digital cinematography

When preparing a digital scene, lights and cameras play a very important role. Both lights and cameras make it possible to view objects, and see them in a realistic context. Artistically, they both allow 3D artists to control the look of their animation with the same creative control as a live-action cinematographer.

In some ways, the most difficult aspect of using lights and cameras in Maya is that the possibilities are endless. It is very easy to fly a camera around without a clear sense of purpose or add too many lights to a scene. The question is whether or not the creative decisions support the story being told. Therefore, it is a good idea to consider how live-action movies make use of camera moves and lighting.

Another challenge for 3D artists is to integrate CG elements and live action footage. They must take lighting and camera properties from the real-world and mimic them in a scene so the audience does not have any idea the CG elements are even there.

How Lights Work

Light affects the way in which we see the world around us. Light defines the shape and form of objects and spaces, while at the same time, it works at an emotional level by setting mood and atmosphere. Learning to control light is an important 3D skill.

Cinematographers use light to illuminate the objects in the scene while supporting the scene's emotional context. The quality of the light in a digital shot is equally important, although the rules are different.

Real World vs. Digital Cinematography

In the real world, light bounces. Light starts from a light source such as the sun or a lamp and is either bounced or absorbed by all surfaces. An object appears red because the green and blue light is absorbed while the red light is reflected. A cinematographer sets up lights, then measures the light levels, which include both direct and indirect light. This information is used to adjust the exposure settings of the camera.

In Maya, surfaces are illuminated directly by lights. There is no bounced light coming from other surfaces. This is because CG lighting doesn't bounce. Here, film isn't exposed to light and camera controls don't need to be adjusted. Light levels are, therefore, controlled using the intensity settings of the lights themselves.

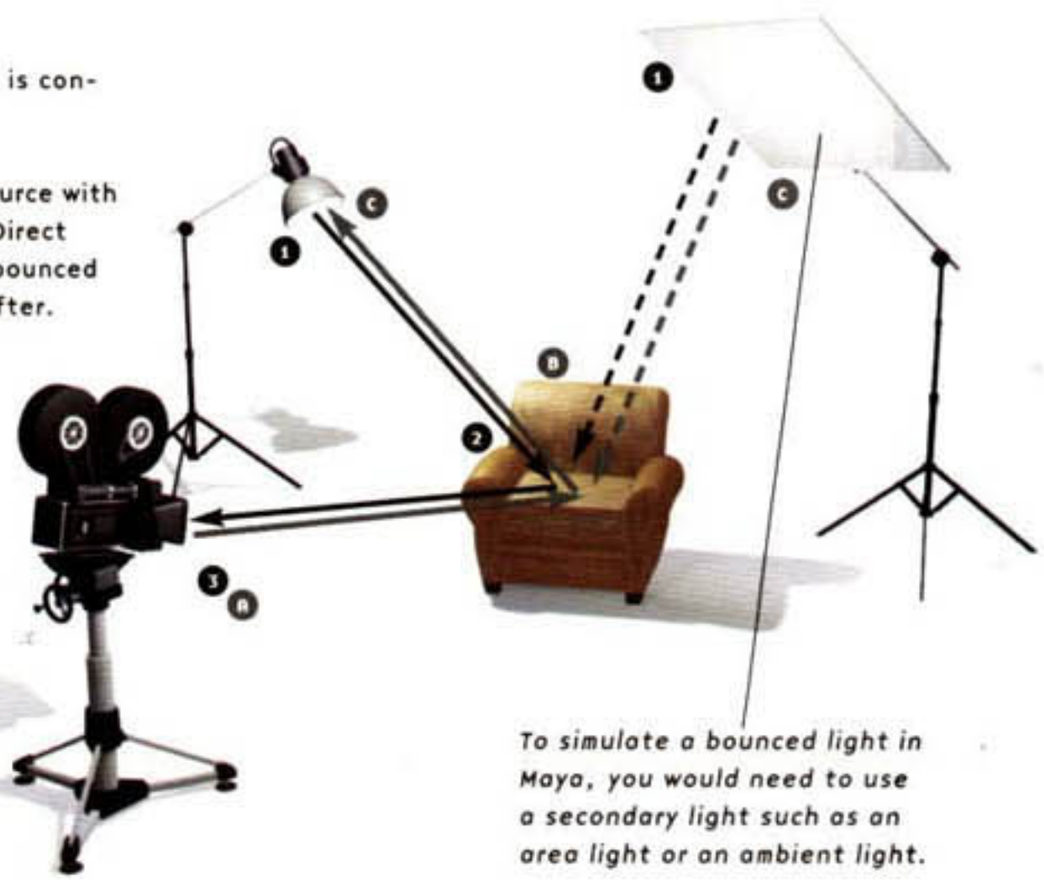
In the Real World

The film's exposure to light is controlled by the camera.

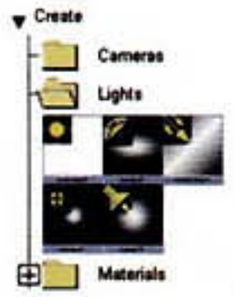
1 Light is emitted from a source with a controllable intensity. Direct light is hard, while light bounced from other surfaces is softer.

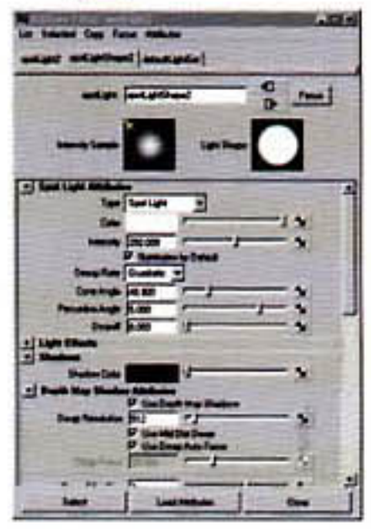
2 Light levels are measured using a light meter to determine the proper exposure settings for the camera.

3 Camera controls such as F-stop, shutter angle, exposure time, and film speed are set to control how much light is exposed to the film.



To simulate a bounced light in Maya, you would need to use a secondary light such as an area light or an ambient light.





Creating Lights

Lights can be created using either the **Create > Lights** menu or using the swatches in the Hypershade. Light attributes can be edited using the light's shape node.

On the Computer

The intensity of the lighting is controlled by the lights.

A From the camera's point of view, the renderer samples a point on a surface.

B From the surface's shading group, a list of associated lights is used to determine which lights should be factored in.

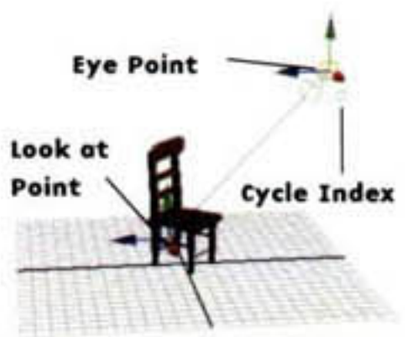
C The light's attributes, such as intensity, color, and decay, are used to calculate the illumination on the surface.

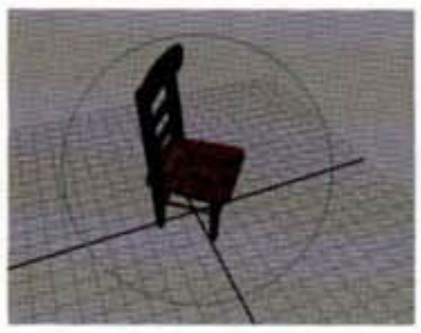
Positioning Lights

Lights can be positioned using the **Show Manipulator** Tool. Each light is displayed with an *eye point* that defines the position of the light source and a *look at point* that defines where the camera is pointing. Adjusting these points sets the translation and rotation values on the light's Transform node.

