in the shadow created by the key light without having the feeling that there is an additional light in your scene.



Fill light brightness adjusted.

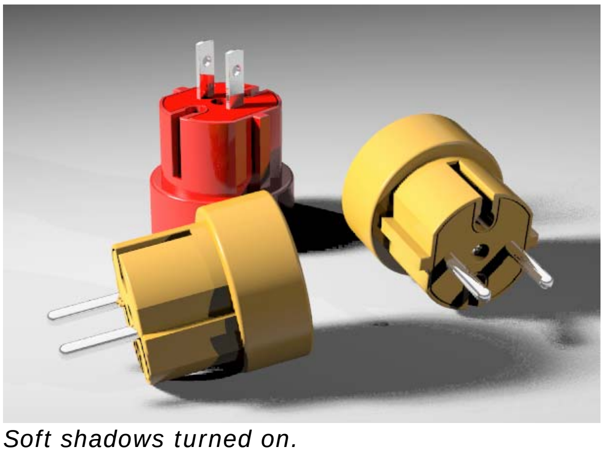
Step 5: Check both lights

After you have determined the right amount of fill light, you can turn on both lights to make the rendering shown below. As you can see, the shadows from the fill light on the ground are barely visible in this image, but the shadow on the plugs is noticeable. This will be corrected in a later step.



Key and fill lights on.

The next image shows the same rendering as before with the global “Soft shadows” setting turned on (Rhino File menu: Properties > Flamingo page). This particular light has “Use soft shadows” turned on and a “Source radius” setting of 150 (Rhino Edit menu: Object Properties: Light page).



Soft shadows turned on.

When rendering with soft shadows, adjust the light properties “Soft shadows” settings (Rhino Edit menu: Object Properties > Light page) as follows:

- If the rendering shows banding artifacts, increase the “Jitter” setting.
- If there is too much noise (speckles), increase the “Samples” setting.

A larger “Source radius” will also require more samples and a higher jitter setting to reduce banding artifacts.

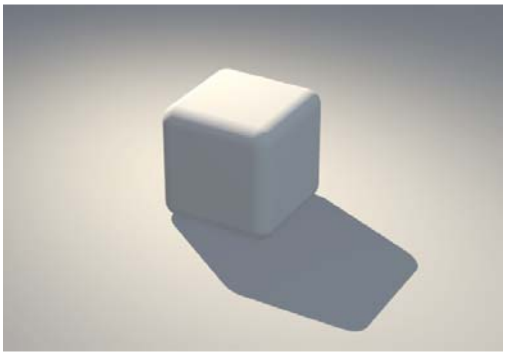
Rendering with “Antialiasing” at 16x (Rhino File menu: Properties > Flamingo page) will also reduce noise caused by the jittered shadow samples. Increasing any of these settings increases render time.

Step 6: Adjust shadows

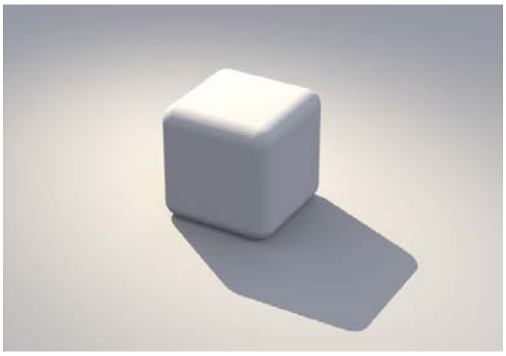
As you may have noticed, the shadows in the previous step are quite heavy and dominant. We cannot add another light that introduces new shadows. This would destroy the whole setup of this rendering. However, we can add another light somewhat in the same plane as our key light to reduce the length of the key light shadow.

Another reason for adding a light is to keep the shadow underneath the objects darker than the rest of the shadows. If you look carefully at various objects in your room, you will notice that shadows become darker near the objects.

In the images below, you can see that the shadow in the image on the right makes the cube appear to be standing on the surface.

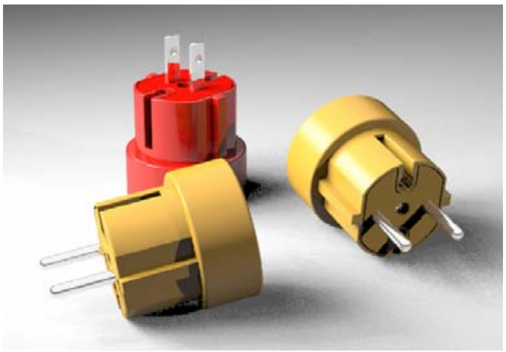


Lack of shadow makes object float.

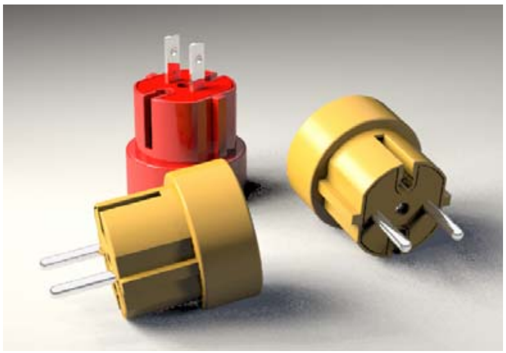


More shadow puts object on ground.

In the next rendering I moved the additional key light to create the highlight on the yellow plug and to change the shape of the shadow to a more natural one.



Objects float.



Extra light added to darken shadow.

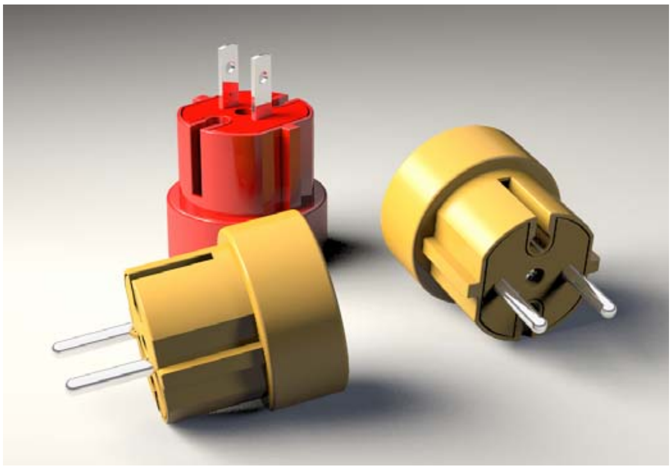
Step 7: Adjust light color

We are getting close to the end of the rendering setup. Until now we only used lights with equal amounts of red, green, and blue. Real life lights are never perfectly balanced white lights. It may seem so because our eyes have the ability to correct this balance. You may have noticed that on a bright sunny day, when you walk inside to get a drink, the lights in your home suddenly look very yellowish. That's the moment before your eyes have adapted to the color of the lights. The color that you see at that moment is the same as you would see on a photograph when you make a picture with film not balanced for indoor lighting.

For this particular scene, I chose to use a yellowish tone for key light. The fill light has more or less a complementary color, in this case a bluish color. Using blue for the fill light has the advantage of balancing the yellow key light a bit and it helps to increase the sense of depth in the image.

Step 8: Increase antialiasing and shadows

Once you are satisfied with the lighting setup, it is time to increase the render settings to more antialiasing samples and/or more shadow samples. The final image was rendered at 16x antialiasing, shadow samples were left the same.



Antialiasing increased for final rendering.

The last thing I want to discuss in this section is why this final image is a studio-quality rendering. In the examples at the beginning of this chapter, I mentioned two important aspects—the viewer should not be distracted by visual noise, and the rendering should help the viewer to make the right perception of the three-dimensional form. These requirements have been fulfilled.

Furthermore, there is a good contrast in the image: the combination of lighter and darker sides properly demonstrates the objects' three-dimensional quality. The shadows are useful and fulfill two tasks. They connect the objects to the ground surface, and they give information about the shape of the objects.

Rendering a floating object

In this example a popular model, a cellular phone is used, because it is a nice object to render on its own without additional objects or a background.

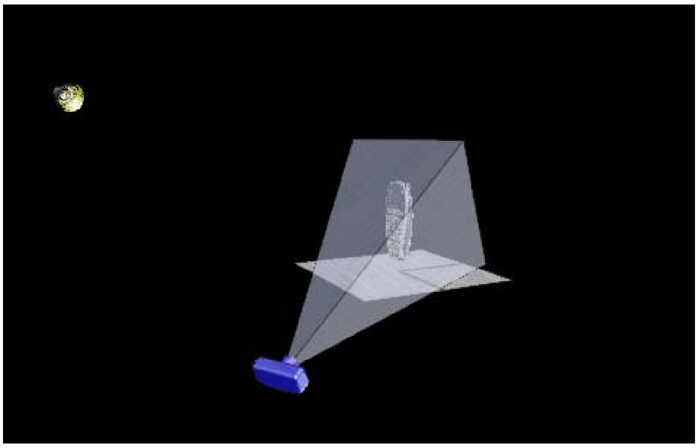
Floating object with black background.

The lighting setup for this scene is quite simple. Three lights are used. In addition, a rectangular luminous plane simulates a square light in a studio. To learn more about this scene, let's take look at the lights and study what each light contributes to the final image. Open the model: **My Documents\Studio-Quality Rendering\Models and Images\Lights and Shadows\Phone\Phone.3dm**.

Key light

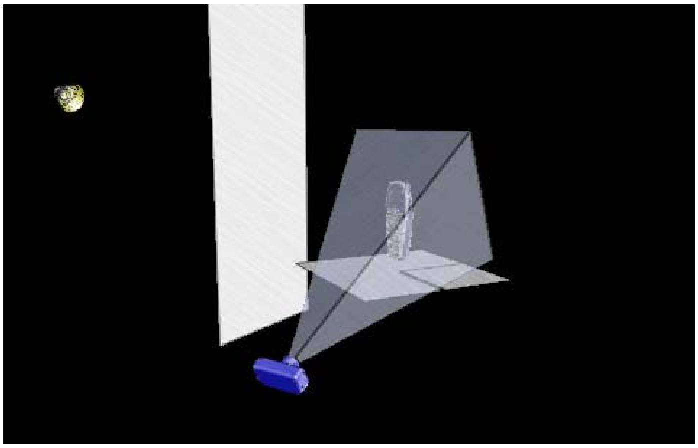
The key light is located at the left shoulder and is placed behind a plane that has a material with self-luminance assigned. This plane acts like a large rectangular light. This plane is set to cast no shadows so the key light won't be blocked. The luminous plane is backed up by a bright spotlight causing it to feel like a rectangular light reflection. In this case, I chose to give the key light a light blue color to support the silver look of this phone. The spotlight hardness is set to 9, brightness to 33. I set the hardness low to get some variation in the spotlight brightness over the surface of the phone, which gives the lighting a more natural and exciting look.

Below you see two renderings with only the key light, the first one is without the self-illuminating plane and the second one with the self-illuminating plane. However, the side and bottom of the phone remain dark, so these two areas require another light.



Render setup showing camera and key light.

Key light only.

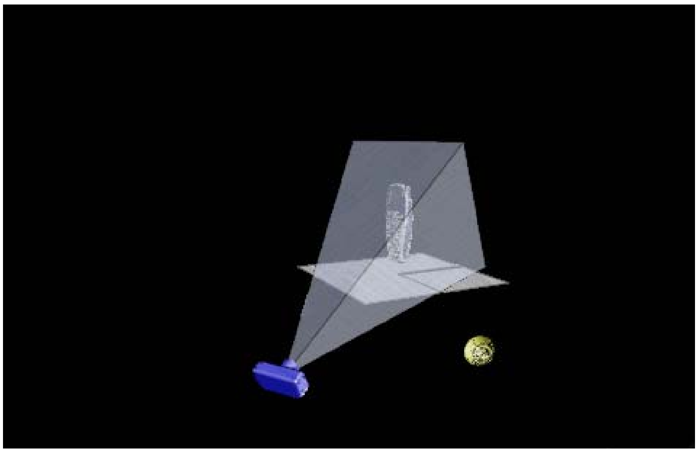


Render setup showing key light, camera, and luminous plane.

Key light and luminous plane.

Fill lights

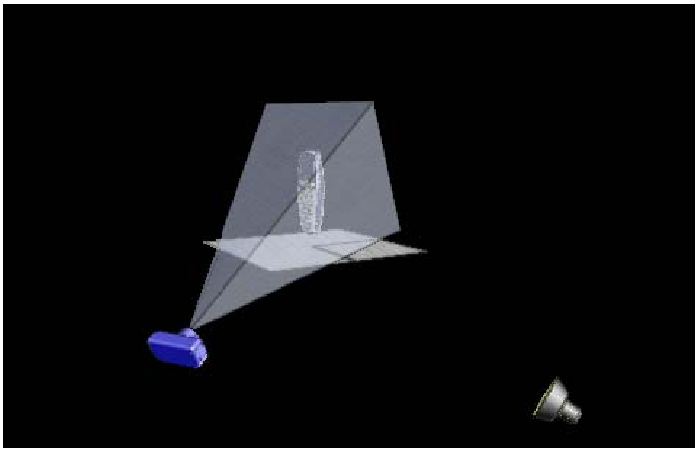
The first fill light is added to light up the bottom part of the product. It casts only 50% shadows, which makes it possible to light up the buttons, as well to give a nice rim light.



