

# Chapter 8: Materials

## In This Chapter

After you build a dollhouse or assemble a plastic airplane model, you can't wait to paint it and stick decals on it. With 3D animation, it's usually the same feeling! This chapter addresses creating and applying all manner of materials. One of the delights of 3D animation is trying out all those "what-if" material choices. What if the car was painted chrome with red leather trim, or purple plastic with chrome polka dots? Simulating these surfaces with Maya is a straightforward task when you use Maya's Hypershade—the material "laboratory." Applying revised materials and rendering the scene again is a snap. In this chapter, you'll focus first on the basics of creating materials and then learn how to add complexity and realism through mapping:

- **Using Hypershade** An overview of Maya's material creating and editing tool.
- **Creating materials** Building a surface type from scratch.
- **Using maps** Replacing a material's solid color with an image.
- **Using procedural textures** Replacing a material's solid color with a solid texture created by a mathematical formula.
- **Bump maps** A texturing method that gives the impression of bumpiness on a surface.
- **Using maps for any attribute** Replacing a solid color or a fixed number with an image to change the value across an object's surface.

## Key Terms

**material** The definition of all the ways a surface responds to light, including shininess, color, bumpiness, transparency, and so forth.

**shader** A shader refers to both the material and the lighting of a surface with respect to rendering.

**Hypershade** Maya's material editor.

**texture map** A 2D image applied across a surface; typically, a bitmap image, such as a photo of wood grain, that can be tiled.

**UV coordinates** Position information embedded in a 3D object, used to size and position a texture map on it. Objects can have multiple sets of UV

coordinates.

**environmental textures, environment map** A simulated surrounding world for a material to reflect.

**volumetric material** A material type for simulating non-solid materials, such as steam, smoke, dust, or clouds.

**procedural texture** A 2D or 3D texture created mathematically.

**bump map** Applying a texture to create the illusion of perturbing a surface's smoothness.

**Phong** A material type with sharp, tight highlights.

**Lambert** A flat material type without highlights.

**Blinn** A material type with softer highlights.

**Anisotropic** A material type with non-uniform highlights.

**transparency** The opposite of opacity; the ability to see through a material, such as glass.

**translucency** Semi-transparent, but with a scattering of light, such as light seen through a green maple leaf.

**specular color** The component of a material that reflects a light source—the highlight.

**self-illumination** The material's sensitivity to light; fully self-illuminated materials are not affected by scene lighting, nor do they emit light.

## Hotkeys to Memorize

**Shift+T** open Hypershade

**Shift+S** open the Script Editor

**6** enable Hardware Texturing

**t** show Manipulator Tool

## Materials Overview

Novice animators often gloss over applying materials and lighting to scenes. "Add a few lights, make this red, that blue—we're done!" The results are typically washed out, flat, and harsh. Much of traditional media artists' criticism of computer art is based on seeing crude, simple renderings that emphasize only the limitations of the process. Good art is possible with Maya, however. It just takes time to get more interesting and complex shading. CG artists spend as much, if not more, time on lights and materials as on modeling.

Materials are a critical part of creating attractive images and animation in a 3D program. Materials interact with lights, so lighting drives some material choices; for example, if your overall lighting is bright, you might need to make your scene materials somewhat darker. Generally, you build your scene with lighting and materials progressing together, with frequent renderings to test your adjustments. Compensating for the limitations of virtual lights to create an effective and subtle light layout is an art, one that's discussed in the next chapter. In this chapter, you'll concentrate on materials.

What do we mean by materials? It's a catch-all term to describe all aspects of what a surface looks like. At first glance, novices usually notice the surface color—red, wood brown, metallic silver. To an artist, however, there are many other factors: An object isn't just metallic silver, for example—it's a mirrored smooth finish that relies on the reflected surroundings for its appearance. In addition to factors of color, shine, and reflection, Maya also considers transparency, incandescence, translucency, refraction, bumpiness, and many other user-controlled parameters. Attention to these details gives your rendered results more subtlety and complexity.

## A Tour of Hypershade

As with most 3D programs, Maya has a material builder called Hypershade that lets you see your material creations on spheres (called "swatches") as you design them. After you've perfected your material to the limits of the spherical swatch, you use Maya's IPR render to fine-tune the results on actual geometry in your scene.

Hypershade uses a free-form approach to material design. Swatches connect to one another to create effects; for example, a brick image might wire to the Bump attribute on a material to create bumps in the pattern of bricks. Hypershade also doubles as a kind of browser so that you can view and select existing scene lights, cameras, materials, and other elements.

To open Hypershade, choose Window | Rendering Editors | Hypershade (hotkey: **Shift+T**). The default dialog box is divided into thirds (see [Figure 8.1](#)). The left vertical panel is called the Create Bar. The top and bottom panels on the right are called simply top tabs and bottom tabs, and you can adjust the divider lines between the two tab areas.

### [Figure 8.1](#)

Maya's Hypershade—a materials creation laboratory.

## Create Bar

At the left is the Create Bar, which displays all the material types you can create for a selected category. Simply click on a type to create that item in the Work Area. To select a category, click the down arrow on the bar at the top of the Create Bar; the options are Materials, Textures, Lights, Utilities, and All Nodes. For the tutorials in this chapter, leave the Create All Nodes category selected. To toggle the Create Bar on and off, click the checkered button to the far left (refer to [Figure 8.1](#)).

## The Tab Panels

The top and bottom tab panels can be customized to include almost any type of tab. For the following descriptions, we'll describe the tab panels in the default installation mode, which uses the top tab for showing existing materials and the bottom tab for creating and editing materials. After you become familiar with Hypershade, you can customize the tabs to your liking, and even add Work Area tabs to simultaneously edit several materials.

### Top Tabs

The top tab area displays all the elements that are *already part of* the current scene file in these tabs: Materials, Textures (for those that are part of existing materials), Utilities, Lights, Cameras, and Projects (to browse the project folder for other files). In this area, you can select anything that's already been created for several purposes:

- To duplicate it, so that you can modify the original when you have only slight variations to make
- To edit it
- For materials, to select objects that have been assigned a specific material or to assign a material to currently selected objects
- For lights, to make and break links to selected objects
- For textures, to reuse an existing texture with a different material, when the texture with all its parameters is identical for the materials the texture is assigned to
- To easily export a material for use in another scene

In all cases, double-clicking the swatch in the top tab area opens the Attribute Editor for that entity.

## Bottom Tabs

The bottom tab area is usually used as the Work Area—the assembly point for new materials. When you start a new scene, very little appears in the top tabs until you begin creating scene elements. Therefore, the first thing you would do when you open Hypershade is put a new blank material in the Work Area and assign it to an object in the scene. You could also go to a Shader Library tab and assign materials from there. Later in this chapter, we'll show you how to create your own tab and add the materials you've created to this library.

## Basic Material Types

The major material types, shown in [Figure 8.2](#), are described in the following sections.

### Figure 8.2

In general, highlights are softer with PhongE than with Phong, and softer with Blinn than with PhongE.

## Lambert

Lambert is a flat material type that yields a smooth look without highlights. It calculates without taking into account surface reflectivity, which gives a matte, chalk-like appearance. Lambert material is ideal for surfaces that don't have highlights: pottery, chalk, matte paint, and so forth. By default, any newly created object gets the Lambert shader assigned to it. If the object should have highlights, though, it's a good idea to assign another shader. You'll want to see highlights even during the modeling stage, to see whether they are breaking across the model (indicating a seam in the surface).

## Phong

The Phong material type takes into account the surface curvature, amount of light, and camera angle to get accurate shading and highlights. The algorithm results in tight highlights that are excellent for polished shiny surfaces, such as plastic, porcelain, and glazed ceramic.

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**Tip** - If you notice that the highlights of a surface with a phong shader applied are exhibiting flickering in your animation, or you see a "ropy" appearance from line to line, switch to a Blinn material type, which has smoother highlights. This problem can also be made worse by bump mapping.

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## PhongE

PhongE is a faster rendering version of Phong that yields somewhat softer highlights than Phong. Most artists use regular Phong for objects with intense highlights and Blinn for everything else.

## Blinn

The Blinn material type calculates surfaces similarly to Phong, but the shape of the specular highlights in Blinn materials reflects light more accurately. Blinn is good for metallic surfaces with soft highlights, such as brass or aluminum. Because Blinn is a versatile material type and generally renders without problems, it's the primary material type we've used in these tutorials.

## Anisotropic

The Anisotropic material type stretches highlights and rotates them based on the viewer's relative position. Objects with many parallel micro-grooves, such as brushed metal, reflect light differently depending on how the grooves are aligned in relation to the viewer. Anisotropic materials are ideal for materials such as hair, feathers, brushed metal, and satin.

## The Others: Layered Shader, Shading Map, Surface Shader, and Use Background

The four remaining material types are for more advanced purposes, so this section just gives you an overview of what they're used for. The Layered Shader lets you combine several materials to create a more complex material. For example, if you want chrome polka dots on a wood surface, you can simply use a polka dot mask in a Layered Shader and then bring in your already-completed chrome and wood materials.