The line between the eye and look at points defines the light's direction. Spot, Area, and Directional lights must have their directions set to work properly, while Ambient and point lights only require an eye point position.

You can also position a light by selecting the light, then choosing **Panels > Look Through Selected**. This lets you use the **Alt** key to Dolly, and Pan the view as if it were a camera. This method often makes it more intuitive to position the light and its look at point.





Looking through light

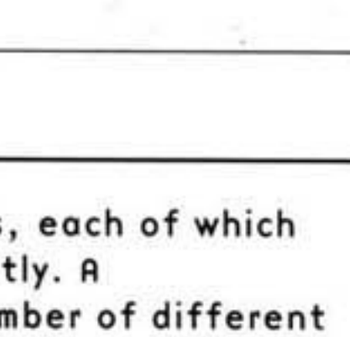
Light Types

Maya has several light types, each of which illuminates a scene differently. A typical scene combines a number of different light types. You can switch between light types in the Attribute Editor.

Spot

Spotlights emit light that radiates from a point within a limited cone angle. You can use this cone angle to limit the area receiving light.

Directional

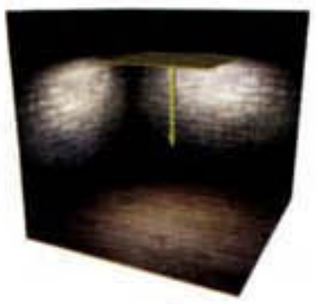


Directional lights use parallel rays of light to illuminate a scene. Shading is very uniform without any hotspots. These rays are similar to the light of the sun, which hits the earth with parallel rays.

Point

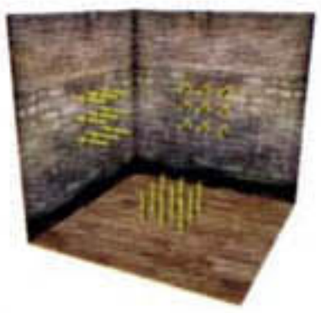
Point lights emit light in all directions, radiating from a single point. This creates an effect similar to a light bulb. This light creates subtle shading effects with definite hot spots.

Area



Area lights emit light using a two-dimensional area. The area light's icon can be used to help define the light's direction and intensity. A larger area light has a stronger intensity.

Ambient



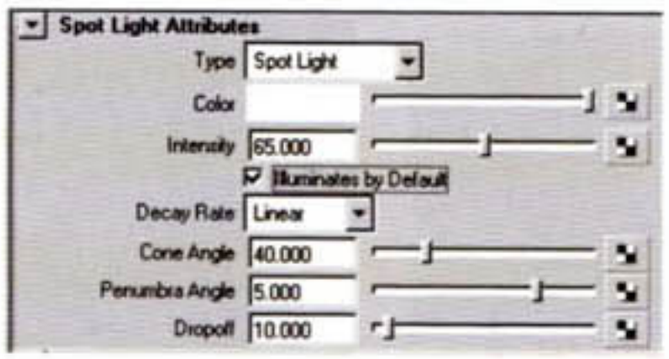
Ambient lights emit light uniformly in all directions. The **Ambient Shade** attribute adds positional behavior. Bump maps are not visible with ambient light alone.

Light Nodes

When a light is created, it is built with two nodes. The Transform node holds all the information about the light's position and orientation. For most light types, Scaling a light will not change its shape, or the effect of its illumination, but it will allow you to change the size of the light icon to make it more visible in the workspace. The one exception is area lights where their intensity is affected by scaling. The Shape node holds all the information about the light's illumination. Some of the spot light attributes can be edited using the **Show Manipulator** Tool. When using the **Show Manipulator** Tool to position a light, you can click on the **Cycle index** icon to access manipulators for controlling different attributes such as Cone Angle and Penumbra Angle.

Spot Light Attributes

The spotlight's Shape node contains attributes that control how the light will illuminate the scene. Since the spotlight contains the most attributes, it is used as the example here. The other light types contain a subset of the Spot Light Attributes.



Intensity
This attribute determines how much light is emitted from the light source. As you increase the **Decay** and **Dropoff** values, you need a more intense light.

Color
You can set RGB values for the light being emitted. This will have an influence on the color of your scene.

Decay
This attribute determines how much the light intensity diminishes as the light gets further from its source. Therefore, if you choose to use **Decay**, you need to increase the **Intensity**.

Dropoff
This attribute determines how much the light intensity diminishes as it gets to the outer edge of the light. This puts more emphasis on the light's hotspot.

Cone Angle
This attribute determines the width of the spotlight's cone of influence. The areas outside the cone are not illuminated.

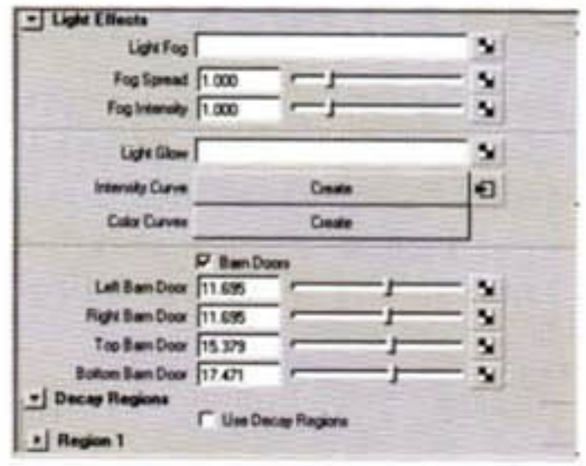
Penumbra Angle
This attribute creates an area at the edge of the spotlight where the light fades. A larger value here creates a soft look for the light.

Hotspot
The point where the light is most intense is referred to as the hotspot. You also know it as a *specular highlight*. The look of the highlight is a result of the intensity of the light and the shading qualities of the surface's Material node.

Light Effects

To create professional lighting effects, you have a number of tools at your disposal. You can turn on Barn doors or texture map the light's color or intensity to create Gobo effects and you can also use Color and Intensity curves to affect these attributes over distance.

These effects offer you the kind of control a lighting technician needs to fully control the illumination of a scene. It is important to take your lights beyond the basic default settings if you want to achieve a professional look.

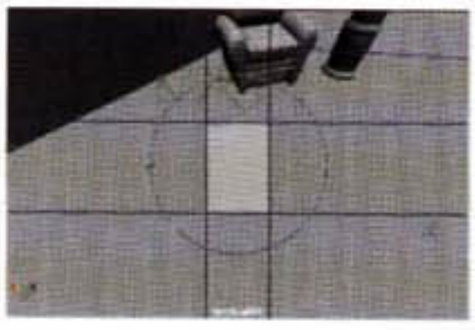


Light Effects Attributes

These attributes can be turned on, set, and mapped in the Attribute Editor.

Barn Doors

When a lighting technician wants to prevent the light from spilling in all directions, he or she uses the light's Barn doors. Barn doors are flaps that surround the light that can be opened and closed. In Maya, you can turn on Barn doors in a spotlight's Attribute Editor. Select **Look through selected** to see the Barn doors and adjust them to block light in your scene. Using the **Show Manipulator** Tool, you can cycle to the Barn door manipulators and adjust them interactively. In the image shown here, the Barn doors are used to give a spotlight a rectangular shape that mimics a window that is off the stage area.



Mapping Lights

It is possible to texture map the **Color** or **Intensity** of a light. These maps cover the area of the light and can be used to create Gobo or slide projector effects.

Gobos

A Gobo is a cutout that lighting technicians place in front of a light to get interesting shadow effects. To create a Gobo effect in Maya you can texture map the light's **Intensity**.