Render setup showing fill light 1.

Fill light 1 only.

The second fill light has been given a warm purple color. Again, this light is casting 50% shadows. Notice that it gives a subtle lighting to the side of the phone but also to the sides of the buttons, which were thus far left unlit.



Render setup showing fill light 2.

Fill light 2 only.

I rendered the illuminated panels and numbers of the phone separately to show their contribution. These are not real lights, but consist of Flamingo decals with self-luminance. To create this image all the lights are turned off and a light with black color is inserted to turn off the default light.

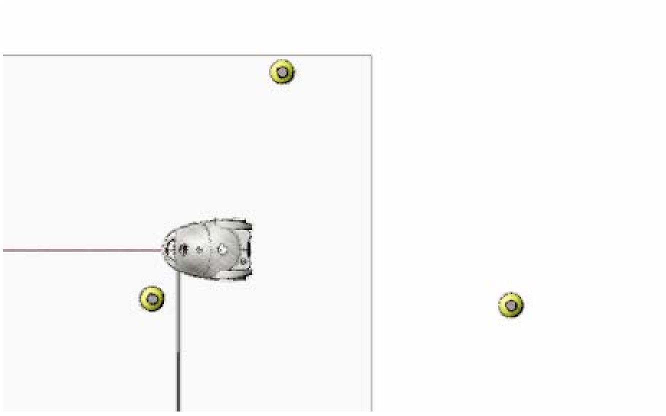
Self-luminous backlight panels.

Rendering a bright environment

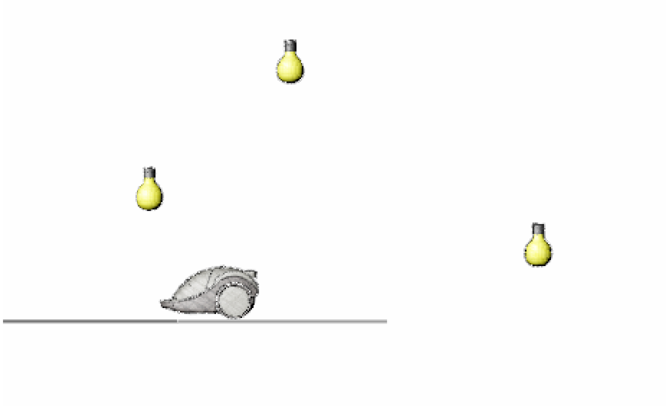
The next example uses point lights to create a bright overall environment with indistinct shadows. Again, I will show all lights rendered separately. Open the model: **My Documents\Studio-Quality Rendering\Models and Images\Lights and Shadows\vacuum cleaner\NK_102.3dm**.

Bright rendered environment.

Three point lights are used in the scene: a key light, fill light, and back light. The key light has a light yellow color. The fill light has a complementary blue color. The back light is white to highlight the top edges of the object. The images below show the relative placement of the lights in this scene.



Top view of lights.



Front view of lights.

The first three images were rendered with a black environment to show only the contribution of the light.

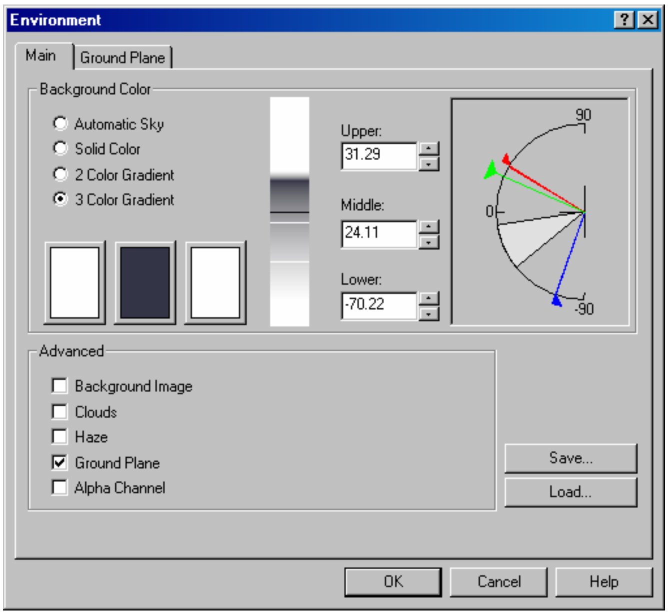
Render key light only.

Render back light only.

Render fill light only.

Now we add a three-color gray gradient to the environment, which adds a nice reflection to the chrome parts and the partly reflective housing. What you can clearly see from these separate renderings is that the reflected environment plays a key role in visualizing the chrome parts.

To render the reflected background only, turn off all lights except one. It does not matter which light you leave on. Set this light's color to black. Setting the light color to black causes it to turn off the default lighting but contribute no light to the scene. This lets you render a black scene. You cannot simply turn off all lights, since this turns on the default lighting.



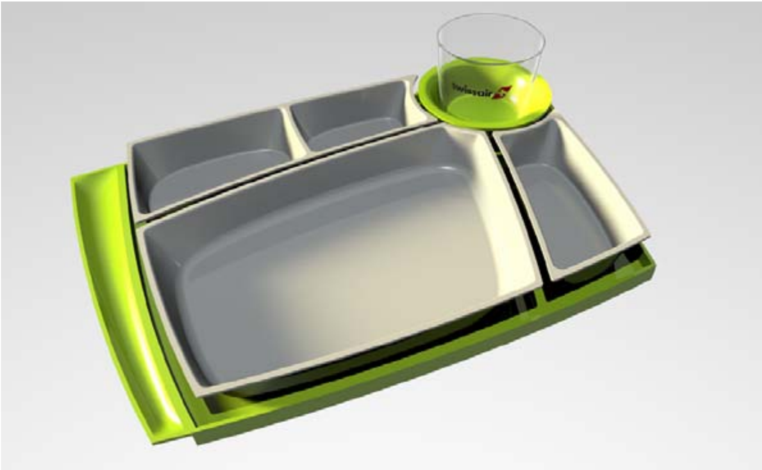
Environment settings.

Render environment only.

Conclusion

You have seen that lighting plays the most important role in your rendering. You will have more control over your lights when you render each one separately in the setup phase. If you work systematically in building your light set, the time for setting up a rendering can be reduced drastically, and you will see that this adds to the quality of your renderings as well.

3 Materials



Hard plastics with sharp reflections and bright highlights.

In this chapter, I will discuss several rendering materials. I have included materials that are commonly used in industrial product design. These materials are included in the **Models and Images\Materials\Tutorial.mlib** material library on your CD.

- Opaque plastics
- Transparent plastics and glass
- Chrome
- Brushed metal
- Rubber

Opaque plastics

Although the first man-made plastic was unveiled by Alexander Parkes in 1862 at the Great International Exhibition in London, the invention of bakelite, by the Belgian Dr. Leo Baekeland in 1907, was the beginning of a revolution in plastics. One can hardly imagine what the world would look like without them.

Of course, there are too many plastics to discuss them all, and for rendering we don't need to know everything about plastics. It is important, however, to study various kinds of plastics to simulate their look and feel in your rendering.

The following table compares the surface smoothness (shininess) of some popular plastics. Keep in mind that the production process will also have its influence on the surface appearance, but surface smoothness is a good indication of what category the plastic belongs to.

Average surface smoothness

Smooth	←		→ **Rough**
PC	POM	PA	PE
ASA	PS	PVC soft	PB
PMMA	PVC hard	PP	
ABS	PETP	UF	
SAN		PF	
PPO		MF	
CA/CAB/CP			

Note: Higher smoothness gives sharper, smaller highlights, more reflection, higher contrast; lower smoothness gives less reflection and dimmer, larger highlights.

Soft plastics

As an example I rendered a bottle which is a typical PE blow mold material. PE is a quite soft plastic with little reflectivity: the highlights on the product will be large and dim.

PE blow mold material.

Look through the material definitions for this model. When you examine the properties of these plastic materials, you might wonder why I use angular blend for plastics. I do this to vary the reflectivity with the viewing angle. The variation of reflectivity depending on viewing angle is called the *Fresnel* effect. Although the increase in reflectivity is not linear in real life, angular blend materials are a nice way to mimic this effect.

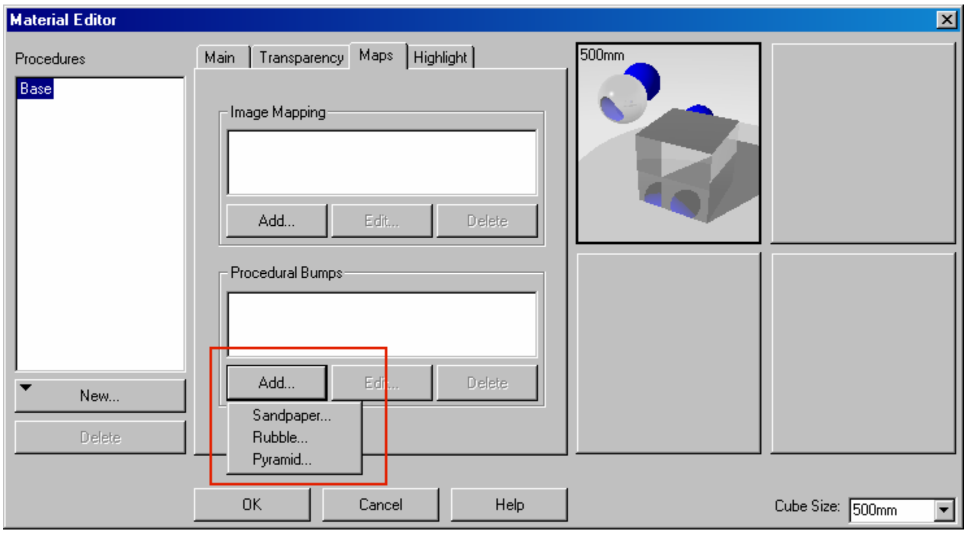
Note: The materials used for this rendering are in the Tutorial material library, **Models and Images\Materials\Tutorial.mlib**.

The sticker was added as a planar decal. Using planar decals is discussed later in this tutorial.

In this image you see the same rendering as above, but now the surface of the bottle was given a fine rubble bump pattern. This is an extra option you can add to the material to get closer to how a real PE bottle would look. Use the rubble bump to add large, soft bumps with random variation. I think for this material it is about perfect. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\rendering PE.3dm**.

PE blow mold material with rubble texture.

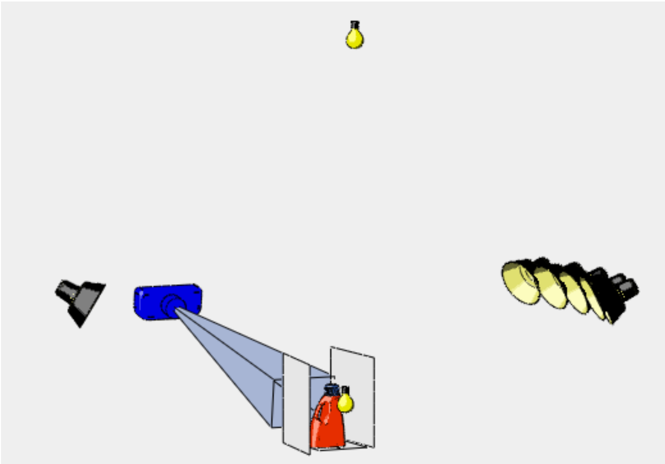
Rubble, sandpaper, and pyramid are procedural bumpmaps you can add to any material. (Flamingo Material Editor, Maps tab).



Material Editor Maps tab.

About the setup of the bottle scene

The bottle scene is shown in the image below. The self-luminous planes are not very useful in this rendering, but they will be in the next one and are put there for comparison.



Lighting setup for bottle rendering.

Rim light 1.

Rim light 2.

Examine the lighting in the model. Two point lights are placed. The most distant one is used for making rim light 1 at the right side. The second one is placed for making rim light 2 at the inner side of the handle.

Normally, I would not use so many spotlights as in this scene, but to spread the light over the entire bottle and handle, I made a group of spotlights (key light 1) to achieve a better illumination of the bottle. For the second key light, one spotlight appeared to be enough.

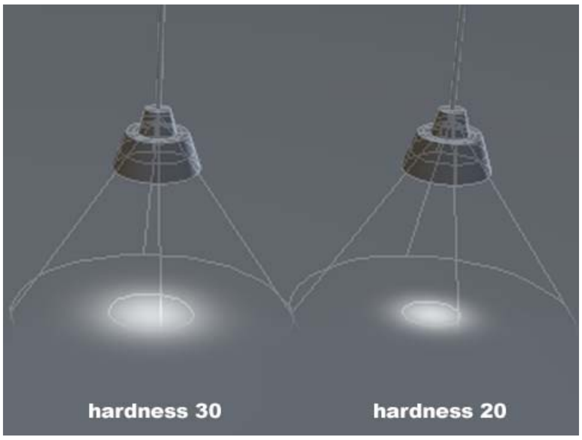
Key light 1.