The Shading Map material is primarily designed to let you get a "cel" look in 3D, like typical animated cartoons. You can use this shader for a 2D painted-in look rather than smoothly shaded 3D. The Ramp Shader, new in version 4.5, is a material designed to make it easier to create and control a cel or illustration-style look. The Shading Map material can be used for special effects. Its prior application for cel style shading is now taken over by the Ramp Shader.

The Surface Shader is used when you want to control a material's color, transparency, and/or glow with something else in Maya. For example, you could link color to any object's XYZ position, and the material would then change colors as that object moved around the scene.

The Use Background shader applies the background (image plane or environment) color

to the surface that it has been applied to. This allows you, for example, to have shadows cast on an image of a road used as an image plane. This shader type can also be used to cut a "hole" in the image's alpha channel where objects with the material appear. This material is useful for a technique in which separate rendered images are combined in a compositing program to create the final results (for more information, see Chapter 15, "Your Next Steps: Efficiency and Artistry"). CG artists usually do this to divide a large, complex animation into more manageable parts or to combine 3D animation with photographed/filmed live action.

## Material Settings

Having reviewed the major material types, now take a look at the variables available in the material you'll most commonly use: Blinn. The other primary materials—Phong, PhongE, and Lambert—have many of the same variables.

To edit material settings, double-click on any material in Hypershade's top or bottom tabs. Usually you create a blank Blinn material in the Work Area of the bottom tab panel, and then double-click it to open the Attribute Editor with the material type loaded. Refer to [Figure 8.3A](#) as we travel down the Attribute Editor and discuss its sections.

Notice the material name at the top of the Attribute Editor, which Maya sets to blinn1 for a default starting name. Maya increments the number if you create more Blinn materials. You should edit this text to something more descriptive, though, to help you navigate through your scene materials.

The image next to Material Sample shows a rendered sample sphere that updates as you change the values for the attributes. You use the Type drop-down list to change a material to any other type; if the new material type has different parameters, however, it automatically has the default settings, and the name is reset to the default name.

Next is the Common Material Attributes section, followed by the Specular Shading section. These two sections, displayed by default, are used the most in material editing. The other sections remain closed unless you click to expand them.

Note that the first four variables under Common Material Attributes have a color swatch, a slider, and a checkered button. You can brighten or darken these variables with the slider, but you must click the color swatch (which opens the Color Chooser) to fine-tune a color. Use the checkered button to override a solid color with a texture.

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**Note** - Once you apply a texture, the color is no longer editable and the slider becomes locked, as shown in [Figure 8.3B](#). The checkered button is replaced with a right-pointing arrow, and the color in the swatch is meaningless.

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### **Figure 8.3A**

A basic Blinn material in the Attribute Editor.

### **Figure 8.3B**

Applying a texture will make the "checker" button icon change to a connection icon, and the slider and swatch no longer are editable.

These are the Blinn attributes in the Common Material Attributes and Specular Shading sections:

- **Color** The base color of the surface.
- **Transparency** Adjusts the surface opacity. As soon as it's raised above 0 (black), Maya changes the sample background to a checkerboard to help gauge the transparency effect. You can use colors to create a tinted glass effect.
- **Ambient Color** Adds to and blends with the color value. It's a good idea to leave this value set to 0 (black) except for special effects, as it diminishes the contrast and 3D depth in your rendered results where it's applied.
- **Incandescence** A simulation of emitted light. At low values, it tints and self-illuminates the material, and at high values, it overtakes the material's color and becomes self-illuminated. Keep in mind that the rendered material might look like it's luminous, but it doesn't cast light into the scene; you have to simulate that by adding lights.
- **Diffuse** Intended to simulate a material scattering light, but it works like a scaling factor on the color. By default, it's set to 0.8, which dulls down the color value you've set. Often animators apply "dirt maps" in this attribute to add realistic dirt and wear that darken a surface. You'll coordinate your diffuse and specular settings, because a "dirty" object wouldn't generally be shiny.
- **Translucence** A special attribute that lets you see shadows cast onto the back of a surface, useful for simulating materials such as frosted glass. This effect relies on the light sources around and behind the object you're applying the translucent material to.
- **Translucence Focus** This controls how light scatters from the surface. Lower values make the light scatter heavily and results in a soft, blurry translucence.
- **Eccentricity** The width of the highlight, simulating how polished or rough the surface appears.



- **Specular Roll Off** The brightness/intensity of the highlight.
- **Specular Color** The color of the highlight; usually set to white or a gray value.
- **Reflectivity** The brightness of reflections on the object. Reflections can be raytraced or use texture maps. If no texture is assigned to the Reflected Color attribute, you need to enable raytracing to see any results from this setting. You can enable raytracing in the Render Globals window (unless you're using reflection maps).
- **Reflected Color** For Blinn, the color swatch and slider have no effect. However, when a texture map is applied, it appears to be reflected by the material. Usually, you use one of the environmental texture types. Environment textures are used to simulate an environment surrounding the scene; when applied to a material's Reflected Color attribute, they're used to fake reflection. This technique is often used to get a shiny, reflective effect without the slower rendering caused by raytracing the actual surroundings. Also, sometimes there are no surroundings to reflect; for example, flying logo effects are often set in a black void.

Take a look at the following figures to see the differences between some of these attributes. In [Figure 8.4](#), Transparency is applied to the square on the left so that you can see the object behind it. The square on the right has Translucence applied, so it allows only light and shadow to come through.

#### [Figure 8.4](#)

Transparency versus Translucence. The red is backlit by a shadow-casting light.

[Figure 8.5](#) shows spheres with similar reflective materials applied, but the sphere on the right has a fractal map applied to its Diffuse attribute. The effect is apparent only where the map is darker, which causes a "dirt" effect—meaning the sphere is darker and its reflections are less intense in those areas.

#### [Figure 8.5](#)

The Diffuse attribute can darken the color and diminish reflectivity.

In [Figure 8.6](#), the Reflectivity attribute is always at 1 (100%), but varying approaches are used to get different effects. The leftmost image has nothing applied to the Reflected Color attribute. The next image has a chrome environment map in the Reflected Color attribute, which creates the impression of a background despite the sphere's actual surroundings. In the third image, raytracing is enabled but the Reflected Color attribute is disabled, so a perfect reflection is computed. The rightmost image shows the effect of combining raytraced reflections with environmental texture mapping to produce real reflections that have priority over the environmental (Reflected Color) reflections.

## [Figure 8.6](#)

Using different approaches with the Reflectivity attribute.

## The Color Chooser

The Color Chooser appears whenever you click on a color swatch. The 14 color buttons at the top are a clipboard. To select the color for a color button, you simply click on it. To replace a color button, RMB-click it. Use the eyedropper tool to pick a color anywhere in the window.

A color spectrum appears in the Wheel area. Generally, the best way to select a color is to use the sliders below the wheel (see [Figure 8.7](#)). The sliders can be set to RGB (red-green-blue) or HSV (hue-saturation-value) mode in the list box at the bottom of the Sliders section, but HSV mode is often the most useful. Pick the color tint first in the hue slider, and then select the color's intensity, as compared with gray, in the saturation slider. Finally, adjust the darkness, or black mix, with the value slider. At the bottom is the alpha slider for setting transparency, but it's rarely, if ever, used.

## [Figure 8.7](#)

Maya's Color Chooser in HSV mode.

## Tutorial: Creating Solid Materials

The most basic materials have a solid color and a consistent surface. In this tutorial, you'll use Hypershade to create some solid-colored surfaces and apply them to objects. Load the scene file noted below the CD icon so that you have a starting point for the sample world you're adding materials to.

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**On the CD** - Chapter\_08\movies\ch08tut01.wmv

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## *Pottery*

For the pot, you'll apply a pottery material created by using a dark orange color in a Lambert material.

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1. Open Hypershade with **Shift+T**. Make sure the Create Bar and both tab panels are showing. Right-click the bar at the top of the Create Bar and choose Create Materials. MMB-drag a Lambert material type to the bottom tab panel. Double-click the new material and the Attribute Editor should appear with the new material loaded. If this doesn't work, you can RMB-click on the new material and choose Attribute Editor.
2. Rename the material from `lamBERT2` to `pottery`. Set the color to dark orange in the Attribute Editor by clicking the swatch next to the Color value, and setting the color in the Color Chooser. We set the Hue to 33, Saturation to .8, and Value to .7. Click the Accept button in the Color Chooser.
3. Select the flower pot object in the scene, RMB-click the edited material in Hypershade, and choose Assign Material to Selection. You should see the pottery object in the Shaded view become dark orange.

## *Plastic*

For plastic materials, you'll use the Blinn material with bright highlights:

4. In Hypershade, MMB-drag a Blinn material to the bottom tab panel. Open the Attribute Editor as before, and rename the material from `blinn1` to `red_plastic`.
5. Set the color swatch to bright red. You can click the red color button in the Color Chooser, or use the HSV sliders to get a red you like.
6. In the Specular Shading section of the Attribute Editor, make the shine level bright and tight by setting Eccentricity to 0.1 and Specular Roll Off to 1.0, and dragging the Specular Color slider all the way to the right to get a pure white. The material sample sphere at the top of the Attribute Editor should look like shiny red plastic.
7. Select the cylinder in the scene. In Hypershade, RMB-click on the red plastic material, and choose Assign Material to Selection. You should see the cylinder turn red in the Shaded view.