Slide Projector

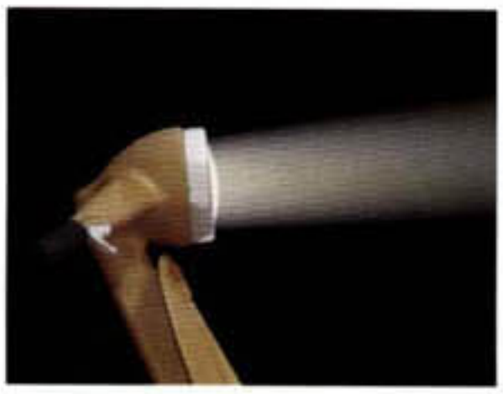
If you texture map a light's **Color**, you get a slide projector effect. The light projects the image onto whatever surfaces lie in its path.

Negative Intensity

If you want to darken part of a scene, you can add an extra light that has a negative **Intensity**. This means that the light will remove light from the scene instead of illuminating it. This is a great tool for darkening the corner of a room.

Fog and Opti-FX

Fog and Opti-FX, such as Glows and Lens flares, let you mimic the way in which light reacts with the atmosphere, the camera's film back, and with our eyes. When a scene is rendered, Glows are calculated at the end and composited onto the rendering while fog is rendered as part of the scene. Fog and glow are covered in more detail in the **Effects** chapter of this book.



Light Fog

When you apply Fog to a light, a shape is attached to the light that is mapped with a volume shader. This gives the appearance of the light beam illuminating dust and particles in the atmosphere.

Opti-FX

When you apply Glow to a light, the point of the light's source can have halo and star effects. These simulate the real-life reaction of a camera's lens and film to light. The lens and retina of our eyes also react in a similar way.

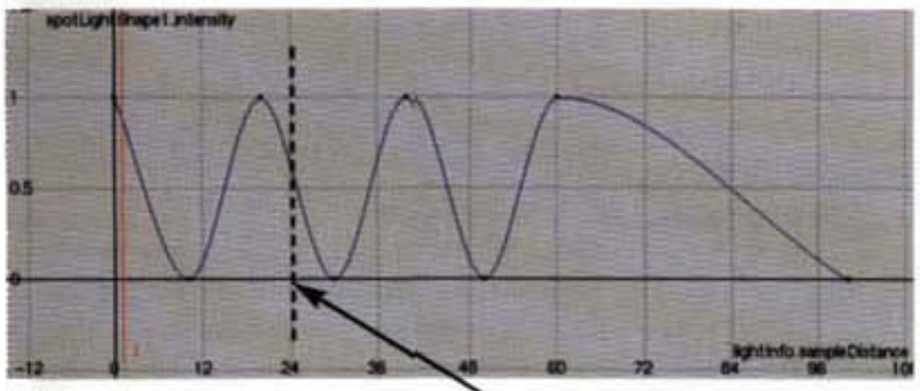
Intensity Curves

Another way of controlling the decay on a spotlight is to use Intensity Curves. These curves let you specify the intensity of a light over distance in 3D space. You can use actual measurements from the scene to determine intensity.

To help measure the distance, you can constrain the light to distance locators. Select **Create > Measure Tools > Distance Tool** and place the two locators. Now **Point constrain** the light to the first locator and **Aim constrain** the light to the second locator. Now you can position the light using the first locator while the position of the second locator records the distance from the light to your aiming point. This distance can be used to set up the Intensity Curve.

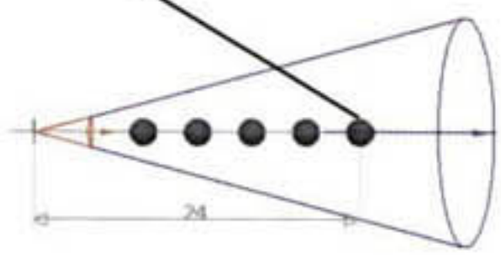
To demonstrate how Intensity Curves work, the following diagrams show several spheres that lie on the light's illumination path. You can judge the results by comparing the curves to the illumination of the spheres. Fog has also been added to the light to further illustrate the effect of the curves.

This scene uses Intensity Curves to put less lighting on the chair while using more intense lighting on the back wall.



Creating the Curves

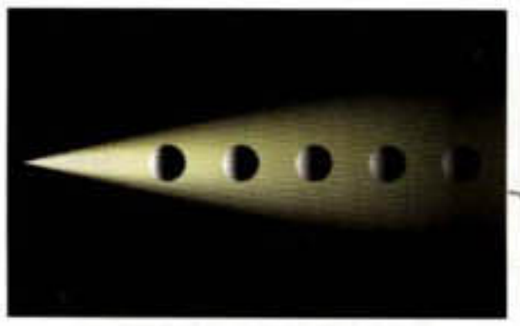
Click on the **Create** button next to **Intensity Curve** in the lights Attribute Editor, then view the curve in the Graph Editor. At first, the curve uses default settings as shown above.

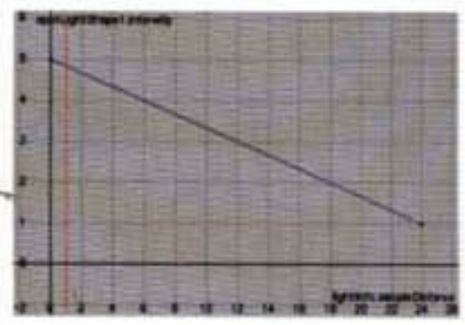


Delete the middle points on the curve and change the distance of the second point from the default distance of 100 to a value that matches your measured distance. Later you can add points to the curve to manipulate the illumination. The key is to remember that you are modifying intensity over distance. Therefore, you need to know the distances of objects from your light.

Simple Curve

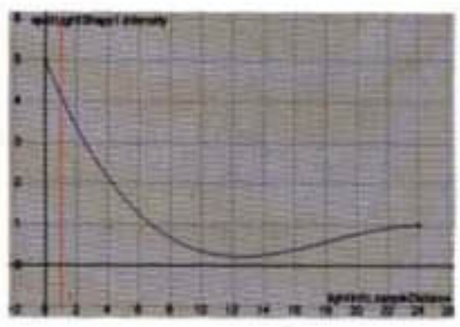
This curve shows a linear decay from an **Intensity** of 5 to 1. The **Distance** value of the second key was taken from the **Distance** Tool measurement.





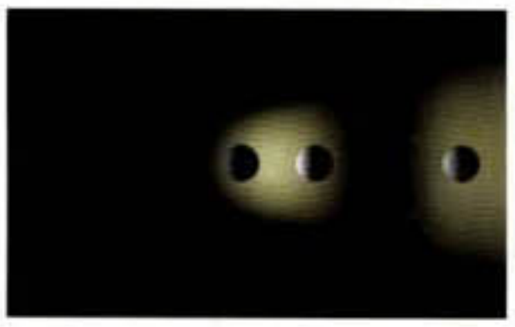
Reshaped Curve

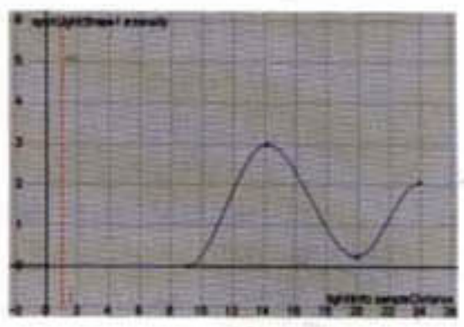
This curve goes from an **Intensity** of 5 to 1 with a dip in the curve near the middle. Correspondingly, the illumination diminishes at that distance.



Multiple Points

The Intensity jumps up and down to put the focus of the lighting on the center sphere and the background. Other objects are not affected.