Key light 2.

About spotlight hardness

Adjust your spotlight hardness to about 30 to avoid hard edges where the hotspot ends. The hotspot is visualized by the small inner circle of the light. Be sure to make the spotlights large enough so that the small circle is at least as big as the object. By doing this, you make sure the light covers the whole object. In addition, when you want to light only a small part of your object, it is wise to decrease the spotlight hardness to 30 (default is 50) or less. See a comparison below representing a spotlight hardness of respectively 60, 40, 30, and 20. As you can see, a spotlight hardness of 40 and higher produces a visible edge where the hotspot ends.

Spotlight hardness 60 and 40.



Spotlight hardness 30 and 20.

Hard plastics

If your product uses a relatively hard plastic like ABS, a household vacuum cleaner, for example, you will have to do a little more work to make the material look realistic. Hard plastics have clearer reflections (depending on the surface finish of the mold), and this must be visualized by using an image in the environment or by self-reflection or inter-reflection of objects in your scene. If the material finish is matte, you will still be able to see that the material is a hard plastic. This is because you will see reflections when the viewing angle is near to parallel with the surface and the highlights will remain relatively small sized. Moreover, hard plastics can be more contrast-rich than soft plastics, because they interact more with their environment.

Although the bottle from the previous rendering is not the kind of product you would see manufactured in hard plastic, I rendered the same bottle in reflective plastic to make a comparison. The exact same scene and lighting were used.

As you can see this material reflects the self-illuminating planes at the sides very clearly. It also shows self-reflection in the handle area. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\rendering ABS.3dm**.

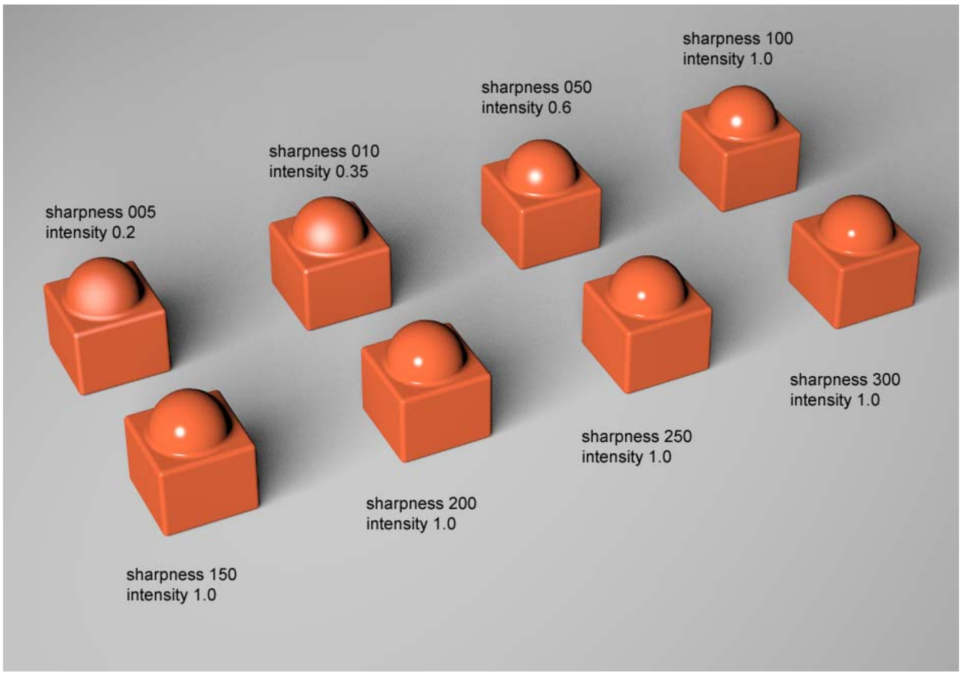
Bottle with hard plastic material.

About highlights

Because we are so familiar with highlights in computer graphics, most people probably don't realize that highlights are actually an unnatural thing. They were introduced in computer graphics to simulate the reflection of a light source, which is a lot brighter than object reflections. If you are familiar with high-dynamic-range images and renderings (see www.debevec.org) you will know that, in fact, a real highlight is a reflection of very bright light.

Since we can't use high-dynamic-range images in Flamingo raytrace, you can simulate a light source reflection with a highlight. Keep in mind that it should simulate the right kind of reflection of the light source. Therefore, you should use smaller, brighter highlights when the material is smoother and more reflective and larger, dimmer highlights when simulating a matte surface structure.

To illustrate this, I made an overview of eight different highlight types. The intensity gradually decreases when the highlight sharpness gets below 100. This should be done to keep a realistic look (highlights will otherwise look hard edged and too bright). What this image shows is that the highlight tells a lot about the surface structure, even when no reflections are visible. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\highlight test.3dm**.



Highlight sharpness and intensity.

Transparent plastics and glass

Transparent objects are probably the most difficult to render properly. A transparent object is visualized by its reflections and refractions. More than with any other material, your surrounding scene is of major importance to get a good result.

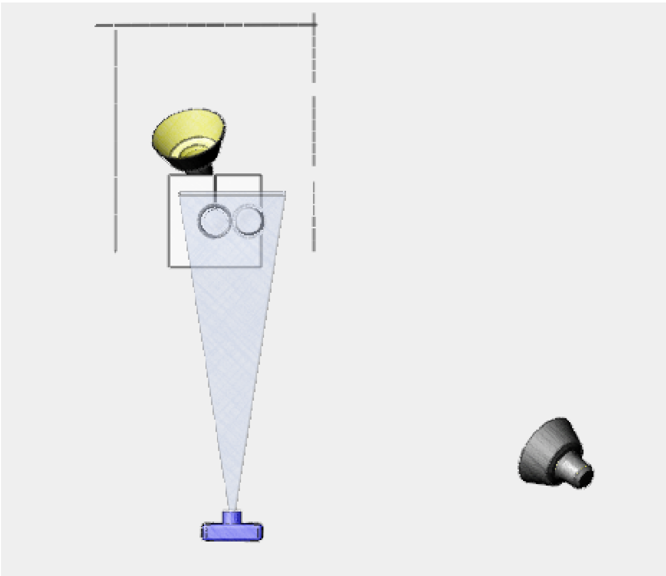
Angular blend materials are great for visualizing transparent objects. In the following example I used a dual angular blend. The reflectivity increases when the angle between the viewing direction and the surface normal increases. In contrast, the transparency decreases when this angle increases. In the first part of the blend, from 0 to 45 degrees, the transparency decreases from 0.934 to 0.606; From 45 to 90 degrees the transparency decreases from 0.606 to 0.336. An *index of refraction* (IOR) of 1.6 was used. Look at the model **Models and Images\Materials\glass.3dm** and examine the characteristics of the materials used in the model.

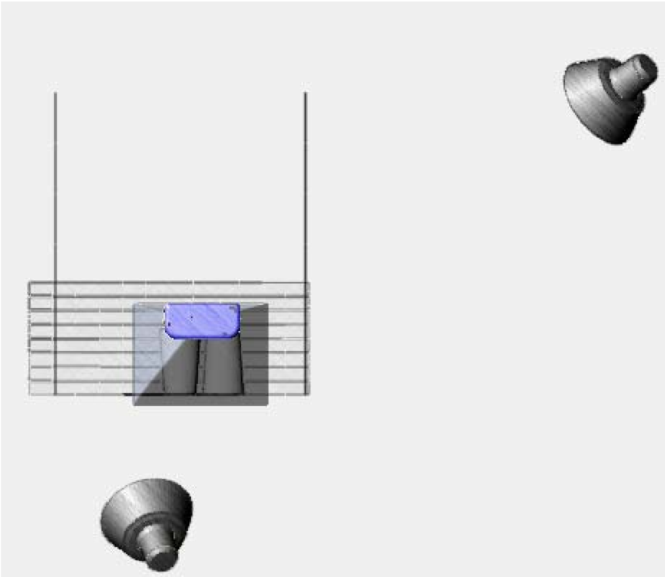

Transparent glass material.

The environment for transparent objects can be built with bright and dark objects, usually large planes. Flamingo will render both the reflection of these planes on the inside as well as the outside of the glass, which enhances the realism.

Setup of the glass scene

If you look at the glass scene, you will notice that I have placed a rather large plane at the left side and three narrow planes of same height at the right side.


Glass scene setup, plan.



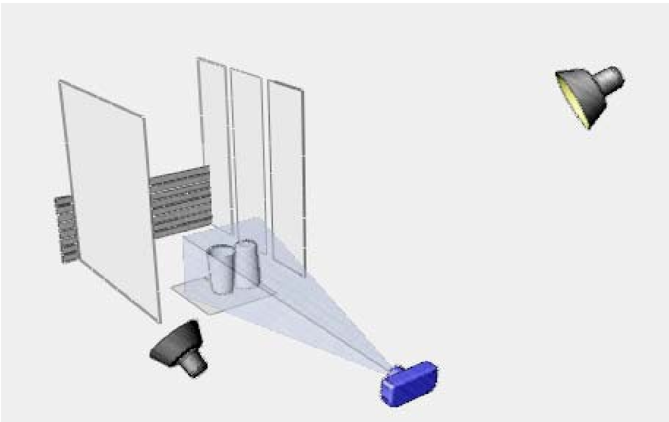
Glass scene setup, elevation.

One light is pointed at the glass and is set to cast no shadow. The large plane is set to 30% self-illuminant white, the three narrow planes are set to 100% self-illuminant white. These planes simulate large lights/bright windows that will appear as reflections in the rendering. They should not be directly visible in the rendering. I always set these illuminative planes to cast no shadow (Rhino Edit menu: Properties > Flamingo page).

The ground plane uses a reflective material that is included with Flamingo: BlueBlack Metallic in the Car Paint library.

In the background of the scene you will find horizontal planes with a default gray color. The nice thing about these planes is that the horizontal stripes will help to visualize the transparency and refraction of the glasses.

The smaller light in the left corner is placed for two reasons. It makes the background more interesting, and it makes the large light plane more convincing.



Glass scene setup.

Reflections, refractions, and rendering time

Because both reflections and refractions have to be calculated, rendering glass can be very time-consuming. Do not set the bounces for reflection and refraction too high, as a high setting will greatly effect the rendering time (both default to 3, which is sufficient in most cases). If you get unexpected results (opaque black glass, for example) you will need to increase the bounce setting (Rhino File menu: Properties > Flamingo page or Rhino Tools menu: Options > Flamingo page).

Filled glass

When you have a transparent object that is a container for fluid (like a drinking glass), you will need to create three different materials: one for the container, one for the fluid, and one for the transition between the two. This transition material must be used where the two materials touch each other.

For example, if the container is glass with an index of refraction of 1.6, and the fluid has an IOR of 1.3, the transition material has an IOR of 1.6/1.3 or 1.23. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\Filled glass.3dm**.

Note: The meniscus (the curved upper surface of the liquid) is modeled as well. The liquid does not look realistic without this surface.

Filled and empty glass.

Visualizing hard transparent plastic

The renderings above are undoubtedly glass material. If the same objects were made of plastic, the refraction, as well as the transparency and reflection, is less. Of course, the thick bottom is another cue to tell you it is not made out of plastic.

In the following rendering, I replaced one glass with a transparent plastic disposable one. The whitish color fractionally washes out the background behind it. As you can see, this gives the material a true plastic look. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\Transparent plastic.3dm**.

Plastic and glass.

In the following section, I will dig more deeply into transparent plastics. You will learn some important material properties of transparent materials and see what makes plastics so much different from glass.

Properties of transparent plastics

The table below shows some transparent plastics and their optical properties. In general, plastics have a lower level of transmission of visible light than glass. For example, PMMA is one of the most transparent plastics. Its transparency matches that of glass. The highest possible transmission level is about 92%. Transparency of 100% is not possible, because of loss due to surface reflection. Transparency will decrease when the material is thicker, as shown by the “Maximum level of transmission” column. The level of transmission is measured using a plastic thickness of two millimeters.

The “Haze” column describes the percentage of light that is being scattered inside the material. You can compare it with clear water that has had a few drops of milk added. If the haze value exceeds 30%, the material no longer qualifies as transparent. In that case, the material is described as translucent. This haze factor makes the biggest difference when comparing glass with transparent plastics.