## *Metal*

Creating metal requires a trick. The sliders in the Attribute Editor imply an upper and lower limit that doesn't really exist. You can type in any value in most of the numeric entries, and the slider will adjust its ranges. In some cases, you can get useful and unique results from "overdriving" a value in this way.

8. MMB-drag a new Blinn material type from the Create Bar to the bottom tab panel. Open the Attribute Editor for this new material, and name it `gold`.

9. In the Color Chooser, set the color swatch to dark brown (HSV: 40, 0.8, 0.2), and click Accept. Under the Specular Shading section in the Attribute Editor, leave the settings at their defaults: Eccentricity at 0.3 and Specular Roll Off at 0.7.
10. To get the metal look, click the Specular Color swatch and set it to orange, but with a value higher than 1 (HSV: 40, 1.0, and 2.0), as shown in [Figure 8.8](#).

### **Figure 8.8**

Setting the highlight color for a gold material.

11. Select the oblong sphere object in the scene, RMB-click on the gold material in Hypershade, and choose Assign Material to Selection. The object in the Shaded view should turn gold.
12. Try a test render to see what the materials really look like. RMB-click in the Perspective view, and render by clicking Hotbox | Render | Render Current Frame.
13. A Render View window appears and the image is rendered. Leave this window open.

### ***Reflective Raytraced Metal***

The gold looks metallic, but what if you want it to reflect its surroundings? There's a Reflectivity slider in the Attribute Editor, but you won't see any results unless you enable raytracing in the renderer or apply an image to the Reflected Color attribute.

14. In the gold material's attributes, raise the reflectivity value to 1.0. Click the clipboard icon to the left in the Render View window, and the image will re-render. However, the gold remains non-reflective. Set the reflectivity value back to 0.5.
15. Click the Render Globals button, shown in [Figure 8.9](#). In the Render Globals window, find the Raytracing Quality section, select the Raytracing check box, and close the Render Globals window. Render again by clicking the clipboard icon, and you should see reflective effects in the gold object. Orbit the Perspective view and render from some different angles to see the effect. Notice that the red plastic material is also reflecting. The default setting for Reflectivity is 0.5—half reflective. You need to change this value when you don't want reflections on materials.

### **Figure 8.9**

Open the Render Globals window to enable raytracing for reflections and refractions.

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**Tip** - You can zoom and pan the rendered image with the mouse as in any 3D panel. You can also zoom and pan the swatches in either tab panel in

Hypershade.

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### ***Refractive Raytraced Glass***

You can also have transparent materials that refract light. That is, light passes through the objects but is bent, so you see a distorted view of what's behind the refractive object.

16. MMB-drag a Blinn material to the bottom tab panel. Open the Attribute Editor and name the material `glass`.
17. Set the Color to black and the Transparency to white. As soon as you begin to raise the Transparency value, you'll see a checkered background appear behind the swatch in the Attribute Editor and in Hypershade, which means the material is transparent. Set the Eccentricity to `0.1`, the Specular Roll Off to `1`, and the Specular Color to white.
18. Now open the Raytrace Options section in the Attribute Editor. Select the Refractions check box, and set the Refractive Index to `1.5`. This is similar to glass. Most materials have an index between 1 and 2. Select the ring object to the left of the pot in the scene, RMB-click on the glass material in Hypershade, and choose Assign Material to Selection.

### ***Duplicating Materials***

You can start with an existing scene material and then duplicate it so that you can use the old material as a starting point for an unassigned new material.

19. Select the gold material in Hypershade, in either tab panel, and press `Ctrl+d` to duplicate. A new material named `gold1` appears.
20. In the Attribute Editor, rename the material as `chrome`. Change the Color to dark blue by setting Hue to `240` in the Color Chooser. Set Specular Color to white by changing Saturation to `0`. You now have a bluish metal look. Crank the Reflectivity to `.85`, and assign the material to the large sphere in the scene. Render the Perspective view image. The sphere looks like a mirror, reflecting the scene around it.
21. Render the Perspective view. If it looks a bit fuzzy in the refractive and reflective areas, that's because the quality is set low for faster response. To turn the quality up, open the Render Globals window. In the Anti-aliasing Quality section, select Production Quality in the Presets drop-down list, as shown in [Figure 8.10](#). You might also want to increase the resolution; currently, it's only 320x240 pixels. In the

Presets list box, select Full 1024, which gives you a 1024x768 resolution image. This setting takes quite a bit longer to render than before, but behold the final image! To see the image at full scale, click the 1:1 button in the Render View window. You can load the final scene from the file noted below the CD icon.

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**On the CD** - Chapter\_08\ch08tut01end.mb

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### **Figure 8.10**

Turning up the rendering quality level in the Render Globals window.

## **Adding Basic Materials to Your House**

In Chapters 5, "NURBS Modeling Basics," and 6, "More NURBS Modeling," you created a house with NURBS modeling techniques. In this section, you'll texture the house by following the tutorials to add materials for the doors, windows, and so forth.

### **Setting Up Default Lights**

Before you start adding textures, you need to add some lights to the scene from various angles so that your test renderings while working on materials give you an accurate view of the fully lit house. To ease the process, we've created a MELscript that adds three Spot lights to your scene:

1. Start by opening the Script Editor (hotkey: **Shift+S**).

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**On the CD** - Chapter\_08\movies\ch08tut02.wmv

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2. In the Chapter\_08 folder on the Maya Fundamentals CD-ROM, you'll find the script file ch08Lights.mel. Open this file in the Script Editor (File | Open Script).
3. At the bottom of the Script Editor, you'll see some text, which is the command set you want to run. Click to get a cursor at the bottom of this command set. To run this script, press Ctrl+Enter.

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**On the CD** - Chapter\_08\ch08Lights.mel

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4. Open the Outliner (hotkey: **Shift+O**). You'll see three Spot lights listed. With some lights in the scene, now you're ready to begin creating and applying materials to the house.

### **Tutorial: Materials for Your House**

You should load the file noted below the CD icon from the *Maya 4.5 Fundamentals* CD-ROM. If you use your own ending scene file from the previous chapter, the results might vary.

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**On the CD -** Chapter\_08\ch08tut02begin.mb

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1. To work more efficiently in this tutorial, switch to the saved layout corresponding to materials and rendering (Panels | Saved Layouts | Hypershade/Render/Persp). The viewports should now be replaced with Hypershade, the Render View window, and Perspective view. If you had one of the views open as a floating window, the viewport ignores that particular window in the layout and leaves the floating window available.
2. For the doorknob's texture, you'll create a brushed metal with a worn look. First, hide all the layers in the scene, except for the DoorL layer, by clicking the "V" (for visibility) next to the layer names. If there are other objects, such as cameras or deformers, you can hide them by disabling them in the view (Hotbox | Show | Cameras, Deformers). Orbit and zoom to the DoorKnob object in the Perspective view; this is the doorknob on the outside of the house.
3. The preliminary material for the doorknob is identical to the metal you created earlier in this chapter in the "Creating Solid Materials" tutorial, so follow Steps 8–10 to create a gold metal material and change the material name to DoorKnob-Blinn.

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**Note -** When you use a hyphen (-) between words in filenames, Maya converts it to an underscore ( \_ ).

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4. Make sure the doorknob is still selected, and assign the DoorKnob\_Blinn material by right-clicking the new material and choosing Assign Material to Selection. IPR

render the scene in the Render View window; when it's finished, marquee-select a rectangle that surrounds the doorknob. After a few seconds, this area will render again, and IPR is now set to respond instantly to your material (see [Figure 8.11](#)).

### **Figure 8.11**

Adjusting the texture of the doorknob, using IPR rendering for quick feedback.

5. The doorknob currently has an ugly bright yellow spot, which doesn't look realistic. To fix that, select `DoorKnob_Blinn` again and open the Attribute Editor. Click on the swatch for Specular Color, and in the Color Chooser, change the Value setting to `0.45`. The specular color looks a little duller now.
6. Save the scene as `ch08TexturedHouse`. It's a good idea to save your work frequently.

The door is already visible, so even though you won't finish the texture right now, you can go ahead and add a material for it.

7. For the door, you'll create another Blinn material by MMB-dragging a new Blinn material type from the Create Bar to the bottom tab panel. Name the new material `Door-Blinn`.
8. Select the door object in the Perspective view. Remember that it's a NURBS cube, so after selecting one side, press the up arrow once to select the entire door.
9. In the top tab in Hypershade, RMB-click on `Door_Blinn` and choose Assign Material to Selection. IPR rendering will update in the Render View window.
10. Next, set up the material's attributes in the Attribute Editor. You're creating a wood material for the door, so select a light brown color (HSV: `40, 0.8, 0.3`). Set Eccentricity to `0.5`, thus increasing the size of the specular highlight, and set Specular Color to a lighter brown than the door in the Color Chooser (HSV `40, 0.4, 0.5`). Last, set Reflectivity to `0`, and save your scene again. You'll see the updates in the Render View window after each change.