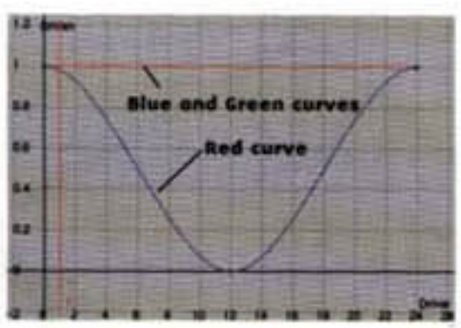


Color Curves

Similar to Intensity curves, Color curves let you use three curves to set the RGB values over distance. You can use these curves to create focused areas of colored light within a scene. Remember that RGB values of 1, 1, 1 create white light. You can animate the RGB values to get different colors of light. You can get the values from a color picker but you have to enter the values in the graph by hand. These curves can then be combined with Intensity curve settings to create even more subtle effects.

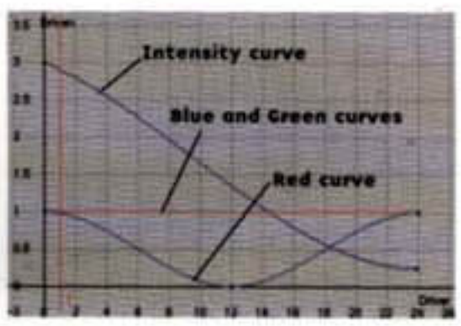
White to Red to White

Three curves are used to transition the color from white to red to white over distance. This adds red to the central object while leaving the other objects uncolored.



With Intensity Curve

By combining Color and Intensity curves, you can create more controlled lighting conditions. Here, the Intensity curve is reshaped to create decay.

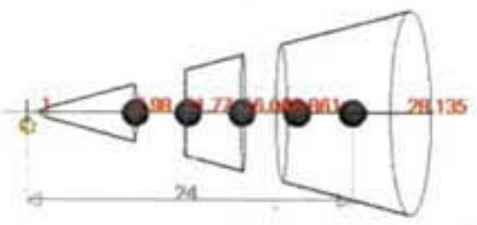


Decay Regions

If you turn on **Decay Regions**, you can set up zones for a spotlight with specific start and end distances. Areas between zones have no light, while the zones themselves show the light's existing decay values. A Spotlight has three regions you can work with. You can interactively edit the positioning of the Decay Regions using the **Show Manipulator** Tool.

Light Manipulators

When you select a light, and then choose the **Show Manipulator** Tool, you can click on the cycle index to go to the Decay Region manipulators. Click-drag the rings on the ends of the regions to position them. The areas between the regions get no light at all and can be used to clip the light. This can be helpful if you want to start a light from a point other than the source itself.



Casting Shadows

One of the most dramatic aspects of lighting is in the area where there is no light. Shadows add drama to your scene while helping to anchor characters and props to the ground. If your character leaps into the air, you know what is happening because the shadow and the character no longer touch each other.

In Maya, there are many factors that affect the look and quality of your shadows. You can choose from Depth Map and Raytraced shadows which offer different levels of quality and speed. Sometimes light attributes, such as Cone Angle will affect your shadows and must be taken into account. The more you know about how shadows are cast, the easier it will be to adjust the appropriate attributes.

Depth Map Shadows

Depth Map shadows are the more efficient of the two shadow types. A Depth Map shadow can be created by setting **Use Depth Map Shadows** to **On** in the light's Attribute Editor.

Depth Map shadows work by recording the Z-depth information from the light's point of view, then using this information to evaluate whether or not a point in your scene is in shadow. The diagram below shows how a spotlight evaluates Depth Map information to generate shadows. You can see that the Depth Map is generated from the light's point of view.

With and Without Shadows

Here are two shots of a scene. The first does not use shadows and the second one does. You can see how the scooter in the second image is much more grounded, and it is easier to read the scene's depth. While shadows do require extra work when you set up a scene, they are well worth the effort.

Step 1

When a rendering starts, a Depth Map is created from the light's point of view that measures how far the various objects are from the light. White is used to show surface points closest to the light, while the various shades of gray show a greater distance from the light.

Stored Depth Map Value

Step 2

When a point on a surface is being shaded during the rendering process, the distance is measured between the point and the light source.

Step 3

This measurement is then compared to the depth information stored in the Depth Map. If the point's distance is greater than the distance stored in the Depth Map, the point is in shadow.

Step 4

If the point is in shadow, the light's illumination does not contribute to the shading.

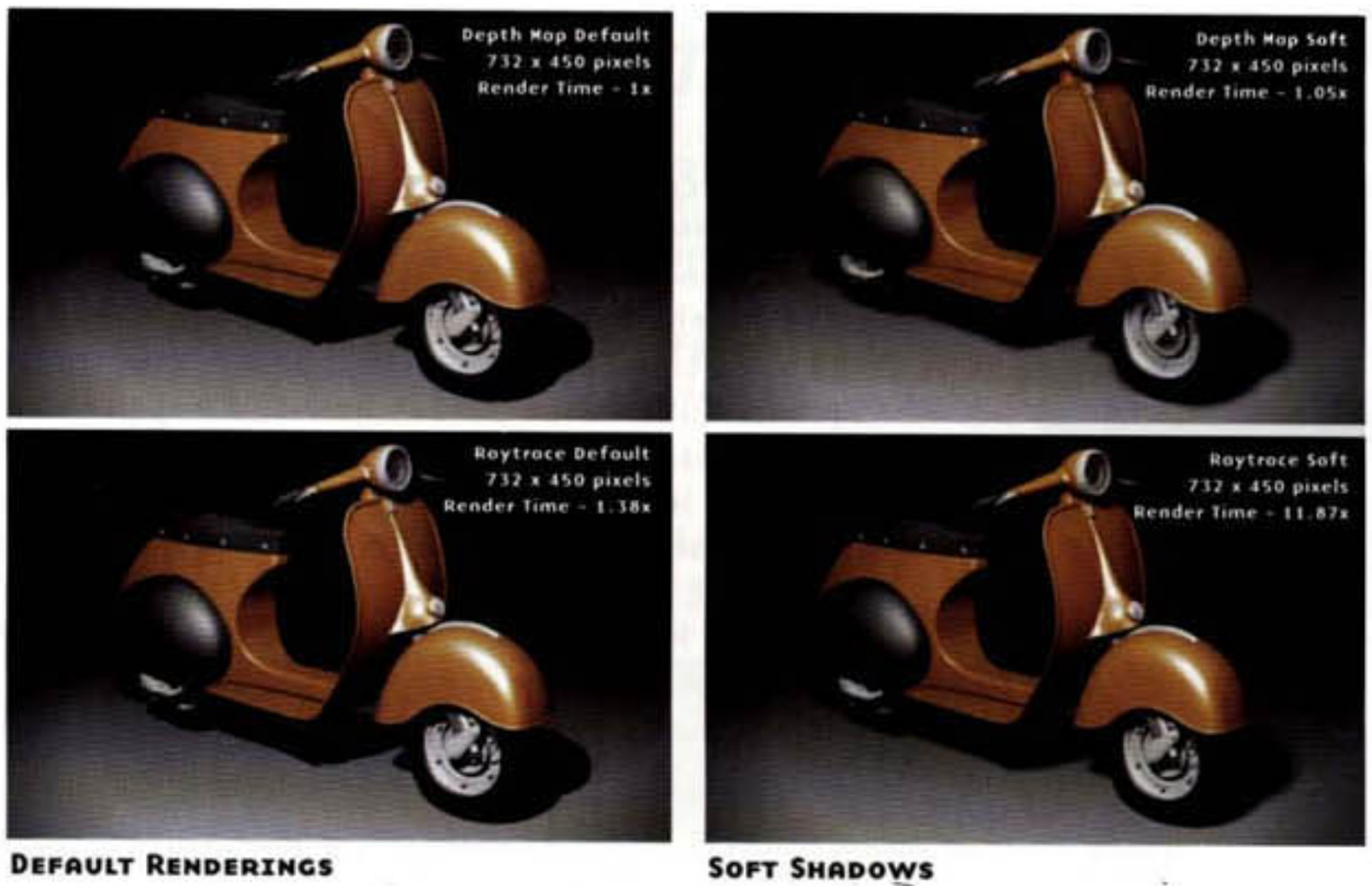
Note: Another light, such as an ambient light, may illuminate parts of the scene where the spotlight does not. That is why you can see the wood texture underneath the chair in this image.