Properties of transparent plastics			
Material	**Index of refraction (IOR)**	**Maximum level of transmission (2mm)**	**Haze**
Glass / crystal	1.5-2.0	92%	0-0.17%
PS	1.58	90%	0.1-3%
PE	1.52		Very high
PMMA	1.50	92%	1.0-3%
PC	1.59	90%	0.5-2%
SAN		87%	0.6-3%

Properties of transparent plastics			
Material	**Index of refraction (IOR)**	**Maximum level of transmission (2mm)**	**Haze**
ABS	1.52	91%	1.7-4%
PP	1.50		high
PA	1.53	85-90%	5-8%

Besides the haze factor there is another material property that differs from glass that is not included in the chart: the yellowness index (YI). Transparent plastics have a slightly yellowish color caused by the polymerization process. For example, for PC this varies between 0.5 and 2.0. Most other plastics have a YI between 1.0 and 3.0. This color is often masked by blue pigments added to the plastic resins. This explains why many so called “clear” transparent products often have a bluish color, especially when looking at an edge of the material.

Now that we know about these interesting properties of plastics, let’s see how we can simulate these in our rendering. I have done experiments with creating materials for transparent plastics and have found that this type of material is best controlled by adjusting Base color, Reflection, Self-Luminance, and Transparency.

Since haze causes a light scattering effect in the material, it tends to light up the material. That is why haze can be simulated by adding a small amount of self-luminance to the material.

Below you see a rendering of three different qualities of PP material, from left to right you would judge these as low-, medium-, and high-quality based on the amount of haze. In this case, “quality” refers simply to our judgment about the plastic material. The only thing that changed is the amount of self-luminance. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\PP dopjes.3dm**.

Low-, medium-, and high-quality PP material.

See how effective haze is to create various colored PP materials using the low-quality material as a basis. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\PP dopjes colored.3dm**.

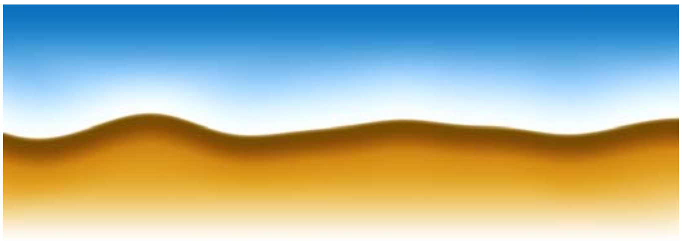
Low-quality colored PP materials.

Chrome

Using the full range of black to white levels is one of the most important things when visualizing chrome. So often I see people struggling with chrome asking why they cannot just dip their product in chrome and let the render application make it look right. Ask yourself, “What makes chrome look like chrome?” Not the material properties themselves, that’s for sure. The problem usually is that there is nothing in the scene to reflect. When putting a chrome ball in a single-color environment, there is no “‘information” to tell the viewer he is looking at a chrome object. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\Chrome gray.3dm**.

Chrome material with no environment,

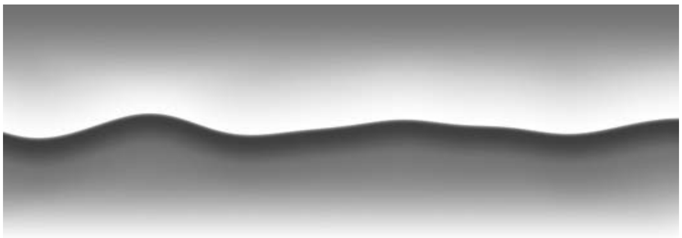
A common metaphoric way of visualizing chrome is to render it with a desert background. This metaphor comes from car photography, from the days that cars used to have lots of chrome parts. It was later taken over by airbrush artists. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\Chrome desert.3dm**.



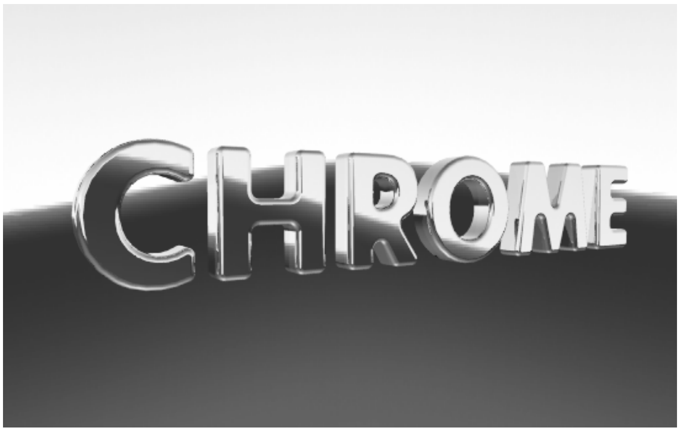
Desert background.

Chrome material with a desert environment.

Although it helps the viewer making the right perception, it is not very useful for studio product rendering purposes, since the color will have a distorting effect on your product. The rendering below is made with a grayscale version of the desert background. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\Chrome gray.3dm**.



Chrome grayscale background.



Chrome with a grayscale environment.

Although this is already a bit better then the desert chrome rendering, this is still not the kind of reflection you would expect in a photo studio and rather looks like painted afterwards in a photo editing program.

What we do need for our studio rendering are large white and black planes, just like those used in a photo studio. Bright white planes in a photo studio are created using square lights called soft boxes. Soft boxes cast soft light with area shadows. We will simulate them using simple planes with self-illuminating material.

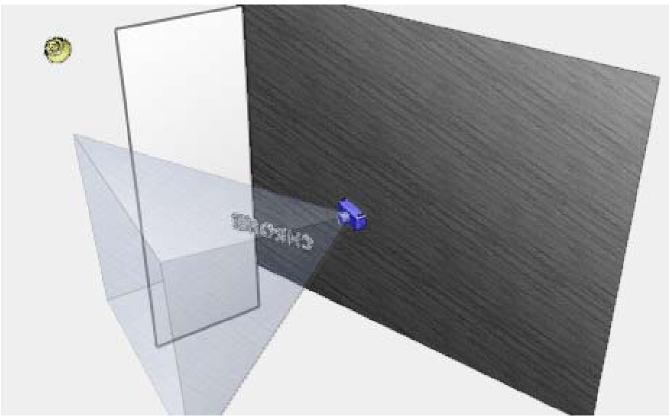
In the rendering below you see a rendering with a three-color gradient background, one white plane for the reflection, and one light. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\Chrome with white plane.3dm**.

Chrome setup with white self-illuminating plane.

The gradient background contains blue, the light is slightly off-white with a warm, yellow tint.

Chrome with gradient background and self-illuminating plane.

In the next rendering a black plane was added to improve the contrast in the chrome text. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\Chrome with white and black plane.3dm**.

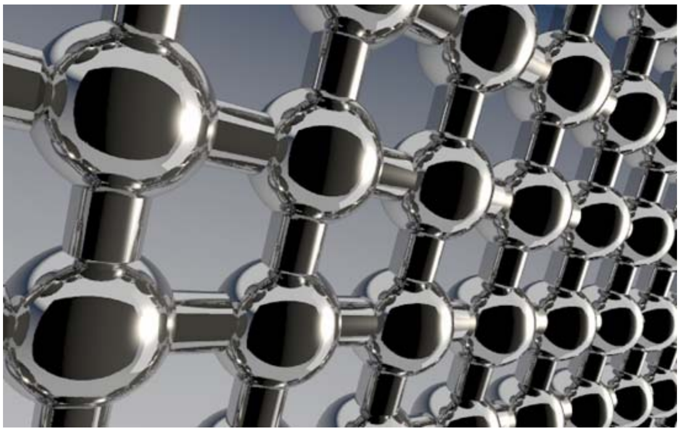


Chrome setup with black plane.

What you will probably notice is that there is a distinct light direction in the rendering. Light is coming from the right and brings in some extra depth to the rendering. The white plane that is reflecting in the last three letters was placed to cross the O in the reflection. By placing the reflection like this, you emphasize that it is a reflection and not an element of the product.

Black plane added to increase contrast.

Using the exact same scene, I rendered this grid of balls and cylinders. As you can see, the white and black plane together with a gradient background really help to visualize chrome. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\chrome grid.3dm**.



Brushed metal

Brushed metal is not the easiest thing to render properly. In this section I will give some hints to get a brushed effect on your objects. Again, I used the glass set environment for the reflection. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\Metal beakers.3dm**.

When rendering metal, the base color will be very important. Aluminum (left) is quite bright and bluish, steel (center) is darker, stainless steel (right) is even darker and slightly reddish.

Aluminum.

Steel.

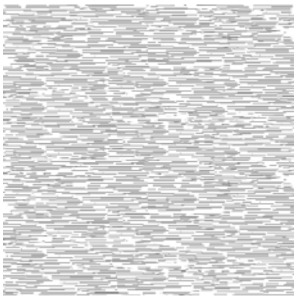
Stainless steel.

To accomplish this effect, you need to adjust both the material and the object. The object needs to have the correct mapping orientation (Properties command, Flamingo page). To properly map the material orientation, you will have to split the bottom from the rest of the beaker to assign different mapping orientation to it. In this case, the material mapping for the vertical sides of the beaker is cylindrical. The bottom has spherical mapping.

Brushed metal.

The brushed effect is simulated by using a bitmap of horizontally-oriented small lines. This has been assigned to the material as a negative bumpmap.

The pictures below show both bumpmaps for a rough brushed effect and a soft brushed effect. The bitmaps for producing these effects are included on your CD. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\fine brushed metal beakers.3dm**.



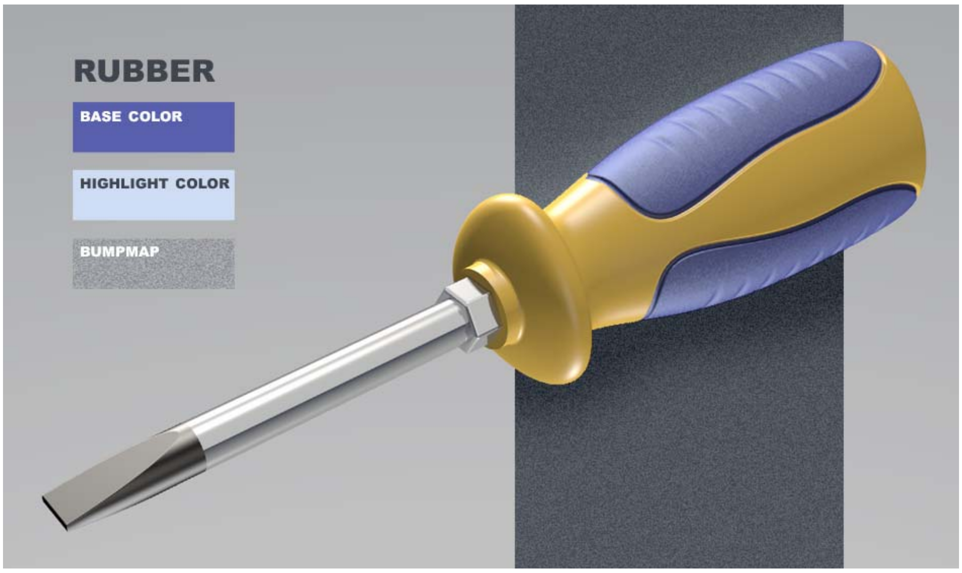
Rough brushed texture.

Soft brushed texture.

Rubber

Many products that have some hand interaction will have parts covered with a rubber layer. Screwdrivers, electric drills, and toothbrushes are examples of products that often have integrated rubber parts. The surface appearance of soft rubbers is, in most cases, very matte. This can be simulated by starting with a material that has a large and very dim highlight. Rubber looks more convincing when the highlight color is not white but slightly colored in the same tone as the base color.

Furthermore, to refine the look of the rubber material, you can add a fine bump to it. The material that was used for the rendering below is a procedural sandpaper structure with a uniform scale of 0.1 and a height of 0.2. Model: **My Documents\Studio-Quality Rendering\Models and Images\Materials\Screwdriver.3dm**.



Rubber grip material.

Conclusion

If lighting is the most important aspect of making studio quality renderings, materials take, without a doubt, the second place. Creating realistic materials means carefully observing objects and materials around you. With the correct lighting and materials, your renderings are more than halfway there.

4 Decals

Decals are 2-D images that are projected on a surface. In Flamingo, decals only show at render time. In most cases, a product will contain a brand name, a type number, or logo printed on the housing. Sometimes these are part of the mold and appear on the product as either embossed or engraved.

Flamingo's decals can also be used to render products for the packaging industry. These can be labels, shrink-wrapped, preprinted foils, or (in case of boxes) complete images.