The next step is setting up a material for the windows in your scene:

11. You're through with the door, so hide the `DoorL` layer in the Layer Editor, and then display the `WindowsL` layer.
12. Create an Anisotropic material, name it `Window_Anisotropic`, and set its Diffuse attribute to `1`. Set the color to black, the Transparency attribute to white, and under Raytrace options, check the Refractions box and set Refractive Index to `1.5`.



13. Click on the window glass object and confirm that the Channel Box lists `Window_Glass`. Assign `Window_Anisotropic` to it. Repeat for the other window's glass, and save your scene again. Notice that because the material is transparent, you can no longer see the plane representing the glass for the window. You can still select it by clicking on the area where you would normally see the plane.

To surround the window, you can add a wood trim, similar to the material you used for the door. After you create the material for the trim, you can use it for other trim on the house, such as along the porch roof or around the door. Reusing a material in this way gives your house a more realistic look—after all, the trim should match, right? This is a more efficient way to work than creating a completely new material for every element in a scene.

14. Instead of creating a new material for the trim, you'll use one you already have. In the top Materials tab in Hypershade, select `Door_Blinn`. Duplicate the material (hotkey: **Ctrl+d**), and change its name to `Trim_Blinn`.
15. Normally, you'd use the Attribute Editor to change values for the material, but this time try using the Channel Box. When a material is selected in Hypershade, its default attributes appear in the Channel Box (just as with any other object in Maya). Under `Trim_Blinn` in the Channel Box, change the material's color by entering values in the three text boxes for red, green, and blue: Set Color R to 0.4, Color G to 0.35, and Color B to 0.25, as shown in [Figure 8.12](#). The material will become a darker brown, varying slightly from the original `Door_Blinn`.

### **Figure 8.12**

The Channel Box is an alternative to the Attribute Editor when modifying materials.

16. Next you need to apply the material to the window's trim. Click on one of the window's `Window_Frame` trim that borders the window, and assign `Trim_Blinn` to the selection. The wood trim intersecting the window needs to have the material applied. In the Outliner, expand the Windows group. Under either window, select `Window_CrossH` and `Window_CrossV`, and assign the material to them. Do this for both windows.
17. Now that you've finished the base materials for the windows, hide the `WindowsL` layer, and save the scene.

### **Tutorial: Creating the Remaining Base Materials**

So far you've been creating a material and then immediately applying it to a designated object. That workflow method is fine when you're trying to get materials tweaked and have the details and attributes ready for specification. In this tutorial, though, you'll see how to speed up your workflow to create the rest of the base materials and assign them to

the house. You need to create base materials for the following portions of the house:

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**On the CD** - Chapter\_08\movies\ch08tut03.wmv

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- Vertical porch rails
- Horizontal porch rails
- Outside wall
- Outside foundation
- Chimney base
- Chimney pipe at top
- Roof

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**On the CD** - Chapter\_08\ch08tut02end.mb

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Because you're just creating materials, you don't need to have the other viewports visible. With the Hypershade view active, tap the spacebar to maximize it. Increasing the workspace can help improve your productivity. You can start where you left off with the preceding tutorial or load the scene from the CD-ROM.

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**Tip** - You can also hide the UI (user interface) to further increase the workspace (Display | UI Elements | Hide UI Elements). This removes everything from the Status Bar to the Help Line. You can turn the interface back on by selecting Restore UI Elements instead of Hide UI Elements.

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1. The porch needs two separate materials for the vertical and horizontal beams on the porch. Select Trim\_Blinn in the top Materials tab in Hypershade and duplicate it twice. Name Trim\_Blinn1 as VertPorchRail\_Blinn. Change the name of Trim\_Blinn2 to HorizPorchRail\_Blinn. That's all you need to do for the rails

right now.

2. The house's walls are next. Create a PhongE surface material by selecting PhongE from the Create Materials Bar. Name the new material `Foundation_PhongE`. The foundation will have a wet look, so PhongE is a good material to start with. Next, create a new Blinn material and name it `Walls_Blinn`.
3. Open the Attribute Editor for `Foundation_PhongE`. Under the Common Material Attributes section, click the swatch next to Color to set the value in the Color Chooser (HSV: 65, 0.45, 0.35), and click Accept. Next, decrease Diffuse to 0.7. Continuing down to the Specular Shading section, increase Roughness to 0.810, decrease Highlight Size to 0.15, and set Reflectivity to 0. Finally, click the color swatch for Whiteness to set the value in the Color Chooser (HSV: 270, 0.010, 0.2), and click Accept.
4. Next, select `Walls_Blinn` in the top Materials tab in Hypershade. In the Channel Box (press Shift+C if it's not open), set Color R to 0.9, Color G to 0.68, and Color B to 0.4. You should have a brownish-orange color for the material.
5. Next, you'll create a Lambert material for the chimney. The chimney is made up of brick, which usually doesn't have any highlights, so Lambert is the perfect material candidate. With the new Lambert material selected (`lambert2`), change the name to `ChimneyBase_Lambert`. Then duplicate the material, naming the duplicate `ChimneyPipe_Lambert`. Select `ChimneyBase_Lambert` in the top Materials tab. Open the Attribute Editor, use the Color Chooser to set the material's color to dull red (HSV: 0, 0.6, 0.5), and click Accept. In the Attribute Editor, click on `ChimneyPipe_Lambert` in the Materials tab, set its Color attribute (HSV: 0, 0.4, 0.5), and click Accept.
6. The last base material you need to create is for the roof. You haven't used a Phong material yet, and the roof would look good with a mossy wet material, so create a Phong material and name it `Roof_Phong`. In the Channel Box, change the material's color by setting Color R to 0.34, Color G to 0.312, and Color B to 0.102, which results in a dark brownish-green color.
7. The Work Area bottom tab is cluttered with material nodes at this point and should be rearranged. RMB-click a blank space in the Work Area, and choose Graph | Rearrange Graph from Hypershade's menu to organize all visible materials in the Work Area.

You have now set the foundation for the materials in your scene, and can continue to apply these new materials to the corresponding objects in your scene. If you haven't saved your scene, now would be a good time because you have created quite a few materials. Your Hypershade should have all the materials shown in [Figure 8.13](#).

**Figure 8.13**

The base materials you will build on for the scene.

8. Next, you'll assign the materials you've created to your scene objects. To make it easier, switch to a predefined saved layout (Hotbox | Panels | Saved Layouts | Hypershade/Outliner/Persp). The Outliner makes it easier to select specific components, and having it open in a viewport eliminates clutter. In Hypershade, click the Show Top Tabs Only button (refer back to [Figure 8.1](#) to see where this button is) because you don't need to see the Work Area now. For more space, hide the Create Bar by clicking the Show/Hide Create Bar button. Last, hide the UI elements in the scene (Hotbox | Display | UI Elements | Hide UI Elements). Keep the Channel Box visible (hotkey: **Shift+C**) so that you can easily work with the layers in the house. Your interface should now be set up to efficiently assign the remaining materials to objects (see [Figure 8.14](#)).
9. In the Outliner, all the scene elements are grouped under Old\_House. Display all the layers in the scene. To assign a material to the house's outer walls, in the Outliner, select OuterWall and assign Walls\_Blinn. You should see the green wireframe of the outer walls, indicating that they're selected. In Hypershade, RMB-click on Walls\_Blinn and choose Assign Material to Selection. With the Perspective view active, press 7 to make sure textures are hardware-rendered for viewing and lighting.
10. Select Foundation in the Outliner. RMB-click on Foundation\_PhongE and choose Assign Material to Selection. The outer walls of the house now have their base material assigned.
11. Select Chimney, and assign ChimneyBase\_Lambert to it. Under the Chimney group in the Outliner, select Chimney\_Top and assign ChimneyPipe\_Lambert. Even though the material for the chimney's base had been assigned to the pipe, it had no affect on new materials being applied, which immediately override the object's existing material.

**Figure 8.14**

By using Hypershade, the Outliner, and Perspective view, you can easily assign materials to objects in your scene.

12. Expand the Roof group in the Outliner. Under RoofSide, select RoofSlab, and assign Trim\_Blinn to it. Shingles should also be located in this group. Assign Roof\_Phong to Shingles. Next, assign Trim\_Blinn to RoofSlab in RoofSide1 and Roof\_Phong to the Shingles in RoofSide1.
13. Close the topmost Roof parent in the Outliner. Hide the RoofL layer and save your scene.

14. The final base materials need to be assigned to the porch before you're ready to move on to texture mapping. Using the Outliner, select the three box objects that make the trim of the porch floor and assign Trim\_Blinn to them. Select the horizontal parts of the porch rails, along with the stairs and the porch floor, and assign HorizPorchRail\_Blinn to these. Now select the vertical elements of the porch, including the poles, the porch legs, and rail bars, and assign VertPorchRail\_Blinn to these.
15. You have finished applying base materials to objects in your scene; in the following section, you'll learn how to add more detail to your textures. Hide the PorchL layer, and save your scene as usual.

If you got stuck in this tutorial, load the file ch08tut03end.mb, which contains the finished scene for this tutorial.

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**On the CD** - Chapter\_08\ch08tut03end.mb

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## Texture Mapping

The next step is to replace a surface's solid color with a texture. Normally, a texture refers to applying a 2D image around a 3D surface, rather like wallpapering a curvy surface. Because a 2D image can be stretched, wrapped, and projected onto a surface in many different ways, you must take control of how the image is applied.