Raytraced Shadows

To calculate Raytraced shadows, Maya sends a ray from the camera and when this ray hits a surface, it spawns another ray toward the light. This shadow ray reports whether or not it hits any shadow-casting objects on its way to the light. If it does hit a shadow-casting object, then the original surface is in shadow.

Raytraced shadows have the disadvantage of being slower to render than Depth Map shadows. However, depending on the look you are interested in, there are several reasons why you would use Raytraced shadows in your scene. These include transparent shadows, colored transparent shadows, and shadow attenuation.

If you want Raytraced shadows, but not reflections and refractions, then set **Reflections** and **Refractions** to 0 in the **Render Quality** section of the **Render Globals**.



Default Renderings

Using the default settings built into a spotlight, the Raytrace rendering offers a sharper shadow than the Depth Map shadows. Rendering time is longer for the Raytraced scooter.

Soft Shadows

By tweaking the Depth Map shadows attributes you can see much better results. Using **Light Radius** and **Shadow Rays** to soften the Raytraced shadows, you can see how the rendering took even longer.

Transparent Shadows

When casting shadows from transparent objects, Depth Map shadows do not take into account the transparent qualities of a surface, while Raytraced shadows do. This may be a deciding factor when it comes to choosing which technique you will use to cast shadows.

Depth Map Shadows

When a Depth Map is generated at the start of a render, it does not take transparency into account. For this reason, the shadow generated by a Depth Map will appear solid.

Raytraced Shadows

Raytraced shadows are computed during the rendering process. Therefore, the transparency of the object is taken into account. As a result, Raytraced shadows clearly represent the details of a transparent or transparency mapped object.

Colored Transparent Shadows

Another feature of Raytraced shadows is that you can create colored transparent shadows. For example, in the real world, when light passes through a stained glass window, you see the colors transmitted by the light passing through the window onto the floor. In Maya, Raytraced shadows will automatically create colored shadows when the transparency channel on a material is colored or it is mapped with a colored texture.

Raytraced Shadows

The color of the transparency automatically casts a colored shadow.

Shadow Attenuation

By default, raytraced shadows look more accurate and crisp than Depth Map shadows. This can result in an undesirable computer-generated look in most cases. To avoid this, the shadows can be softened using a combination of a non-zero **Light Radius** and **Shadow Rays** greater than 1. These controls are found in the **Raytrace Shadow Attributes** section of the Attribute Editor for a light.

The biggest difference between a Raytraced soft shadow and a Depth Map shadow is that a Depth Map shadow is evenly soft around its edges. By contrast, a Raytraced shadow will dissipate or attenuate with distance from the shadow-casting object. This can be slow to render but is often used to create beautiful looking shadows in still renderings.

Depth Map Soft Shadows

The light's **Dmap Filter** value affects the softness of a Depth Map shadow.

Raytraced Soft Shadows

Light Radius and **Shadow Rays** define the softness of a Raytraced shadow.

Shadow Limit

When working with Raytraced shadows, you should also set the **Shadow limit** attribute. For example, if you have a shadow-casting object with several transparent surfaces behind it, followed by an opaque surface, you would expect to see a shadow on the opaque surface. In order to see this shadow, set the **Ray Depth Limit** on the light to a value that is the number of transparent surfaces + 1. Be sure that the **Shadow limit** in the **Raytracing Quality** section of the **Render Globals** is not set lower than this value, or you will not see your shadow.

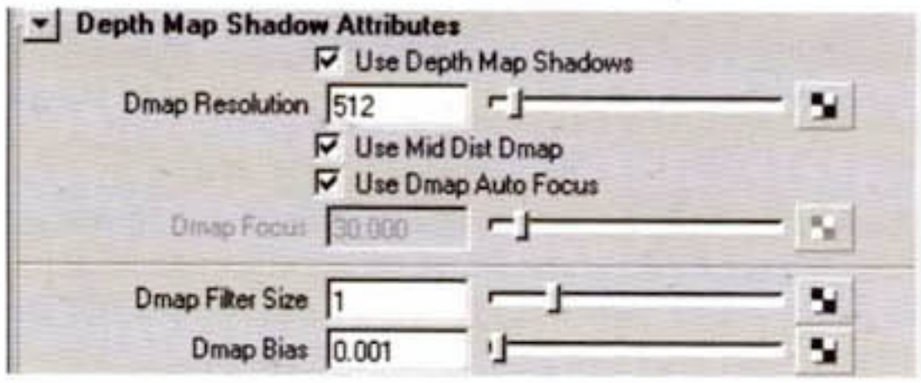
Depth Map Shadows

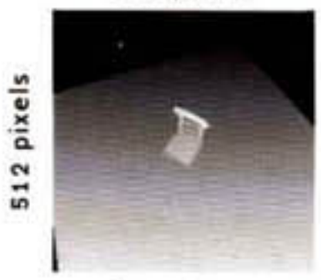
To successfully shadow your scenes using Depth Map (Dmap) shadows, you must work to get the best quality shadows with the least impact on rendering time. Various shadow attributes influence the final look of a shadow and how fast the scene will render.

To control the quality of a Depth Map shadow, there are several key attributes that affect how the Depth Map is generated and how it is used during a rendering. For example, the **Depth Map Filter Size** lets you soften the edge of the shadow, while the **Dmap Resolution** lets you generate more detailed Depth Maps. Other light attributes such as **Cone Angle** and **Dmap Focus** determine how much area is shadowed by the light. By learning more about these key attributes, you will be in a better position to make good shadowing decisions.

Shadow Quality

The quality of a Depth Map shadow is influenced by the shadow attributes as well as other attributes such as **Shading Anti-aliasing**.



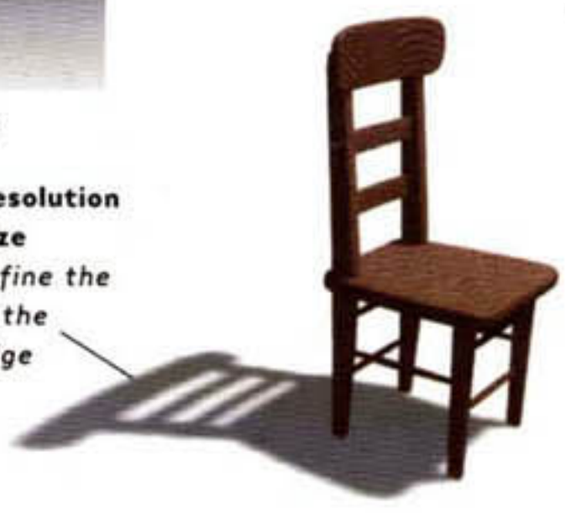


Depth map

***Cone Angle** and **Dmap Focus** affect the coverage of the depth map*

Light

*The **Dmap Resolution** and **Filter Size** together define the softness of the shadow's edge*



Dmap Resolution

This value determines the size of the Depth Map. The higher the resolution, the more accurate the details of the shadow will be. As the resolution increases, the rendering time goes up. Therefore, you should make sure that your Dmap is focused as tight as possible on the shadow-casting object before increasing the **Dmap Resolution**.

A

Dmap Resolution: 512

B

Dmap Resolution: 1024

Dmap Filter Size

This value blurs the Depth Map as the shadows are being rendered. This helps soften the edge of the shadows and create better anti-aliasing. The appropriate **Filter size** value depends on the resolution of your maps and how the shadow is focused on your shadowing objects. If you increase the **Filter size**, your render time will increase. If you increase the **Dmap Resolution**, you need to increase the filtering to get the same softness, which will also lengthen render time.