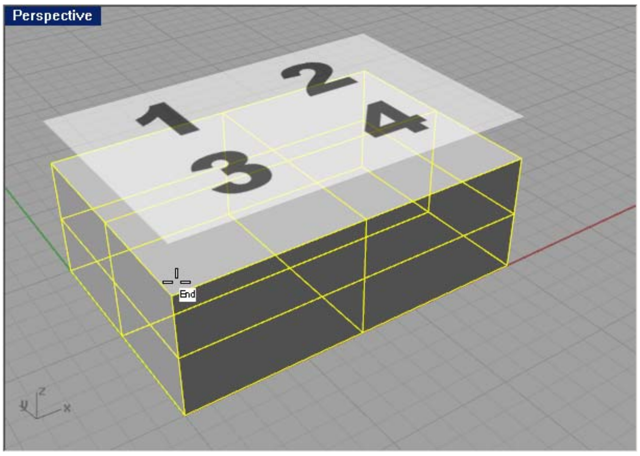
With regard to the way they are used there are three different kinds of decals:

Decal application style	Common Flamingo decal type
Stickers / wraps	Planar / UV or cylindrical decal without masking
Silkscreen prints	Planar or cylindrical decal with masking
Cut-out or embossed lettering	Planar or cylindrical decal used as a bump map

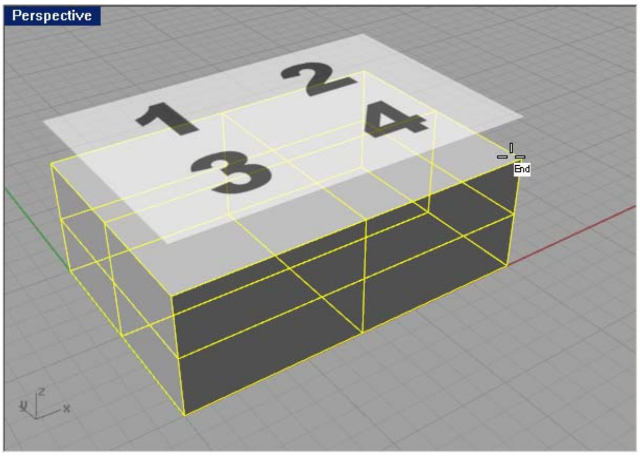
Planar decal

Placing decals in Flamingo is a bit tricky. To help with decal placement, it is a good idea to draw curves you can snap to. Decals are object properties. The control is found in the Properties dialog box (Rhino Edit menu: Object Properties > Decal page). The Flamingo Help has detailed instructions on how to place decals.

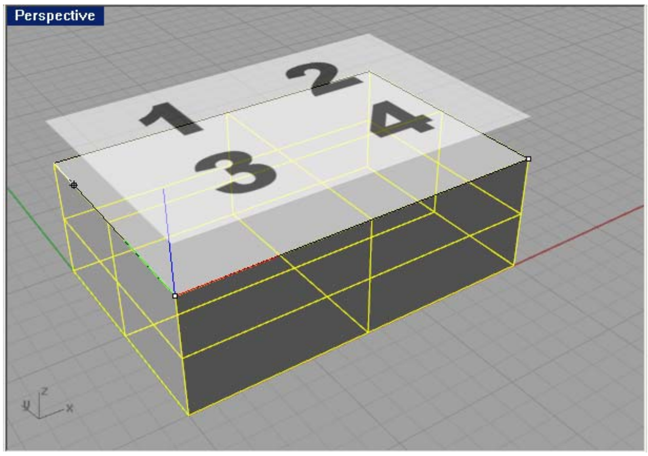
The following image shows the placement on the top of the box in three steps. I added the decal image above the object in Photoshop to make the orientation of the decal clear.



Place the "lower left" corner.



Place "lower right" corner.



Place "upper left" corner or rotation direction.

Decals in Flamingo need to be placed *behind* the surface, with the front face of the image pointing towards the surface. If the decal is placed on or above the surface, it may show only partially or not at all in the rendering. Decals are automatically placed slightly behind the object, so if the surface is planar, you can normally simply snap to the surface. However, if the decal appears smudged or parts do not render, then you need to move it farther back.

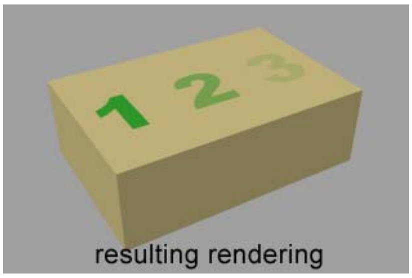
Masking for decal transparency

In Flamingo, there are two ways to make parts of your decal invisible. The easiest way is to use Flamingo's built-in color transparency masking. This can be used with all image formats that are available for decals. It sets a specific color to be masked.

The second more powerful option is to use one of the image formats that has an extra channel besides the common red, green, and blue channels. This extra channel is an opacity channel, also called alpha channel. The alpha channel tells which part of the image should be visible and which part should be invisible without reference to the color of the other channels. Targa (.tga) and Tiff (.tif) are examples of image file formats that support alpha channel.

The completely white parts of the alpha channel mean the pixels in that area will be 100% visible. The completely black parts of this channel mean the pixels in that area will be 100% invisible. The following example shows this idea more clearly.

Decal masking with alpha channel to create transparent decal.

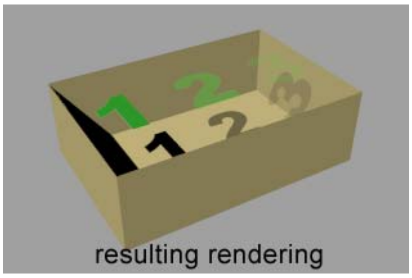


Decal transparent.

Masking for surface transparency

The same way that we use a selective color or an alpha channel to mask parts of our decal, we can use this information to make parts of the surface the decal is projected onto transparent. This can be done by selecting the Transparent checkbox in the Edit Decal dialog box, Map tab. Again, using alpha channel masking allows more control over visibility and transparency. The number 1 is fully opaque and casts a 100% black shadow, while the number 3 casts only a thin light gray shadow.

Decal masking with alpha channel to create transparent object.



Object transparent.

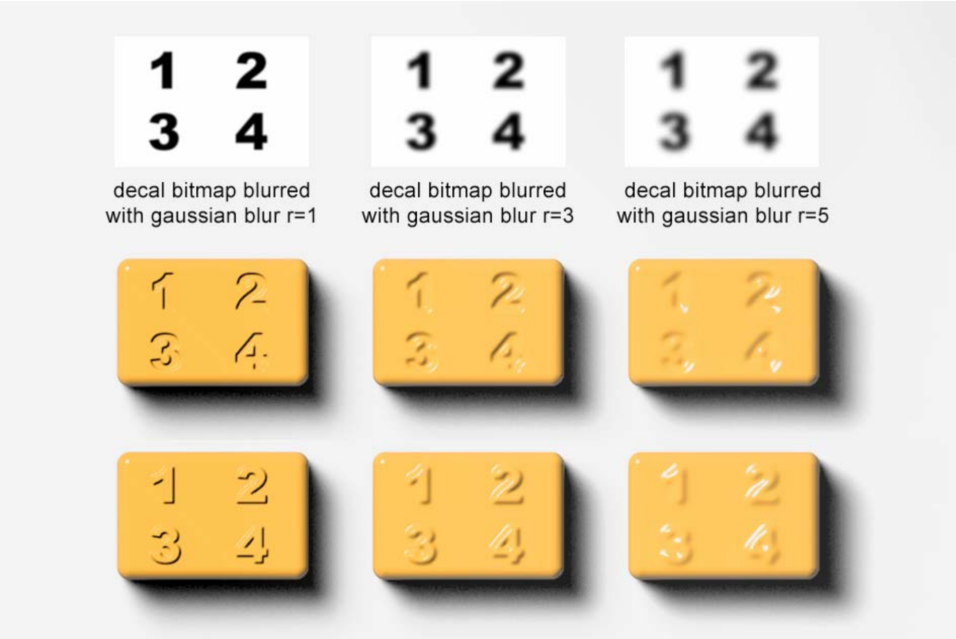
Bump mapping

In certain cases, bump mapping can replace modeling geometry. Think of small details like holes and anti-slip ribs that you want to appear in your rendering, but not in your model. For example, bump mapping can be used if details are added in a later stage or with a different application, or make your model too heavy, or when you want to explore different details before actually modeling the geometry.

To use images for bump mapping, you need to keep the following properties of bump maps in mind:

- The completely white parts of your image means no illusion of change in height of the surface.
- The completely black parts of your image means maximum illusion of change in height of the surface.
- Smooth transitions between the black and the white parts of your images results in smooth looking bumps.

Let's take a look at the following examples where the decal and rendering are displayed above each other. The decals in the upper row have a negative bump value. The decals in the lower row have a positive bump value.



Bump mapping with decals.

Plastic products often contain parts that are partially smooth and partially textured. Although you can make materials in Flamingo that contain such a texture, they do not give local control. This is where decals can come in handy. The following decal example and its rendering are shown to give an idea about the possibilities.

Bump mapping example

Decal bump mapping is very useful when you need to explore various detail options for your product. As an example, I modeled this safety device, a necklace called RESQ that can transmit an emergency signal in case of danger. This simple product is enhanced by the graphical details. For this rendering setup, two planar decals were applied as bump maps. The cord was made by applying a UV map, which will be discussed later on in this chapter. Model: **My Documents\Studio-Quality Rendering\Models and Images\Decals\RESQ.3dm**.

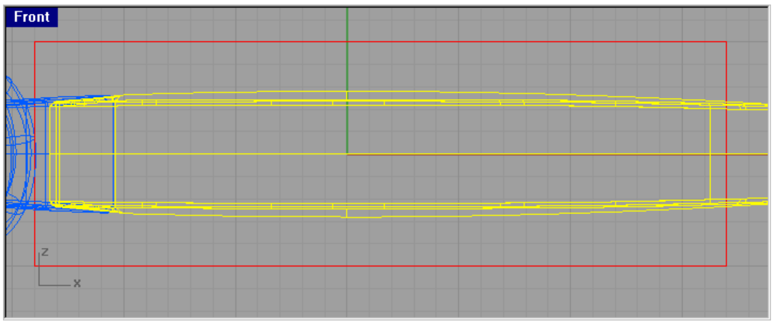
Decal mapping creates both color and texture.

Side decal bump map placement

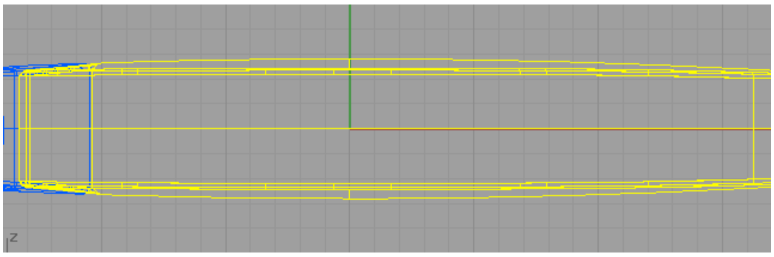
For the side decal of this device, I explored three different graphical designs. To make placement of the decals accurate and predictable, Photoshop is added in the workflow. The following simple steps explain how.

To create the decal image

1. Draw a rectangle around the device that will later be used for placing the decal.



2. Make a screen shot in Rhino with ScreenCaptureToClipboard or Ctrl+C.
3. Paste the image into Photoshop or other image editing software.

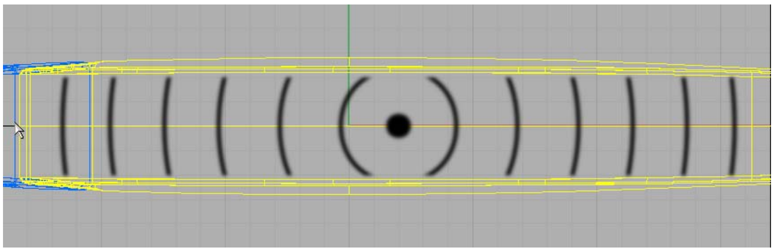


Screen shot cropped to the size of the rectangle around the device.

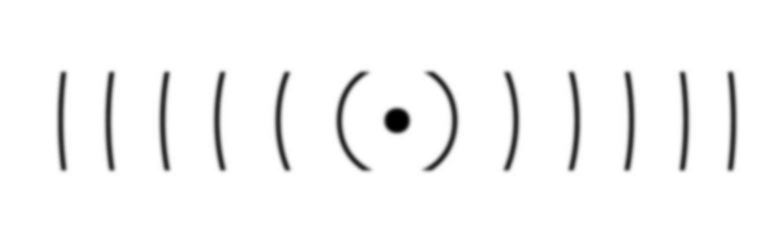
4 Crop this screen shot to the size of the rectangle.

5 On a new layer, draw the decal.

If you keep the background visible, you can easily determine the right location for the decal image.

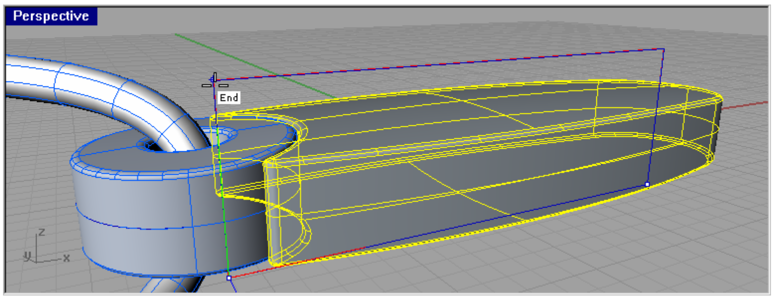


Decal image drawn in a new layer in Photoshop.