### Mapping Coordinates

Mapping coordinates, also known as UV coordinates, tell the 3D renderer how to place the 2D map across the geometry, which varies depending on whether the model is created from NURBS or polygons. For NURBS, parametric mapping is inherent to the surface and this is typically what's used. Because NURBS are already parametric surfaces, mapping can automatically flow smoothly across the surface. You can also adjust NURBS mapping, to move and rotate how the map is positioned on the object.

For polygon surfaces, mapping is normally applied by projecting 2D maps across the 3D surface in one of several ways: planar, cylindrical, spherical, and a special method called automatic mapping. As you might expect, when you apply a 2D texture to a 3D object with a planar map projection, you'll see a smearing effect in areas of the object that's perpendicular to the direction of the map projection. The cylindrical and spherical projections would seem to solve this problem, but both mapping types have their drawbacks—*singularities*. These are points at the poles of the sphere or cylinder where

the mapping is pinched into a point (see [Figure 8.15](#)). Generally, you must apply the best mapping method for the surface and the areas seen during the animation. That is, if the ugly part is in an area that won't be visible to the camera during the animation, the problem is solved. In tough cases, a combination of automatic mapping, multiple mapping coordinates, and lots of photoediting work can usually fix the problem.

### [Figure 8.15](#)

Three teapots with planar, cylindrical, and spherical mapping (from left to right).

## Maya's Interactive Texture Placement

To make adjusting mapping on a surface less confusing, Maya offers interactive texture placement. This feature lets you see the maps move on the surface in real time as you move, rotate, and scale the manipulator for the mapping. To make this work, you need to have Hardware Texturing turned on for at least one of the 3D panels. To do that, select the panel (RMB-click over the panel) and then click Hotbox | Shading | Hardware Texturing (hotkey: **6**). By default, materials with a texture applied to the Color attribute have the color texture map set to appear in the hardware-textured panels.

## Procedural Maps Explained: 2D Versus 3D

In addition to applying an image or movie to a surface, Maya provides many other texture types called *procedural textures*. Instead of using actual images for mapping, procedural textures use formulas. Many patterns, such as bricks, tiles, and gradients, are so repetitive that they can easily be represented by an equation. By using special forms of seemingly random values, many natural effects can be simulated mathematically: Marble, leather, water, granite, and many other complex and random textures are included with Maya as procedurals.

Maya's procedural textures come in two varieties: 2D and 3D. You can think of the 2D procedurals as a calculated form of a bitmap. A formula is responsible for the image, but the image must be applied to the 3D geometry with some form of mapping, so it's subject to all the benefits and drawbacks of 2D mapping. When 3D procedurals are applied, however, they exist throughout 3D space, and object surfaces define where you see the texture. It's like carving the object from a block of the material. This method has the benefit of not requiring any mapping, but if the object bends or warps, the procedural texture can seem to "swim" through the object (but Maya has an advanced option for getting around this limitation called Texture Reference Objects).

Procedural textures have several benefits. Because they are formula based, their parameters can be adjusted to instantly synthesize all kinds of different effects. Because the simulated random "noise" used for the natural textures varies at every point in space, the procedurals don't repeat, as is common with a tiled image of, say, marble. Also, because 3D procedurals exist throughout 3D space, you often get good results on objects

that would otherwise be hard to map. Instead of trying to wrap a 2D texture around a complicated sculpture, you can apply a 3D procedural and it will appear to be perfectly mapped.

## 2D Procedurals

Maya's 2D procedurals can be divided into two categories: regular patterns and noise patterns. The regular patterns include grid, checker, bulge, cloth, and ramp. With these patterns, you can create tiles, bricks, and many other man-made repeating effects. Noise patterns include fractal, mountain, noise, and water. These pseudorandom textures are excellent for creating the complex "dirty" surfaces common in nature.

## 3D Procedurals

All of the 3D procedurals but snow are random types. Some, such as wood and marble, clearly imitate nature. However, all are excellent for synthesizing random effects. Even when animating a man-made world such as a building interior, you still need noisy patterns—the bump texture on ceiling tiles, some splotchy carpet patterns, and even the brushed solid-color paint on walls are slightly randomly textured.

## Tutorial: Applying Textures

In this tutorial, you'll apply some textured materials to the objects and edit the placement of those textures. You can load the scene file noted here to pick up from the end of the "Creating Solid Materials" tutorial.

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**On the CD** - Chapter\_08\movies\ch08tut04.wmv

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1. Open Hypershade (hotkey: **Shift+T**). Make sure the Create Bar and both tab panels are displayed. RMB-click the Create Bar and set it to Create Materials. MMB-drag a Blinn material to the bottom tab panel, and double-click it to open the Attribute Editor.
- 

**On the CD** - Chapter\_08\ch08tut01end.mb

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2. Rename the material `checkerfloor`, and click the checkered button to the right of the color swatch. The Create Render Node dialog box opens to the Textures tab, displaying all the 2D and 3D procedurals and textures (see [Figure 8.16](#)). Click on

the Checker type to apply it to the Color attribute.

### **Figure 8.16**

The Create Render Node dialog box lists all available map types.

3. Make the Perspective view full screen and set it to Shaded view (hotkey: **6**). Activate Hardware Texturing for this view (Hotbox | Shading | Hardware Texturing).
4. You'll use the drag-and-drop method to apply a material to an object. MMB-drag the checkerfloor swatch from the top tab panel of Hypershade to the scene's floor surface. You should see a checkerboard appear on the floor.
5. Double-click the checkerfloor material in Hypershade to make it active in the Attribute Editor. In the Attribute Editor for the material, open the Hardware Texturing section, and set the Texture Quality to High. You should see the checkerfloor texture sharpen in the Shaded view.
6. In the Attribute Editor for the checkerfloor material, the Color swatch is light gray, and the icon to the right of the Color slider has changed from a checkered button to a right-pointing arrow, indicating that the color has been overridden by something else. Click the right-arrow icon to have the Attribute Editor display the parameters for the Checker node.

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**Tip** - To navigate back to the original node after you have applied a texture, click the right-arrow icon. If you need to undo a texture's assignment, RMB-click on the *name* of the entry and choose Break Connection, as shown in Figures [8.17A](#) and [8.17B](#).

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### **Figure 8.17A**

Use the lower of the two connection buttons, "go to input connection," to return to the material's base properties when finished editing a texture.

### **Figure 8.17B**

Right-click over the text label for a material attribute to get a dialog option to "break connection"—removing the texture that was assigned to that attribute.

7. A dialog box opens where you can change the colors of the checkerfloor material from black and white to other colors, as shown in [Figure 8.18](#). To the right of these color sliders are checkered buttons you can click to replace one of checkerfloor's solid colors with another texture. To replace the white squares in checkerfloor with



a 3D marbled texture, click the checkered button to the right of Color1 (white), and then click Marble under 3D Textures in the Create Render Node dialog box.

8. The Attribute Editor now shows the settings for the marble texture. The veins in the marble are much too tiny for your scene, however. To scale the procedural marble texture higher, click the place3dTexture tab in the Attribute Editor, and set the three Scale values to 10. Render the Perspective view, and you should see a marbled checkerfloor material. The floor is somewhat reflective because the default Reflectivity value of 0.5 was assigned to checkerfloor.

### **Figure 8.18**

The Checker texture node in the Attribute Editor.

9. Next, you'll place a 2D texture on the polygonal shield object with the text "Maya Fundamentals." Create a new Blinn material, and open the Attribute Editor. Name the material `m4fshield`. Click the checkered button next to Color, and in the Create Render Node dialog box, select File in the 2D Textures section. Next to the Image Name text box in the Attribute Editor, click the button with the folder icon to select the image you want to apply. For this object, it's the file noted below the CD icon. After selecting and accepting the file, click the `m4fshield` material in the top tab area of Hypershade. Then MMB-drag the material onto the shield object to the right of the flower pot. You should see the texture appear in a distorted way.

The shield is a polygonal object made with a revolve. Mapping is applied to the revolve, but it's applied circularly in the direction the spline spins to create the surface. In this case, you simply want a flat sign on the front of the shield, so you need to override the default mapping that has been applied.

10. Select the shield object and planar map it (Hotbox | Edit Polygons | Texture | Planar Mapping). You should see the mapping on the surface change immediately, and the mapping manipulator is displayed.
11. Now you can adjust the size and position of the map manipulator to make the text fit neatly on the shield. In one corner of the manipulator is a red "L"; when you click on it, it turns yellow and three manipulator handles appear: a single circle (for activating Rotate mode) and the Scale and Move icons with X, Y, and Z active, as shown in [Figure 8.19](#). If you click on the circle, the Rotate X, Y, and Z manipulators appear, as shown in [Figure 8.19](#). Using these manipulators, you can transform the application of the image to the shield until it's placed correctly. Note that if you click the corner "L" again, the manipulator reverts to its original mode, which is designed for easy sizing. Use the corner Ls (to the left in [Figure 8.19](#)) to adjust the map's size.