A

Dmap Resolution: 512
Dmap Filter Size: 1

B

Dmap Resolution: 512
Dmap Filter Size: 3

C

Dmap Resolution: 256
Dmap Filter Size: 3

Soft Shadows

Very soft shadows can be achieved by lowering the resolution and increasing the filter size which will render very quickly. However, with animations, lowering the resolution too much can lead to flickering shadows. You must find the right balance.

Focusing the Depth Map on a Spotlight

As you position your lights and set your **Cone Angle**, you affect the area which may be included in the Depth Map calculation. If the Dmap Resolution remains the same, increasing the cone angle can force each pixel in the Depth Map to describe a larger area, potentially causing a pixilated shadow. It is important to learn how Maya focuses the Depth Map and how you can control it.

Shown below are several cases where the **Cone Angle**, **Use Dmap Auto Focus** and **Dmap Focus** have been set. You can see how the Depth Map relates to the actual **Cone Angle** in each case.

If not focused, a light can create a poor quality, jagged shadow. A better result may be achieved with a more tightly focused Depth Map.

Cone Angle 40 - Dmap Focus: Auto

The **Cone Angle** limits the size of the Dmap coverage when the light covers an area smaller than the shadow casting objects.

Cone Angle 80 - Dmap Focus: Auto

When the **Cone Angle** covers an area larger than the shadow casting objects, **Auto Focus** keeps the Dmap tightly focused on their bounding box.

Cone Angle 80 - Dmap Focus: 36

With **Use Dmap Auto Focus** set to **Off**, you can set a specific angle to focus the Depth Map on the chair.

Cone Angle 80 - Dmap Focus: 20

If you set the **Dmap Focus** too small, the shadow will be cut off or may not appear at all.

Reusing Depth Maps

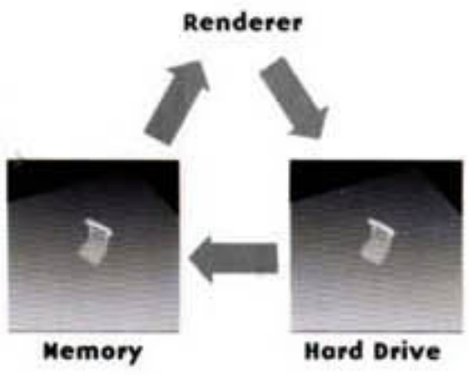
By default, a Depth Map is generated for each light for each frame of animation. This is designed to make sure that the changing position and/or shape of animated objects is taken into account for each frame. If the lights and objects in a scene are not animated, such as camera-fly-throughs, then you would only require one depth map for the entire animation.

To accomplish this, use the Disk Based Dmaps attributes found in the light's Attribute Editor to write and re-use Depth Maps. This will speed up your render time because Maya will not need to re-render the Dmap at the start of each frame.

Shown below are the three options available under Disk Based Dmaps and a description of what happens when each is used.

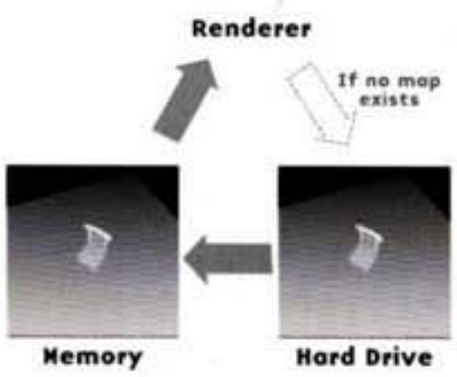
Off

A Depth Map is generated at the start of each frame. Once the Depth Map has been used to calculate shadows for that frame, it is thrown away.



Overwrite Existing Dmap(s)

The Depth Map is created and used in calculating shadows. At the same time it is saved to your hard drive so that you can reuse it in future renderings. This new depth map will overwrite any existing map. You can use the **Fcheck** utility to view the map. Press **z** in Fcheck to see the depth channel.



Reuse Existing Dmap[s]

If a depth map has been previously saved, it is loaded from your hard drive and reused. If there is no map then a new one is created and stored on the hard drive.

Directional Light Depth Maps

Since directional lights do not have a Cone Angle, **Use Dmap Auto Focus** determines the Depth Map coverage. To get accurate detailed shadows, you may need to use the manual **Dmap Focus** attribute to reduce the area covered by the Depth Map and possibly increase the **Dmap Resolution**.

Point Light Depth Maps

Point lights can each create up to 12 Depth Maps. This includes the Mid Distance Dmaps and the standard Dmaps for positive and negative X, Y, and Z axes. The light looks in all these directions, and only generates Dmaps when it encounters any shadow casting objects. You can also control exactly which axes the light can cast shadows along.

Point Light Maps

Shown are three Depth Maps produced to create the chair's shadow.

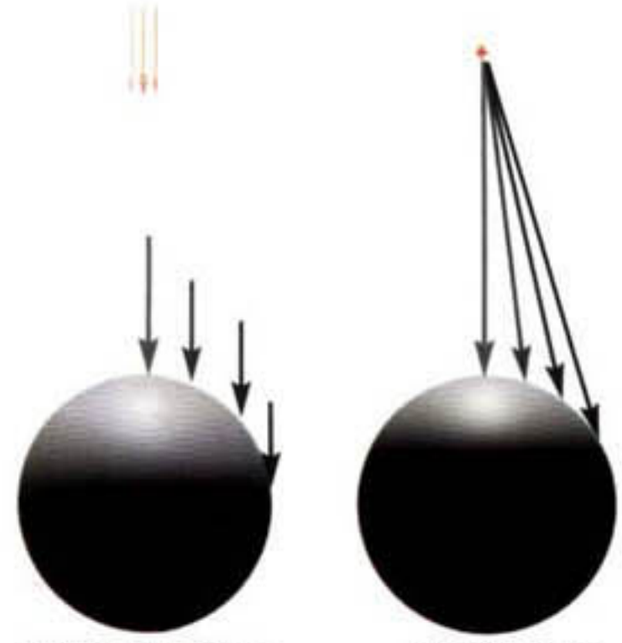
Lighting Setups

Setting up lighting involves a combination of several elements. The direction of the light, how many lights you use, and the properties of each light all contribute to the illumination of a scene. In many cases, you are attempting to create lighting that either mimics real-world lighting or studio/movie set lighting.

The Importance of Light Placement

The way an object is shaded helps define its shape and form. This shading is dependent on the placement and quality of the lighting. You can, in fact, use light to sculpt an object by controlling the way its shading and shadows work together. First, you must learn how to place lights so they enhance the form of your objects.

If you set up a single light, you can see how its placement affects the look of an object. If you then add a second light, you can begin to set up more complex lighting.



Shading with Light

The shading of the object is defined by its material qualities and by the angle and intensity of the light hitting it. In a simple example, you can see how the angle at which light hits the surface defines the shading.

The light is hitting the objects directly from above. The spherical shapes appear cut in half, while the rectangular shapes are only defined on one of their faces.

The light is hitting all the surfaces equally. The rectangular objects are receiving equal illumination on all faces. This makes it hard to read the shape. The object's shadow is also hidden.

The light is hitting each surface at a different angle. Now the faces are clearly defined with distinct levels of illumination. The drawer's shape is more clearly defined by this shading.

With multiple lights and different intensities, you get a more subtle sculpting of the form. Illumination appears less like stage lighting with the addition of ambient lighting.

Soft Lighting

When lighting a scene, you can create a softer, more diffuse look by choosing the appropriate light type and by softening the edges of the shadow and the penumbra.