Decal image layer merged to a white background.

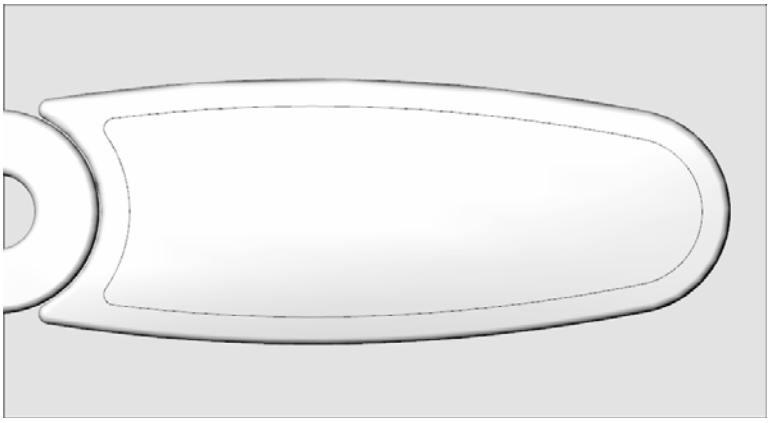
6 Back in Rhino, placing the decal is easy. Just snap to the endpoints of the rectangle and your decal fits perfectly.



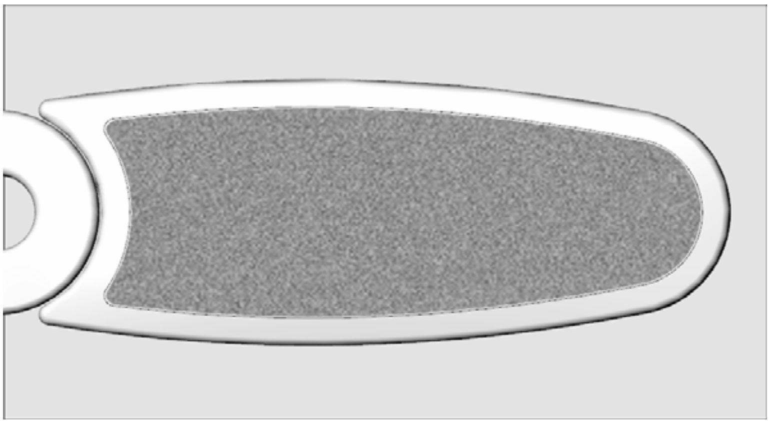
Use the reference rectangle to place the decal.

Top decal bump map placement

The following page shows this process for the top decal bump mapping. To make the sandpaper structure, offset a curve from the outer edge of the device. I have drawn this offset curve and used this as a reference to fill in the area in Photoshop. After that, text was added. This is done in white to make only the sandpaper appear as a bump in the rendering.



Offset curve gives outline of bump area.



Bump area drawn in Photoshop on a separate layer.

Text added in Photoshop.

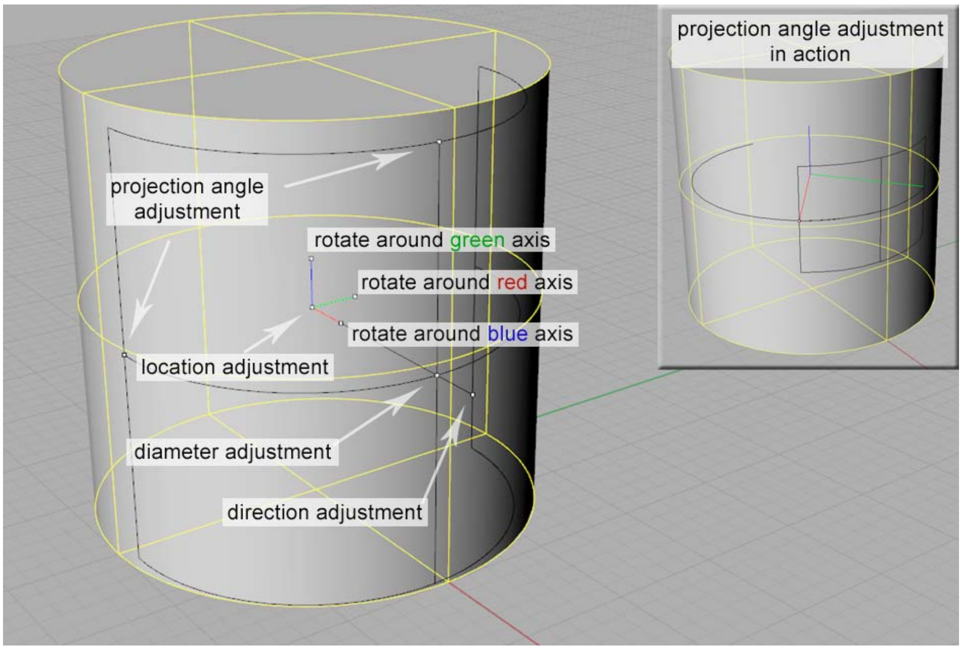
Finished bump map image.

Cylindrical decals

Placing cylindrical decals also offers some challenges. When placing cylindrical decals, the first point corresponds to the center of the cylinder. The second point corresponds to the center of your decal image and also determines the radius of the cylinder.

Since this point can be located anywhere in space, you will make placement a lot easier if this can be done in one of the orthogonal views. If your object is not oriented "orthogonally," make a new set of construction planes that is coupled to this object before placing the decal.

While we are still making our decision for the location of the second point, you will see that the lines form a half of a cylinder. This can be adjusted after placing this second point. For the moment, just make sure the orientation is correct. Size and projection angle can be adjusted after placing the first two points. After picking the second point, it will look something like this:



Cylindrical decal placement.

The three you will use the most are projection angle adjustment, diameter adjustment, and direction/location adjustment. With projection angle adjustment, you can drag the adjustment point to make the default angle of 180° smaller or bigger, to a maximum of 360° to make a full wrap around the object. This is useful for bottles and cans, as you can see on the next example.

Cylindrical decal placement around entire can.

With diameter adjustment you can scale the decal in the radial direction. Try to match the diameter as closely as possible to that of your object to avoid changes in aspect ratio of your image.

Finally, you will use direction and location adjustment to move the decal to a different spot on your surface. The direction adjustment is used to rotate the decal around its axis. This works best in the Top view. The location adjustment is best used in either Front, Back, Right, or Left view, with Ortho on.

Cylindrical decal example

The following example shows the use of cylindrical decals in a bottle design. Bumpmaps were used to simulate geometry that would otherwise have been difficult and time consuming to model. Model: **My Documents\Studio-Quality Rendering\Models and Images\Decals\Chili Sauce.3dm**. Modeling the decorative indentations around the bottle could have increased modeling time considerably.

Cylindrical image and bump map decals.

Paper label

The paper label was applied with three decals:

- white text on red background:

- Yellow rings with red background masked with reflective properties to simulate printed gold:

- Bump map to simulate the texture of the paper:

Bump maps for bottle features

Bump maps were used to make the indentations and bumps on the bottle.

Bottle neck bumps.

Decorative bumps around the bottle.

UV Mapping

UV decals are images that are stretched out over the complete surface area. For this reason there are no controls for placement. When assigning the UV decal, you will need to make a test rendering to see if the placement of your decal is right.

When having unexpected results, use the **Reparameterize** and **Dir** commands to adjust the mapping coordinates and direction. For further detail about these commands, please see the Rhinoceros Help.

Another option is to assign the decal as a Rhino basic render material texture, Flamingo will also render this, and it will display in the viewport when using Rendered Viewport mode.

UV Mapping Example

Since UV maps are not used very often, I will only give a small application example. The cord in the normal decal example, **My Documents\Studio-Quality Rendering\Models and Images\Decals\RESQ.3dm**, has been made with a UV decal. This decal looks like this:

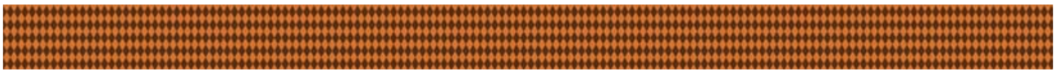
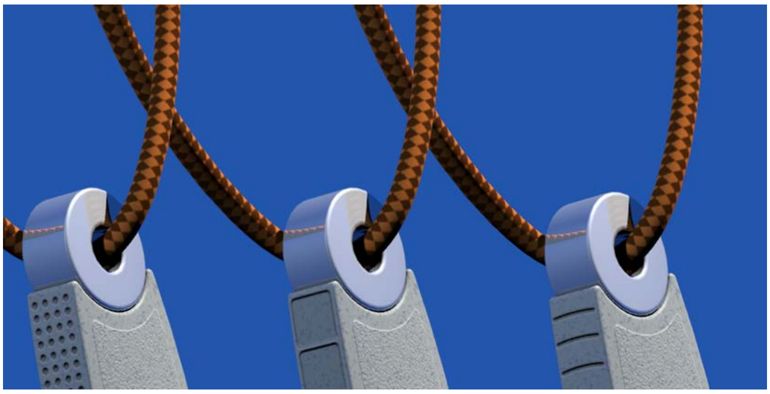


Image for UV mapping on the cord.

Because the decal is wrapped around the tube, the gray and orange parts must match when wrapped. You can always check if your mappings wrap neatly by using the Photoshop Filter menu: Other > Offset, with Wrap Around option selected. In this case, you should make a vertical offset to check the texture’s wrapping.



Conclusion

Once you know the rules of placing decals in Flamingo, it will be a lot easier to get the desired result. Adding placement geometry as explained in the planar decal application example, can make correct placement a lot more accurate and controllable. Furthermore, this helps applying more then one decal at exactly the same location.

By transferring screenshots from Rhino to Photoshop you can use the placement geometry lines to cut out the right decal size. Saving your decal images in Targa or Tiff format allows you to include an alpha channel mask that can let you remove unwanted areas from your decal during render time.

5 Improve Rendering Speed

Many people who use Flamingo like its output, though they complain about its speed when comparing it with other rendering software like 3ds max. First of all, we have to make sure not to compare raytracing with other rendering methods like scan-line rendering. Raytracing is far more accurate than scan-line rendering and is therefore a slower process. Quality has its price in terms of render time.

In my opinion, many problems with render times can be attributed to improper mesh settings and a few other settings in Flamingo. Guided by a series of renderings accompanied by an overview of their settings, I will show you a way to drastically reduce your render times without any hardware investment.

For the rendering examples, an arbitrary device has been modeled, which has both small details as well as larger, nearly flat surfaces.

Check for bad objects

Bad objects can cause Flamingo to become very slow or to not render at all. When experiencing longer than expected voxelizing and/or screen grid build time, check your scene for bad objects, and fix or remove them.

Use smaller resolution

The resolution of your image makes a difference in rendering time. Do not start immediately trying to render your image at 6000 x 4000 pixels. A smaller image will render faster. Starting with a Viewport resolution during the early setup stages, will make your work go faster. Save the high resolution images for your final renderings.

Use Flamingo's built-in ground plane

One of the best time savers in Flamingo is to use the built-in ground plane instead of a modeled one. The following two renderings show why: At the left is a rendering with a modeled ground plane, at the right a rendering with the built-in ground plane. There is no visible difference in the images.

Rendered with modeled ground plane.

Mesh settings: Smooth & slower
Mesh count: 232861 mesh faces
Antialiasing: 16x
Soft shadows enabled
Render time: **2018 seconds**

Rendered with built in ground plane.

Mesh setting: Smooth & slower
Mesh count: 231825 mesh faces
Antialiasing: 16x
Soft shadows enabled
Render time: **634 seconds**

As you can see using the built in ground plane saves more than 68% in rendering time.

Use custom mesh settings

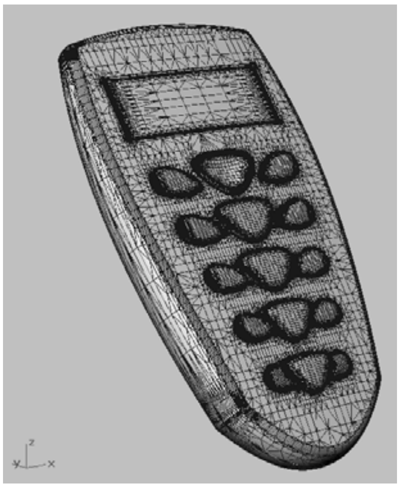
While Rhino's default mesh settings are designed to give you some flexibility, you get better control over the trade-off between render time and quality if you use the custom mesh settings. The following examples demonstrate the time savings. Using the custom settings gives you the best time while preserving enough mesh quality for good rendering. All times given in this example use 16x antialiasing.

Mesh setting: Smooth & slower

The "Smooth & slower" setting makes an attempt to reduce the jagged appearance of the render mesh by increasing the number of mesh faces. This makes the model render more slowly, but with a smoother appearance.

Rendered with Smooth & slower setting.