### **Figure 8.19**

The planar mapping manipulators have been pulled away from the geometry to show the two placement modes, toggled by clicking the corner "L" at the lower left of the manipulator.

12. Now render the view to see what the materials look like. [Figure 8.20](#) shows the planar mapping manipulator in its adjusted placement.
13. If you need to bring the manipulator handles back for texture placement, you can do so by selecting the object, opening the Channel Box (hotkey: **Shift+C**), and clicking the polyPlanarProj entry. If this fails, you need to open the Tool Box (Hotbox | Display | UI Elements | Tool Box). The sixth icon from the top in the Tool Box, just below Scale, is the Show Manipulator Tool button. Click that to get your map manipulator back. The hotkey for the Show Manipulator Tool is **t**.

### [Figure 8.20](#)

The final scene, rendered with the shield map in place. Note that the glass torus doesn't appear in the Shaded view.

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**On the CD** - Chapter\_08\ch08tut04end.mb

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## 3D Paint

### Interactive Texturing

Maya allows you to not only assign textures to your objects, but also to paint them in real time. Although this sounds like an ideal way to texture everything, in practice it is limited in its value because of the awkward man-machine interface. Most of the time, you'll paint features that are required to be in specific locations, and then take the resulting 2D image to a paint program such as Photoshop for further editing.

Interactive texturing requires a fast video card operating in shaded, hardware-textured mode so that you can see the results of your paintstrokes. Note that you can paint channels other than color, such as transparency. However, interactive shaded views do not display attributes other than color, so you must remember as you paint that you are directly editing transparency, for example, rather than color—thus, white means opaque and black means clear.

### Tutorial: 3D Paint Tool

In this tutorial, we'll paint on the cylinder in the scene to create a unique color design on

it. The cylinder is a NURBS primitive, so it already has inherent texture mapping across its surface. All we need to do is start the 3D paint tool, and we'll be painting!

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**On the CD** - Chapter\_08\ch08tut05.wmv

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1. To ease the painting process, we'll isolate the cylinder. Select the cylinder, then choose Display | Hide | Hide Unselected Objects. Center and zoom on the cylinder by using the **a** hotkey—frame all.
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**On the CD** - Chapter\_08\ch08tut04end.mb

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2. Activate 3D painting with Hotbox | Texturing | 3D Paint Tool | option box. This will bring up the interactive paint dialog, as shown in [Figure 8.21](#). Reset the dialog with the Reset Tool button at the bottom of the dialog. Note that the cursor now appears in the 3D view as a paintbrush, but if you try to paint the cylinder at this point, you will see a red X appear over it, indicating that it is not ready for painting.

### **[Figure 8.21](#)**

The 3D Paint dialog.

3. Go to the File Textures section of the 3D Paint dialog. This section will allow you to size and assign a new bitmap to any channel you want. Make sure that color is the selected Attribute to Paint, and click the Assign Textures button. A bitmap sizing dialog will appear—set the values to 256, and click the Assign Textures button on this dialog. Now a 256x256 pixel map has been assigned to the color channel of the material assigned to the cylinder. This new bitmap has been pre-filled with your previous solid color, so you may not notice an immediate difference. If you hold your mouse over the cylinder, you'll now see a circle cursor.
4. You can choose from many pen and paint styles that are available in Visor. Bring up Visor with shift+V. Make sure "Paint Effects" is the selected tab. Choose the "Markers" folder and pick the marker named "defaultPaint.mel." Now you can paint on the cylinder.
5. You can easily adjust the color of the markers in the 3D Paint dialog, under the Color section, using the color swatch/slider. Try adjusting this to various colors as you mark up your cylinder, as shown in [Figure 8.22](#).

**Figure 8.22**

Painting on the cylinder with various marker colors.

6. Besides simple markers, you can also paint in 2D using the various other paint effects materials. You'll find these in the other folders in your Paint Effects tab in Visor. We'll explore using and editing Paint Effects in 3D in more detail in Chapter 13, "Paint Effects." For now, try switching to the blue feathers ("down4.mel") in the Feathers folder. You can size your brush by holding down the **b** key as you LMB-drag left and right. You can also size the brush by entering a value into the scale attribute of the 3D Paint dialog. As you apply blue feathers to the color channel in real time, these paint effects are applying only flat 2D image changes to the texture's color bitmap. Next, paint some more with the other presets offered in Visor—it's fun! After you've tried painting the color channel for a while, render an image to see result. The shininess and all other attributes other than color remain the same, but the solid red color is now painted (defaced?) with your handiwork.
7. Get out of 3D paint mode by switching to the cursor (hotkey: **q**). Hide the current object (hotkey: **Ctrl+h**). Unhide the cone by selecting it in the Outliner and then choosing Hotbox | Display | Show | Show Selection. Use the **a** hotkey to center and zoom on the isolated cone. Invoke 3D Paint with the option box again, and assign a 256x256 map to this object as in Steps 2 and 3 previously.
8. Now, we'll apply a background color of white to this cone by setting the Flood Color (below the Color setting in the 3D Paint dialog) to white, and clicking the Flood All button.
9. In Visor, choose the "Fun" folder, and pick cracks.mel. Now, paint some loop-de-loops on the cone—the crack direction will change based on your stroke direction. Orbit around the object to paint on its sides. You'll find that many of the complex paint effects presets work this way. Finish painting the cone using other crack colors by changing the Color attribute in the 3D Paint dialog. Finish painting with the **q** (cursor) hotkey, and close the Visor and 3D Paint dialogs.
10. Unhide the other objects with the Outliner—select them in the Outliner (using shift to select multiple items), and then unhide them with Hotbox | Display | Show | Show Selection. Now you can render a frame after repositioning the Perspective view to something that encompasses the entire frame, as shown in [Figure 8.23](#). The painted cone may appear more readily in the reflection from the chrome sphere.

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**Figure 8.23**

The rendered result—only the color channel of the red plastic cylinder and gray cone has changed.

11. If you select one of the painted objects, bring up the Attribute Editor, and navigate to the color channel of the material assigned to the object, you can find the bitmap created by Maya from your paint work. Note that if you want to load the book's sample textures, you'll need to redirect these image pointers to the images provided on the CD-ROM.

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**On the CD** - Chapter\_08\coneShape\_color.tiff

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**On the CD** - Chapter\_08\cylinderShape\_color.tiff

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## Adding Texture Mapping to Base Materials

By now, you should have a basic understanding of how textures work with the materials and how to place 2D textures on objects in your scene. In this next tutorial, you'll apply these methods to the house's base materials you created and assigned in the earlier tutorial.

### Tutorial: Texturing the Doorknob, Walls, and Windows

Having a solid color for the doorknob isn't as realistic as it could be. Earlier you learned how you can use a material's Diffuse attribute to create a dirty look, which is exactly what you'll do for the doorknob.

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**On the CD** - Chapter\_08\movies\ch08tut06.wmv

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1. First, load your scene into Maya. You can continue from the previous house tutorial, or load the file noted below the CD icon.
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2. Start by changing the layout you're working with. If you haven't already done so, hide the UI elements, and change to the saved layout for working with materials (Hotbox | Panels | Saved Layouts | Hypershade/Render/Persp).
3. Hide all the layers except DoorL. To begin, you'll modify the texture on the doorknob. By adding a map to the Diffuse attribute, you can achieve a worn metallic look for the doorknob. Select the outer doorknob and focus on it (hotkey: f). IPR render the doorknob and select it for update in the Render View window.
4. In Hypershade, make sure the top and bottom tabs are visible (click the Show Top and Bottom Tabs button if they aren't). Double-click the DoorKnob\_Blinn material to open the Attribute Editor so that you can map a texture to the Diffuse attribute. Click the checkered button to the right of Diffuse to open the Create Render Node dialog box. Under the 2D Textures section, make sure the Normal radio button is selected for placement, and click the Fractal type. The Attribute Editor switches to show the Fractal attributes. Looking at the IPR render, you'll see that it has updated.
5. By changing settings for the procedural texture, you can get a brushed effect on the doorknob; as you change the settings, watch the IPR render to see how the texture is affected. Click the fractal1 tab in the Attribute Editor. Under the Fractal Attributes section (see [Figure 8.24](#)), change Amplitude to 0.5, Threshold to 0.1, Ratio to 0.77, and Frequency Ratio to 8. Now click the place2dTexture tab. Under the 2D Texture Placement Attributes section, change the second text box (for V) to the right of Repeat UV to 0.15. Last, set the Noise UV to 0 and 0.75. Adding this UV noise to the Fractal attribute "swirls" it more. Close the Attribute Editor.

### [Figure 8.24](#)

Using the Attribute Editor, IPR, and Hypershade, you can easily add textures to your materials.

6. Focus on the door, and redo the IPR render with more of the door in the view. Double-click Door\_Blinn in Hypershade to open the Attribute Editor. You'll assign a texture to the Diffuse attribute just as you did with the doorknob, but this time you'll create a Noise texture. To do that, in the noise1 tab, change the values under Solid Fractal Attributes (see [Figure 8.25](#)): Set Amplitude to 0.8, Ratio to 0.35, Frequency Ratio to 20, Depth Max to 3, and Noise Type to Wispy. In the place2dTexture tab, change the first text box for Repeat UV to 4. Finally, hide DoorL because you have finished applying textures to it.