Lights that emit from a single point, such as spotlights and point lights, render with hard edges and strong shading. Lights that emit from more than one point, such as an area light, give a softer look as the surface shading and shadows become less prominent. Multiple spotlights and ambient lights can also be used to create a similar look.

To further enhance the diffuse qualities of a light, you can soften the edge of a light's penumbra by adjusting attributes such as **Decay**, **Dropoff**, and **Penumbra Angle**. To add the same softness in the shadow edges, you can adjust the **Dmap Filter Size** and **Dmap Resolution**.

Single Light with Hard Edges

This light uses default settings to create a hard look to the lighting.

Single Light with Soft Edges

Light and shadow attributes diffuse the edges of the light.

Two Lights with Soft Edges

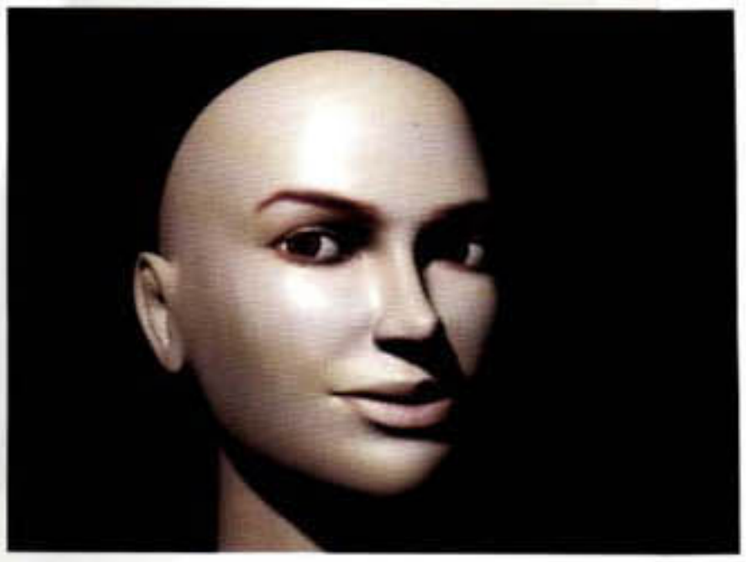
Here a ambient light is added to the scene to create less contrast. Area lights also make good secondary lights.

Multiple Lights with Soft Edges

The scene uses several key lights that are slightly offset from each other. This further softens the shadow's edge.

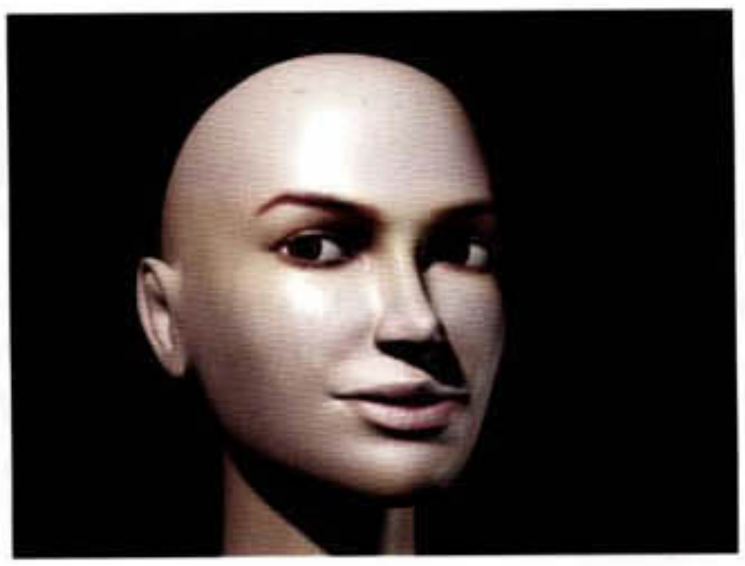
Basic Lighting

In animation, basic character illumination can be accomplished with two or three lights. The key light is the main light that illuminates the scene, emphasizes the character, and helps establish mood. Secondary lights are used to fill the dark areas. Sometimes, back lights are used to make sure that a character stands out from its surroundings. This basic lighting setup works well and, in most cases, you only require extra lights for background objects.



Key Lighting

The key light is the most intense light aimed at a character. In a complex scene, there may be seveeral key lights focusing the audience on different pairts of the set. This light is the hardest light in the scerne and should have strong shadows.

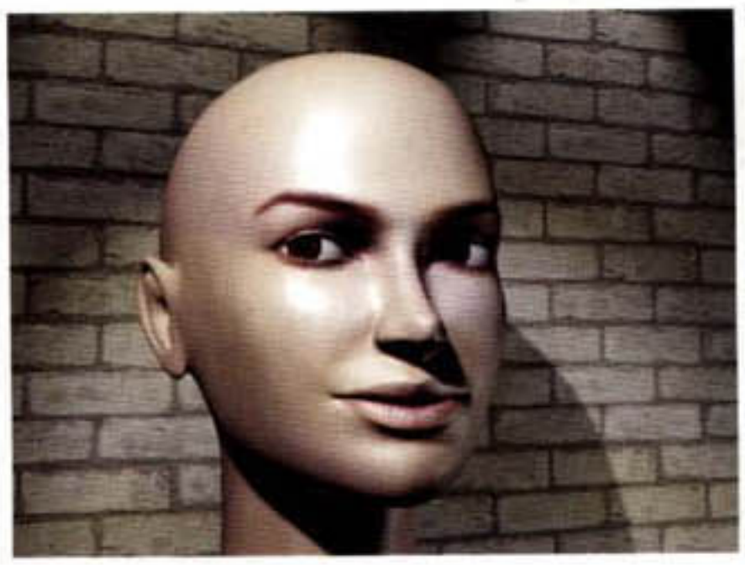


Fill Lighting

The fill light is designed to lighten the shadow areas of a scene. This light is placed on the opposite side of the character. It is a soft light that may or may not cast shadows. Ambient and area lights work well as fill lights because they offer a more even illumination.

Scenery Lighting

If your key light does not fully illuminate your scene, you may need to add special lights. These should work with the key lights and preserve enough contrast so that the scene is not washed out.



Background and Special Lighting

To illuminate a set, you often need to add lights that illuminate the background surfaces, but that do not take away from the main character. One approach is to use light linking to help you design the character lighting and set lighting separately.

Outdoor Lighting

For daytime outdoor lighting, your key light is the sun. A directional light is a good choice for this light because it has parallel rays. In an real outdoor scene, light will bounce which illuminates all the surfaces a little. Some low-intensity directional lights pointing up from the ground can help create this effect.

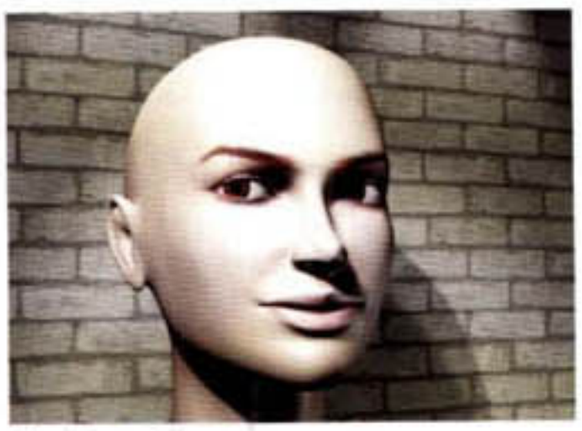
Shadows are sharp and clear during sunny parts of the day, while cloudy or twilight portions of the day create less pronounced shadows. On a cloudy day, you have less definition in the shading as the light is very diffuse.

Sunny Day

In this scene, a strong directional light offers ŧ the key lighting with several low intensity directional lights poininting up from the ground to mimic bounced light. Ambient light is ŏ also used to simulate bounced, diffuse light.