Mesh count: 231825 mesh faces
Render time: 634 seconds



Render mesh displayed.

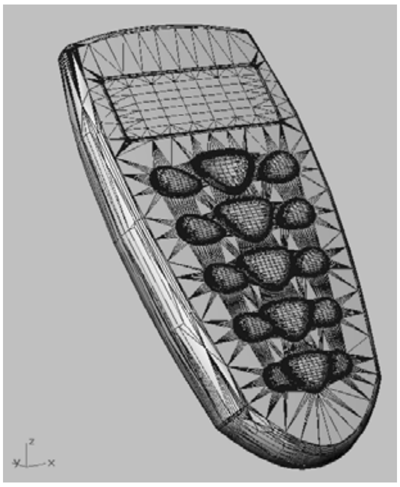
Smooth & slower settings
Maximum angle: 15
Maximum aspect ratio: 6.0
Minimum edge length: 0.0001
Maximum edge length: 0.0
Maximum distance, edge to surface: 0.0
Minimum initial grid quads: 16

Mesh setting: Jagged & faster

Using the “Jagged & faster” setting makes the rendering a bit faster, but also sacrifices some quality. You can see the jagged mesh along the top and right side of the object in the rendered image. Render time is gained at the expense of a jagged appearance on the smooth edges of the model.

Rendered with Jagged & faster settings

Mesh count: 123473 mesh faces
Render time: 597 seconds



Render mesh displayed.

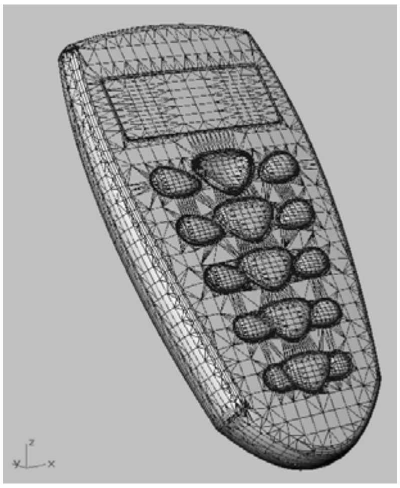
Jagged & faster settings
Maximum angle: 20
Maximum aspect ratio: 0.0
Minimum edge length: 0.0001
Maximum edge length: 0.0
Maximum distance, edge to surface: 0.0
Minimum initial grid quads: 16

Mesh setting: Custom

Using custom settings gives excellent quality with an even greater speed saving. Choose your custom settings based on the shape of the object itself.

Rendered with custom settings.

Mesh faces: 37616
Render time: 365 seconds



Render mesh displayed.

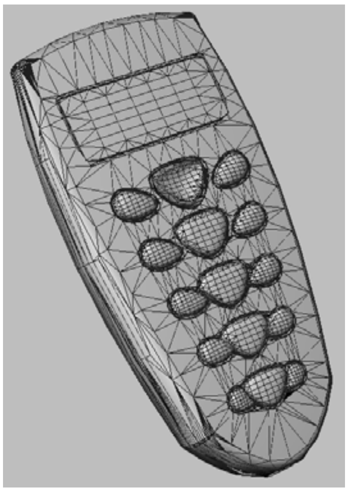
Custom settings
Maximum angle: 0.0
Maximum aspect ratio: 0.0
Minimum edge length: 0.05
Maximum edge length: 5.0
Maximum distance, edge to surface: 0.1
Minimum initial grid quads: 0

As you can clearly see from these examples, it is worthwhile to spend some time on a proper render mesh setting. In this case we save more than 42% render time going from the Smooth & slower setting to this Custom mesh setting.

How to choose mesh settings

Finding the best mesh settings depends on the shape of your model, so some experimentation is required.

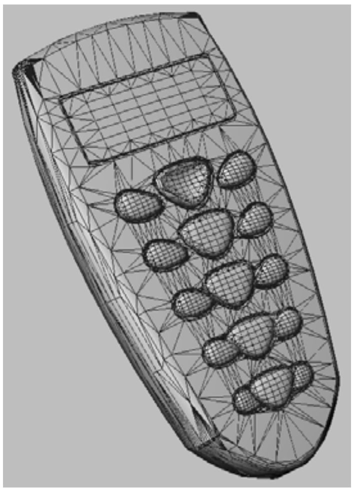
I start by clearing all values in the **Custom** mesh settings (Rhino File menu: Properties > Mesh page) except **Maximum distance, edge to surface**. It depends on the model, but when working on small products, I have found that starting with **1** will give a fast result to use as a starting point.



Initial mesh attempt.

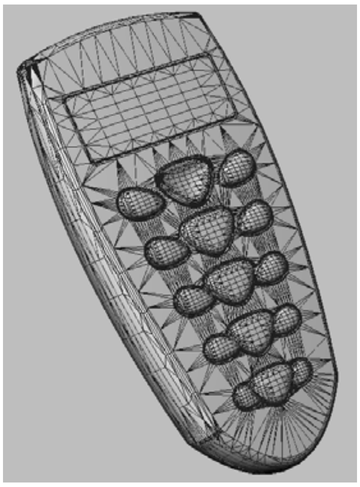
Custom settings
Maximum angle: 0.0
Maximum aspect ratio: 0.0
Minimum edge length: 0.0
Maximum edge length: 0.0
Maximum distance, edge to surface: **1**
Minimum initial grid quads: 0

I then start refining the **Maximum distance, edge to surface** from **1** to **0.5** and then to **0.1**. I lower this value until the larger edges are smooth looking.



Start refining settings.

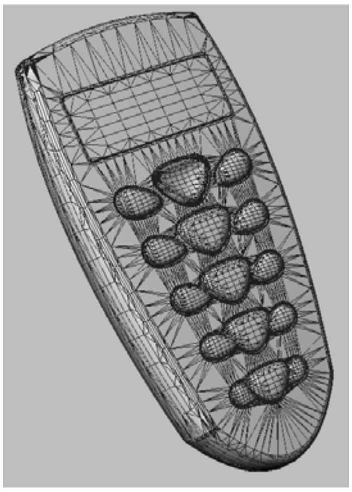
Custom settings
Maximum distance, edge to surface: **0.5**



Decrease distance edge to surface.

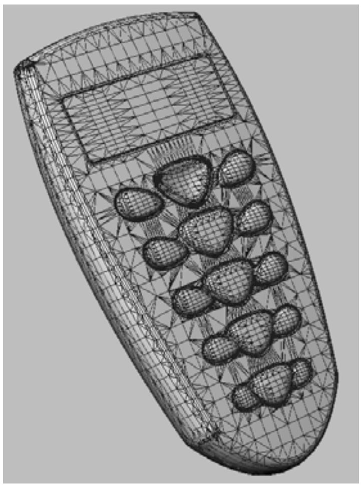
Custom settings
Maximum distance, edge to surface: **0.1**

Next, I check the details. In the left corner of the device, the fillet does not mesh very well. Also, the fillet is approximated by a flat mesh. Instead of lowering the value for **Maximum distance, edge to surface**, I start limiting the **Maximum edge length** setting until this problem disappears.



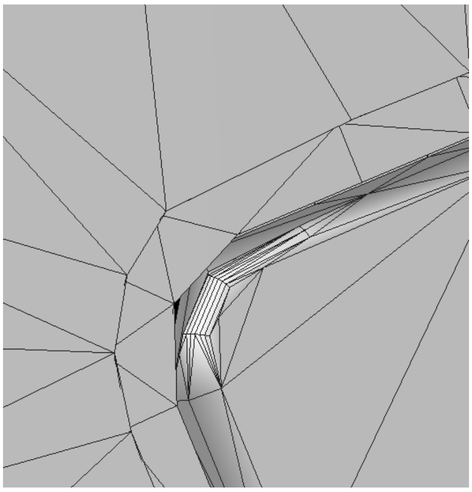
Refine edge length.

Custom settings
Maximum edge length: **10**
Maximum distance, edge to surface: 0.1

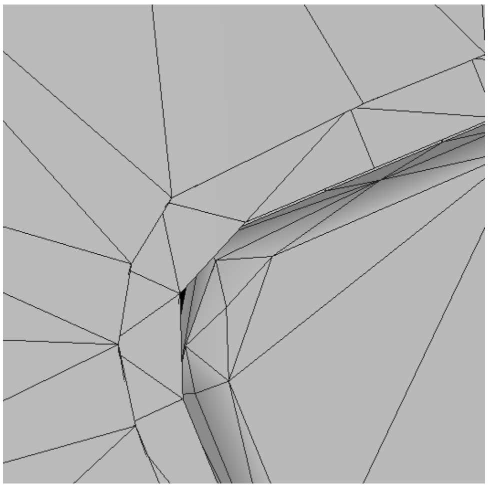


Custom settings
Maximum edge length: **5**
Maximum distance, edge to surface: 0.1

Although the mesh is already quite good, it can cleaned up a bit by limiting the shortest edge size with the **Minimum edge length** setting. For example, the upper-left corner of the screen shows strange and dense meshing as shown below in the example on the left. By experimenting, I found that setting the **Minimum edge length** to **0.1** works well.



Custom settings
Minimum edge length: **0.0**
Maximum edge length: 5
Maximum distance, edge to surface: 0.1



Custom settings
Minimum edge length: **.1**
Maximum edge length: 5
Maximum distance, edge to surface: 0.1

Use low-antialiasing settings during set-up phase

So far, I used only the highest antialiasing settings for the example renderings. In most cases however, it is not necessary to render at 16x antialiasing. Especially during the setup phase of a rendering, you can make good use of lower settings to check the amount of light, direction of shadows, and materials.

The following picture shows a comparison using the custom mesh from the previous examples with different quality settings.

Antialiasing: **16x**
Soft shadows: On
Render time: 388 seconds

Antialiasing: **8x**
Soft shadows: On
Render time: 114 seconds

Antialiasing: **4x**
Soft shadows: On
Render time: 108 seconds

The difference in quality and render time between 4x and 8x is not very great, but it takes more than three times as long to render at 16x. Rendering at 8x saves more than 70% render time.

If we continue to lower the settings and use hard shadows, we can reduce the render time to as low as 17 seconds, and still we can get a good idea about the lighting, materials, and shadows.

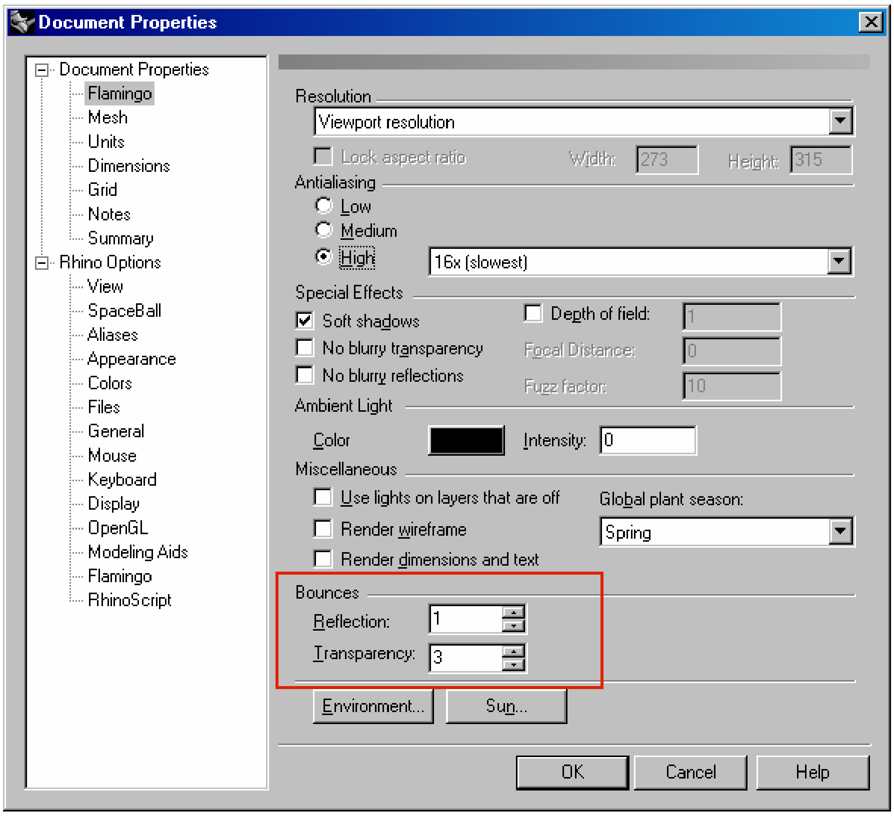
Antialiasing: **High 16x**
Soft shadows: Off
Render time: 146 seconds

Antialiasing: **High 4x**
Soft shadows: Off
Render time: 45 seconds

Antialiasing: **Medium**
Soft shadows: Off
Render time: 17 seconds

Reduce bounces

Finally, an option in Document Properties controls the number of reflective and transparency (refractive) bounces. Generally, you can leave the transparent value at 3, but the reflective bounces can be reduced to 1 without affecting the final output very much.