### [Figure 8.25](#)

Use these settings to change the Noise texture you just mapped to Door\_Blinn's Diffuse attribute.

7. Next, you'll add some texture to the walls. Display the OuterWallsL layer, and IPR render the walls so that you can see them clearly. Open Walls\_Blinn in the Attribute Editor, and change the Reflectivity to 0. Map a Noise texture (again confirming that Normal is selected at the top of the Create Render Node dialog box) to the Color attribute of Walls\_Blinn. Use the settings shown in [Figure 8.26](#): Set Amplitude to 0.5, Ratio to 0.77, Frequency Ratio to 2, Depth Max to 20, Density to 5, Spottyness to 0.3, and Falloff to Bubble.

### [Figure 8.26](#)

Settings to change the Noise texture mapped to the Color attribute for Walls\_Blinn.

Maya provides a "color balance" option to easily adjust the brightness and contrast of the noise. You'll use that now to darken and mute the noise effect:

8. Under the Color Balance section for the Noise, set the Color Gain in the Color Chooser (HSV: 41, 0.315, 0.656). Then change the Color Offset (HSV: 45.5, 0.393, 0.120). After setting those values, click the place2dTexture tab and set Repeat UV to 1 and 5 to make the texture compress in the V direction. Save your scene.
9. Select Walls\_Blinn again and map a 2D Mountain texture to the Diffuse attribute. In the place2dTexture tab, change the Repeat UV to 0 and 3 and set Noise UV to 0 and 0.005. You should also change the values in the mountain1 tab, as shown in [Figure 8.27](#): Amplitude to 0.75, Snow Altitude to 1, and Snow Dropoff to 1.

### [Figure 8.27](#)

Settings for the Mountain texture mapped to the Diffuse attribute of Walls\_Blinn.

10. Now you can move on to the foundation. Open the Attribute Editor for Foundation\_PhongE by double-clicking on the material in Hypershade. You'll map an image file to the Color attribute by clicking on the checker button for the Color attribute. The texture list should appear. Select File. The Attribute Editor displays the file settings. We could now click the Folder button to select the image map by name, but there's an easier way, shown in the next steps.
11. In HyperShade, choose Tabs | Create New Tab. In the Create New Tab dialog box, enter M4F\_maps in the New Tab Name text box, select the Bottom radio button for Initial Placement, select the Disk radio button for Tab Type, and then point the root directory to the Chapter\_08\Textures folder on the CD-ROM (see [Figure 8.28](#)). Click the Create button.

**Figure 8.28**

Adding a new tab to Hypershade.

- In Hypershade, click on the bottom tab Shader Library, and then click the new tab you created. You should see swatches appear for all the textures in the selected folder. These are thumbnail images of the available textures that you can zoom and pan. Click cobblestones.tif to select it, and then MMB-drag the texture to the Image Name text box in the Attribute Editor. The file's location is automatically placed in the text box. Press Enter, and the Texture Sample swatch updates to show the new texture. If you do a test render, you'll see the material applied to the foundation, as in [Figure 8.29](#).

**Figure 8.29**

The cobblestones.tif texture has been linked to the File node.

- Click the place2dTexture tab. Under the 2D Texture Placement Attributes section, change Repeat UV to 3 and 2. Click Foundation\_PhongE again to open it in the Attribute Editor. Map the 2D texture Noise to the Diffuse attribute, and in the noise3 tab, change the Solid Fractal Attributes to match [Figure 8.30](#): Set Amplitude to 0.7, Ratio to 0.77, Frequency Ratio to 5, Depth Max to 2, Frequency to 10, and Noise Type to Perlin Noise. This adds a heavy "grime" layer to the texture. Raising the Threshold value will lighten the noise color and therefore diminish the grime effect.
- Hide the OuterWallsL layer and display the ChimneyL layer. Zoom in on the chimney and IPR render. If you are having trouble seeing it because some areas are not illuminated enough, select spotLight2 in the Outliner and increase its Intensity to 1.2 in the Channel Box.

**Figure 8.30**

Placing this Noise texture on the Diffuse attribute gives the cobblestone a very dirty look.

- Click ChimneyBase\_Lambert in Hypershade. In the Attribute Editor, map a File 2D texture node (the Normal radio button should be selected for placement) to the Color attribute. Just as you loaded the cobblestone texture for the foundation, in the Shader Library tab, locate bricks.tif and MMB-drag it to the Image Name text box in the Attribute Editor.
- The IPR updates, but the brick is stretched. To fix that, RMB-click ChimneyBase\_Lambert and choose Graph Network. Click the place2dTexture node for the brick. Under the 2D Texture Placement Attributes, change the Repeat UV to 1 and 6. The brick looks too clean, so you'll add a Solid Fractal 3D Texture map to the material's Diffuse attribute. To do that, in the place3dTexture tab, click the Fit to Group bbox button. Under the Solid Fractal Attributes section, change the



Amplitude to 0.8, Frequency Ratio to 5, Ripples to 2, 3, and 5, and Bias to 0.05.

17. In the Perspective view, rotate around. Notice that on two sides of the chimney, it seems as though the texture is moving in the wrong direction (see [Figure 8.31](#)). The surface's direction is going in the opposite direction as the other sides of the chimney. In other words, the U and V coordinates have been switched, which is typical of NURBS cubes in Maya. To change the direction of a surface, select the side of the chimney with the direction problem, and reverse the surface direction (Alt+z | LMB-click | Reverse Surface Direction | option box). Make sure the Surface Direction is set to Swap. Click the Reverse button to see the texture magically repositioned in the Perspective view. You'll need to IPR render again to see the change. There are two sides of the chimney with this problem, so repeat Step 17 on the opposite surface.

### [Figure 8.31](#)

Reversing the surface direction will fix the texture mapping on the NURBS object in one step.

18. Before going any further, be sure to save your scene. The last step is to add a texture to the Transparency attribute for your Window\_Anisotropic material. Make all layers visible except for PorchL because the porch isn't anywhere near the windows. You can do an IPR render of the window, but it won't show much without raytracing. In the Attribute Editor for Window\_Anisotropic, map a 2D Texture Ramp (select the Normal radio button) to the Transparency attribute.
19. A Ramp texture can give you a wide range of effects. You can think of it as a gradient, with one color blending into another. Click the ramp1 tab, and select Circular Ramp in the Type drop-down list box (see [Figure 8.32](#)). The Texture Sample swatch updates to show what the Ramp looks like. You can specify the areas that will be transparent by setting a ramp color (the circular color buttons) to white. The Interpolation list box, below Type, defines how the blending (intermediate) colors change; it should be set to Linear.

### [Figure 8.32](#)

The default Ramp has been changed to a Circular Ramp.

20. After modifying all the settings, you will have a faded, more transparent look around the edges of the window. Using the IPR render can help you tweak the positions of the fading transparency. In the Attribute Editor for the Ramp texture, notice that three separate colors are displayed by default. If you click anywhere in the Ramp, you create another color. To move the colors, click on the circles to the left; to delete the colors, click the small squares on the opposite side. Click the green square to delete its color, and click the blue circle to select it. Under this color swatch, set Selected Color to almost completely black. Changed Selected Position to

0.810, U Wave to 0.150, Noise to 0.150, and Noise Freq to 0.600. Watch the IPR render update with each change. Change the other color in the ramp to pure white by clicking the red circle and setting Selected Color to white. Change Selected Position to 0.415. Your Ramp settings should now resemble [Figure 8.33](#). Don't forget to save your scene.

### [Figure 8.33](#)

The Ramp texture has been set up for the window glass.

At this point, you can continue on your own to apply textures to the rest of the house. You have walked through applying textures for the walls, chimney, door, and glass. The next section of this chapter introduces yet another important attribute for materials—bump mapping.

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**On the CD** - Chapter\_08\ch08tut06end.mb

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## Bump Mapping

Another powerful and useful method to add to texture mapping is bump mapping. This kind of map does not change the geometry in any way, but it tweaks the way the surface responds to lighting to give the impression of bumpiness based on an applied map. Only the luminance of the applied bump image is used to create the bump effect, so grayscale images are the norm for bump maps. A middle gray is considered flat, lighter areas are higher, and darker areas are lower. In areas where the bump map's brightness is changing, the surface will look like it's bumpy. Because the bump map effect will not affect the silhouette of a surface, you can't use bump mapping to simulate large features that you'll get near to or the effect will be ruined. For example, you wouldn't normally bump map a character's nose; however, you might bump map the pores on that nose. For many surfaces, bump mapping is perfect—fabrics, craggy surfaces, wood grain, or even metal vents, provided the camera doesn't get too close.

---

**Tip** - To see a bump effect, the material usually needs to have at least a minimal amount of shininess.

---

## Coordinating Texture and Bump Mapping

When you combine texture mapping and bump mapping artfully, you can get an

extraordinary amount of detail from even fairly simple models. Artists often create these maps in a paint program, and carefully match the placement of the bump effects in the grayscale bump map to the corresponding colored areas in the color texture map. Maya uses the bump map's luminance to set the "height," with white being all the way "out" and black being all the way "in." If you try to use an image as its own bump map, it rarely works; the shiny areas appear as large bumps and darker areas that protrude look recessed. It's important to keep bump maps slightly soft; ultra-high-contrast black-on-white images do not work as well as softer images with gradations between the extremes.

### **Tutorial: Applying Bump Maps**

In this tutorial, you'll apply a procedural noise effect to the Bump Mapping attribute of the flower pot's clay material to give it a more natural, rough appearance.

---

**On the CD** - Chapter\_08\movies\ch08tut07.wmv

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1. In Hypershade, MMB-drag the pottery material to the bottom tab area. If the bottom tab area is cluttered, you can clear it by selecting the materials you are done with and clicking the Clear Graph button (refer to Figure 8.1).
- 

**On the CD** - Chapter\_08\ch08tut05end.mb

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2. Double-click the pottery material to open the Attribute Editor. Click the checkered button to the right of the Bump Mapping attribute near the top of the Common Material Attributes section to open the Create Render Node dialog box.
3. Click the Solid Fractal type in the 3D Textures section of the Create Render Node dialog box. The Attribute Editor will show the Bump Value and Bump Depth settings. Notice that the Bump Depth defaults to 1.0. You can intensify or reduce the bump amount with this slider. Click the right-arrow icon next to Bump Value to take you to the solid fractal that's driving the bump. The Solid Fractal Attributes section will appear in the Attribute Editor.
4. Set Ratio to 1.0 to intensify the bump.
5. Click the place3dTexture tab in the Attribute Editor. You can also find this node in Hypershade, connected to the left side of the Solid Fractal swatch that connects to the pottery swatch. In the Attribute Editor, increase the scale of the Solid Fractal:

Set Scale X, Y, and Z to 50. Note the size icon that appears in the 3d panels.

6. Render the scene to see the flower pot's bumpy appearance.

---

**On the CD** - Chapter\_08\ch08tut07end.mb

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### **Tutorial: Applying Bump Maps to Your House**

Applying a bump map to the textures for your house requires a little more work. In this tutorial, we'll guide you through applying a bump map for three materials: the chimney, foundation, and outer walls.

---

**On the CD** - Chapter\_08\movies\ch08tut08.wmv

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1. Load your scene with the textured house (see the file noted below the CD icon). Because bump maps are determined with values taken from a grayscale image, you can often take the color version of a texture you have and modify it to become the bump map, as shown in [Figure 8.34](#). After you have a bump map, all you have to do is set the placement so that it lines up with the texture already applied to the object.

---

**On the CD** - Chapter\_08\ch08tut06end.mb

---

2. Switch into the Hypershade/Render/Persp saved layout. Hide all layers except for DoorL. The material for the door will be the easiest one to add a bump map to. There are no sharply defined lines for the door, so you can use almost any type of bump map. Maneuvering in the Perspective view, focus on the door from an angle. If you look at the door straight on, it's more difficult to see the results of the bump map. Do an IPR render.
3. Double-click the Door\_Blinn material to open the Attribute Editor. Click the checkered button next to Bump Mapping. Select the Normal radio button in the Create Render Node dialog box, and then click File as your texture type. In the File tab, load the file noted below the CD icon into the Image Name text box.

---

**On the CD** - Chapter\_08\BumpMaps\planks\_bump.tif

---

### **Figure 8.34**

The grayscale bump maps in the bottom row were created by desaturating and altering the original color textures in the top row, so that "higher" areas are lighter.

---

**Tip** - If you load the bump map files from the CD-ROM, you'll need the CD-ROM every time you load the scene. A good plan would be to copy the files from the CD-ROM into the sourceimages folder in your project directory.

---

4. The bump map is applied almost perfectly, with the wood grain running vertically. In the bump2d tab, decrease the Bump Depth to 0.6. In Hypershade's Work Area, click the place2dTexture tab for the bump map, and set Repeat UV to 1 and 0.7. Add some Noise UV set to 0.01 and 0 to make the vertical lines "wiggle" a little. Look at [Figure 8.35](#) to see the difference before and after the bump map was added.
  5. Now you'll add a bump map to the walls of the house. Make the OuterWallsL layer visible. Focus on the front left side of the house in the Perspective view, and IPR render. With Walls\_Blinn open in the Attribute Editor, click the checkered button next to Bump Mapping and click File as the texture type. In the bump2d tab, decrease Bump Depth to around 0.5. Next, drag and drop planks\_bump.tif (see the file noted here) to the Image Name text box as before. Double-click on Walls\_Blinn in Hypershade, and you can find the values for the place2dTexture node in the Channel Box (hotkey: **Shift+C**) by clicking on the place2dTexture entry under Inputs. Close the Attribute Editor to get it out of your way.
- 

**On the CD** - Chapter\_08\BumpMaps\planks\_bump.tif

---

### **Figure 8.35**

The door, before and after adding a bump map to its material.

6. The Inputs section of the Channel Box contains information about the material's connections (textures and mapping placement). There are currently three place2dTexture nodes, with the most recent one at the bottom. Click on the last

place2dTexture node to see a plethora of attributes (see [Figure 8.36](#)). Change Rotate Frame to 90, and set Repeat U to 7 and Repeat V to 4.

### [Figure 8.36](#)

In the Channel Box, you can modify values for your material's placement nodes.

7. When adding the bump map to the foundation, you have to set the map's placement to fit with the cobblestone texture. Open Foundation\_PhongE and connect a 2D texture File to the Bump Mapping attribute. Be sure the Normal radio button is selected for the placement. Because the original color texture is set up as normal placement, the easiest way to align the two maps is to use an identical placement setup. Open the file cobblestones\_bump.tif, and drag it to the Image Name text box.

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**On the CD** - Chapter\_08\BumpMaps\cobblestones\_bump.tif

---

8. The default placement for the bump map is way off, which you can see by doing an IPR render. The cobblestones\_bump.tif file is the modified version of the foundation's texture. If the bump map is mapped overlaying the texture, you'll have a much more realistic look. RMB-click on Foundation\_PhongE, and choose Graph Network. Rearrange the graph in the Work Area (RMB-click | Graph | Rearrange Graph).
9. Delete the place2dTexture node that connects to the File node for bump by clicking to select it, and then pressing Delete. Now hold down the Ctrl key while MMB-dragging from the remaining place2dTexture node to the File node for Bump. When you release the mouse button over this node, all the connections should instantly appear.
10. Select the Bump2d node, and in the Attribute Editor, adjust the Bump Depth level to around 1.2, so that it looks like stone with deep grooves. The foundation should look similar to [Figure 8.37](#) after you're finished.
11. The last bump map you'll apply is for the chimney base. Having gone through the mapping process for the foundation, try doing the chimney on your own. The directions are basically the same, except that you'll load the bricks\_bump.tif file (noted below the CD icon) and apply the bump map to the ChimneyBase\_Lambert material.

---

**On the CD** - Chapter\_08\BumpMaps\bricks\_bump.tif

---

**Figure 8.37**

Applying the bump map to the foundation adds a lot of detail.

---

**Going Further** - To further your understanding of materials and texturing, try setting up the remaining materials for the house and experimenting with different methods of applying textures, such as projection methods, 3D textures, and so forth. You could also add some objects inside the house. You could model a coffee table, a lamp, or even a chair, or you can import a file with these objects already created for you.

To import the scene, go to File | Import | option box. Reset the settings to the default, and click the Import button. Then browse to the file's location on the CD-ROM, and click the Import button again. A ground material has been created as well as some objects for inside the house.

---

**On the CD** - Chapter\_08\ch08importObjects.mb

---

You might have to reposition some of the objects, but if you're having trouble, you can load the scene file noted below the CD icon. [Figure 8.38](#) shows the scene with the objects imported.

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**On the CD** - Chapter\_08\ch08tut08end.mb

---

**Figure 8.38**

The objects have been imported.

For your viewing and rendering pleasure, a fully textured version of the house is available on the CD-ROM. Load the scene file noted below the CD icon to see the objects imported and textures added.

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**On the CD** - Chapter\_08\ch08HouseComplete.mb

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## Summary

By working through the tutorials in this chapter, the world of materials has opened up for you. It might seem overwhelming now, but don't get discouraged. It takes time and practice to develop a thorough understanding of how nodes work together and affect your renderings. Using this fundamental knowledge of materials and texturing in Maya, you have a base to build on. Take a look at what you have learned in this chapter:

- **Blinn, Phong, PhongE, Lambert, and Anisotropic** The basic material types are confusing at first glance, but are no longer strangers to you.
- **Working with material attributes** Understanding the basic material attributes is vital to successfully creating a shader, such as plastic or metal.
- **Working with Hypershade** You've learned how to use Maya's material creation tool.
- **Adding materials to the house** Using the house from Chapters 5 and 6, you have moved closer to creating a render-worthy model.
- **Assigning materials and learning workflow** There's no set method for creating and applying materials to a scene, but you've learned a couple of methods to give you an idea of the process.
- **Adding textures to basic materials** A simple material can look good by itself, but adding a texture can bring the material to life!
- **Bump maps** You learned how to fake surface deformation by changing the way that light reacts to the surface.
- **Using 3D Paint** You learned to interactively create textures on 3D objects.

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