Again, I rendered the same picture and compared it with the standard setting of three bounces.

This time we don't win the grand prize, but still we save about 17% render time.

Reflective bounces: 3
Render time: 390 seconds

Reflective bounces: 1
Render time: 325 seconds

Conclusion

In the following table, I have made an overview of all time saving options in Flamingo. If we take the two most distant versions, we can see that Flamingo produces output from blazing fast coarse images, to high-quality images with nice soft shadows. The use of coarse settings during set up can save valuable minutes, if not hours.

Option	Time Savings
Using built-in ground plane	68%
Using customized mesh	42%
Using less reflective or refractive bounces	17%
Total savings while maintaining high quality output	**127%**

The time savings from using a lower resolution varies depending on your final size requirements.

If we also take lower quality renderings into consideration, Flamingo can almost be as fast as you want it to be. I want to note again that during render setup, low antialiasing settings are the most useful to quickly test your lights, shadows and materials.

6 Post-processing

Post-processing rendered images can be as important as the rendering itself. Although you should always strive to make your renderings perfect without any work on the image, post-processing can enhance your images or help you achieve results that would otherwise have been difficult to render. In this chapter, I will discuss adjustment techniques for your renderings:

- Cutting out the background.
- Adding soft focus.
- Adjusting tonal range.
- Rendering lights separately to control lighting.

This chapter assumes you have Photoshop or an equivalent photo editing program to work with. It should at least support paths, layers, and various layer blending modes. This section will give you ideas about how to use post-processing techniques but it is not a Photoshop tutorial. If you are not familiar with using Photoshop, there are many excellent references available.

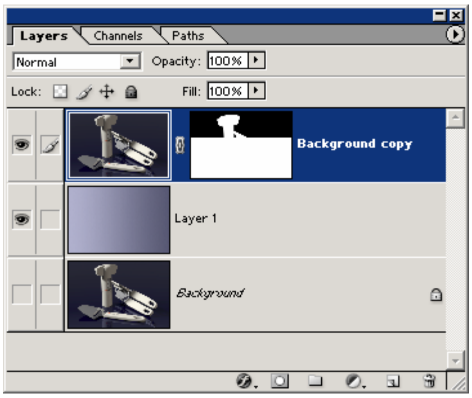
Cut the background

The image below shows an example where the background was post-processed in Photoshop. This background could have been included in the rendering, but since I was using a reflective ground plane that I wanted to keep dark, this was not a possible solution. In addition, rendering the right-to-left gradient background as it is shown here is not possible with Flamingo.

Original rendering.

Background gradient added in Photoshop.

A major advantage of doing this in a photo editor is that you can adjust things in real time. The image above has three layers, as you can see on the dialog box image below. It is a good habit to make a duplicate of your rendering on a new layer for making the adjustments. This makes it easier to go back to the original image, and it gives you the opportunity to easily compare the adjusted with the original. The background layer is turned off.



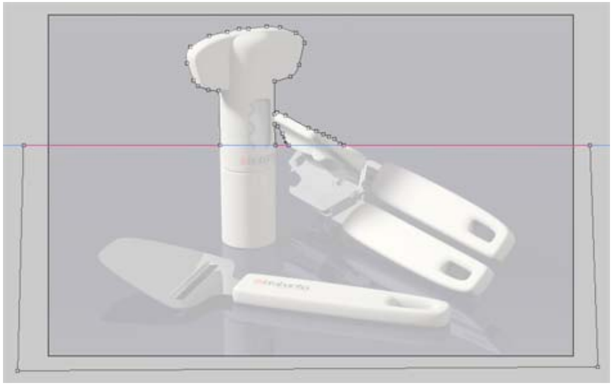
Layers in Photoshop.

To insert a new background into your image, you do not need to delete a part of your rendering or paint over it. Three simple steps are required to make a background show up where you want.

To create a new background

1. Draw a path around the part of the image that you plan to keep.

   By inserting a guideline to snap to, you can make sure the background will be a straight line. As you can see in the image below, the path can be drawn outside the borders of the image.

   Path drawn in Photoshop.

2. Select the path you just created.

   Depending on the resolution of your image, set the Feather Radius value to 0.5-2 pixels.

3. Make a layer mask from the selection (Photoshop Layer menu: Add mask > Reveal Selection).

4. Make a new layer for the gradient background and place this layer below the masked layer we just created (layer 1 in the example).

I used a gradient from left to right and made the left side brighter to emphasize the lighting direction in the image.

Background gradient.

Another application for the path we just created is a clipping path. Layout programs like Adobe® InDesign® and QuarkXpress™ can use these paths to automatically mask the image.

Add a soft focus effect

The term soft focus is not related to depth of field. Soft focus filters are pieces of frosted glass with varying amounts of translucency. These filters, when put in front of a camera lens, tend to soften the light and spread out the bright highlights to give a certain amount of glow.

The image below shows a rendering before and after this soft focus effect was applied.

Before soft focus effect.

After soft focus effect applied.

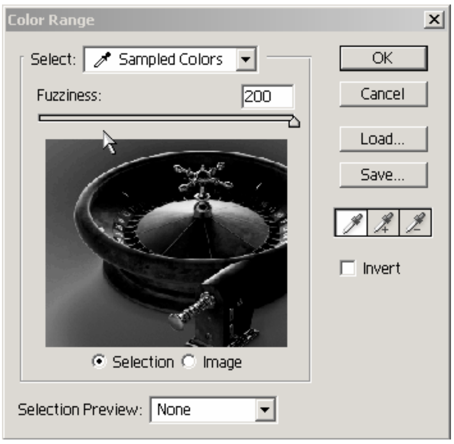
As you can see, this adds the illusion that the light from the back has increased significantly. It gives a softer feel to the rendering, because it mimics light being scattered around by dust particles in the air.

To make this soft focus effect

1. Make a copy of your rendering to a new layer (Photoshop menu: Select > Color Range...).
2. With the eyedropper tool, select the brightest part of your image and adjust the Fuzziness slider.

   The white parts show the parts that are going to be selected.

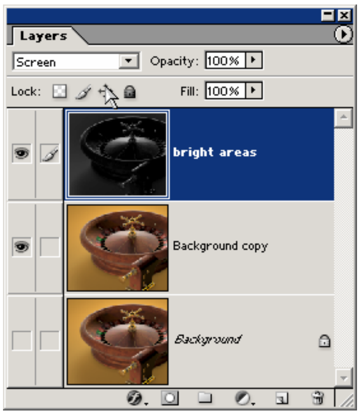
   In this case, I moved the slider completely to the right, because the image is quite dark.



3. Copy the selected pixels to a new layer.
4. Remove the color from this layer by adjusting Hue/Saturation, sliding saturation completely to the left.
5. Make a new layer and fill it with black.

   Place this layer below the previously created layer and merge these two layers to one. This merging to a black layer makes your bright areas more visible, though it is not strictly necessary for achieving the effect.

Your layer state should look something like the image below.



Notice that the layer blending mode has been set to “Screen” for this newly created layer.

Make a copy of this layer and hide the original.

6 Blur the copied layer with Gaussian blur.

Because the layer has already been set to “Screen,” you can preview the result while adjusting the amount of blur. The amount of blur will greatly depend on the resolution of your image.

Experiment with it until you get the desired result. You can increase the effect by duplicating the blurred layer or decrease the effect by adjusting the opacity of this layer.

Adjust the tonal range

In Photoshop show the tonal range of your image (Photoshop Image menu: Adjust > Levels). This tonal range is represented by a histogram that shows the relative amount for every intensity value in the image. The left of the histogram shows the darker range, the right shows the lighter range.

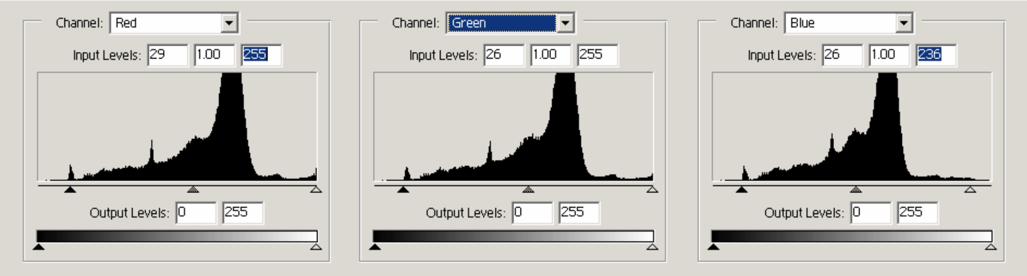
What can we learn from a histogram? The most important thing to check is whether or not the histogram fills the complete range from 0-255. An empty space at the left means there is a lack of very dark tones (shadows). This can be caused by using (bright) ambient light in your rendering or when your rendering is overexposed. An empty space at the right means there is a lack of brighter tones (highlights). In that case, your image is underexposed. When there is an empty space at either end, both problems are present.

Although in certain cases there is nothing wrong with the rendering, most of the time an empty space means there should be some adjustments made to the image.

The following image shows a rendering right out of Flamingo with its histogram before making the level adjustment and the image after making the level adjustment. As you can see by comparing the two images, improved highlights and shadows yield a better contrast and a crisper image.

Before level adjustment.

After level adjustment.



Histogram.

The three arrows below the histogram are markers for the shadows, mid tones, and highlights. In the shadow areas, the image was adjusted by sliding the arrows in all channels to the beginning of the "mountain," where you see the marker on the left in the images. Because in the red and green channel the histogram shows that there are parts of the image with the highest value for these two channels, the highlights were left untouched.

The blue channel however, shows a small gap at the end. I closed this gap by sliding the highlight marker to the left. When there is a gap in only one of the channels, you should not close it automatically (this is what the automated level adjustment does). Base your decision to close the gap on your situation. For example, if your rendering contains only red objects, closing a gap in the blue channel would be irrelevant.

Render in layers

After making a rendering, you will often need to make (small) adjustments. Perhaps the lighting is not perfect, or perhaps you need to add more contrast or brighten it up a little. If you render your lights separately, you can create layers in Photoshop that let you control the amount of light after the rendering is complete. It will take a little bit more time for setting it up and for rendering, but using multiple renderings on layers gives you great control and live updates afterwards.

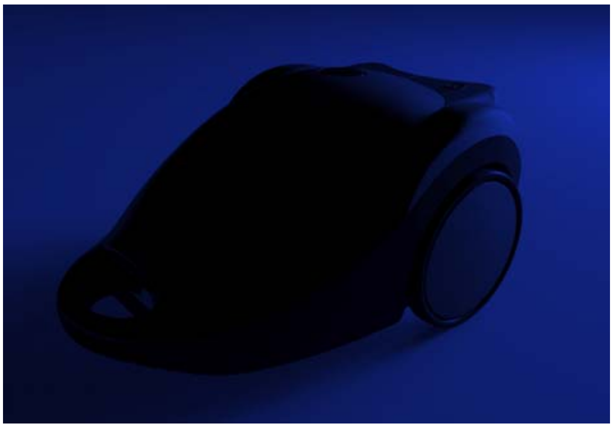
The following example shows a scene lighted with three lights. To get similar results as when rendering all the lights in one pass, you will render the scene four times. You will render the environment reflections separately. Then you will render each light without environment.

To render the environment reflections, turn off all but one light. Set the color of the remaining light to black and render. This disables the default lighting.

To render the lights, set the environment background to black and turn off all but one light. Render an image with only one light on. This will create three separate images in this case.

In all, you will create four separate renderings as shown below.


Rendering of the key light.


Rendering of fill light.


Rendering of the back light.

Rendering of background reflections.

Now we will open these renderings in Photoshop and drag the renderings into a new file with the same size as our rendering. This new file should have a black background. Hold the Shift key during drag to drag the layer into the new image in place.

Set the layer blending mode of all four rendering layers to "Screen."

As shown below you see a comparison between the one-pass version and the four-pass version.

One-pass version.

Four-pass composite.

Although the one-pass version is a bit darker, there isn't much difference between the way these renderings look, but all lighting information is still available. You can easily correct the darkness by putting a curves layer grouped to each screened layer. The result of this is shown below.

Rendering after adjusting curves of each layer.

Now that we have our layered version, we can start playing with the lights. By adjusting the opacity of a layer, you can turn down or switch off a light in real time. Another great option is the ability to duplicate a light to double its contribution. But there is more. You can change the color of each light in real time to create different moods in our rendering.

Just a few seconds in Photoshop adjusts the mood of a layered rendering.

All adjustment layers for this example are included in the file **Models and Images\Post Processing\Composition vacuum cleaner.psd** on the CD.

Conclusion

As you have seen, Photoshop adds a large toolset to complement your renderings. It can save time as well as add effects that are simply impossible using Flamingo alone. Furthermore, it has perfect tools to fine-tune your colors, tonal range, and balance. Rendering in layers is a powerful method to create renderings on which you have lots of control afterwards. It is also an invaluable tool to study your lighting.