Light Linking

One feature available in Maya that doesn't exist in the real world is light linking. You can "tell" a surface to only be lit by specific lights or you can tell a light which surfaces it should illuminate. This lets you design lighting for different parts of your scene without affecting all of the objects. This can help speed up rendering because not all the lights in the scene will be calculated for all of the surfaces.

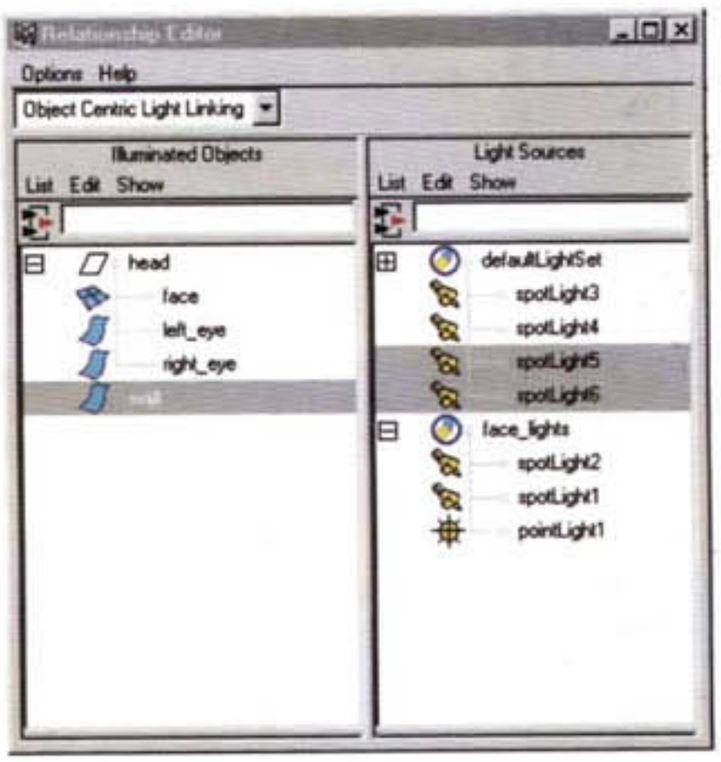


No Light Links

All the lights are being used on all surfaces. The lighting on the face is too intense.

Linked Lights

The walls have their own lights, while the face uses different lights.



Light Linking Workflows

You can select **Lighting/Shading > Light Linking > Light Centric** or **Object Centric** to open up the Relationship Editor. From this editor you can set up light linking relationships by highlighting or unhighlighting items in the two lists. A faster way to link lights is to select your lights and objects then choose **Lighting/Shading > Make Light Links** and **Break Light Links** to make the connections directly without opening the Relationship Editor. IPR is a great help when setting up light linking.

Scenery Lighting

While key lights and fill lights are built with the main purpose of illuminating your character, there is also a need to create lights that are part of the scenery. These background lights are designed to illuminate your digital set and to represent the light sources visible in the scene, such as windows or light fixtures. While there should be some logical relationship between these and the key and fill lights, the main role of scenery lighting is to make the set look realistic.

Light Fixtures

In a typical scene, there are often light fixtures that represent light sources. Since Maya's lights have no physical presence, these fixtures are created with a combination of geometry and lights. In fact, you may use more than one Maya light to help get the look of a particular fixture.

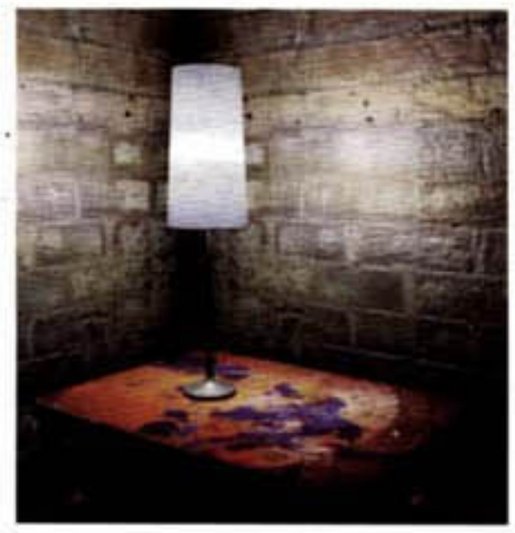


Table Lamp

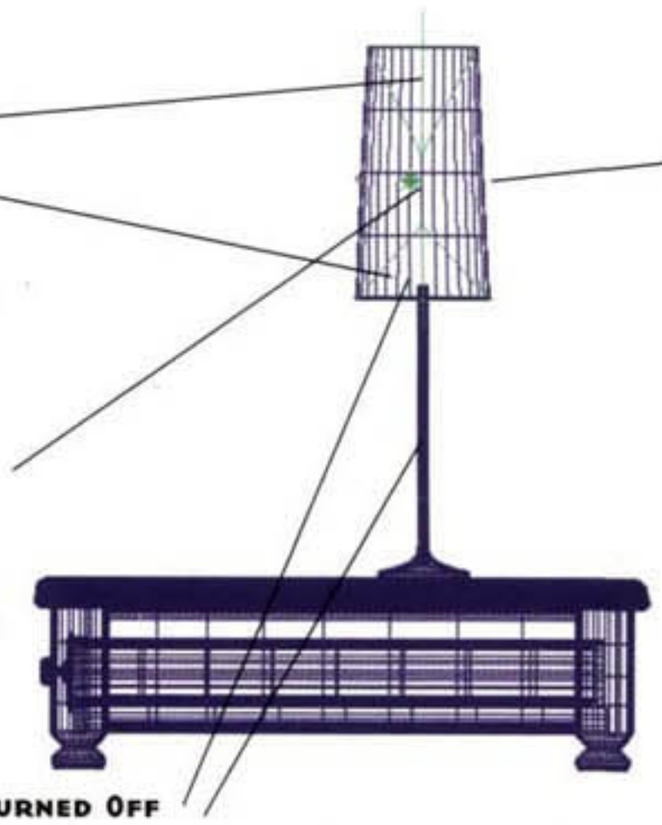
With this lamp, you would expect to be able to use a point light to do all the work. The problem is that if you use this light to cast shadows, the lamp shade and maybe even the lamp post cast big dark shadows and the lamp shade appears dark on the outside. To resolve this, you need to use a few lights and some texture maps.

Spotlights

Two spotlights are used at the top and bottom of the lamp. These simulate the light cast through the top and bottom of the lamp shade without requiring that shadows be turned on.

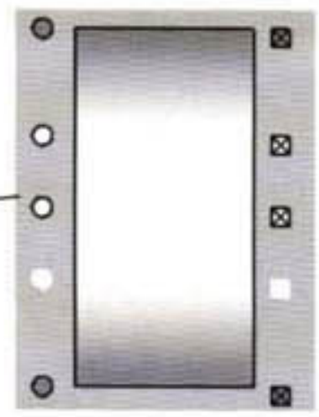
Point Light

A single point light is placed near the center of the fixture. It represents the light that is passing through the lamp shade and is not as intense as the spotlights.



Casting Shadows Turned Off

On the lamp shade and the lamp post you need to set **Cast shadows** to **Off** in the **Render Stats** section of their Shape nodes. This allows the point light to illuminate and shadow other objects without casting a big shadow from the lamp shade.



Incandescence Map

In the real world, the illumination of a lamp shade by the light inside creates some self-illumination. You could use Translucence for this (see below), but an incandescence map offers you more control. Here, a ramp that has a gradation from gray to super white (RGB values above 1.0) is used to map the **Incandescence**.

Translucence

In the case of the lamp shade, you need to see the illumination of the light on the side of the surface that is facing away from the light. There will be other surfaces in your scene, such as blinds or screens, that may need to have light and shadows pass through them to illuminate the back side of the surface. You can accomplish this by setting the **Translucence** attribute on the object's Material node. This value will determine how much of the light will be visible on the back side of the surface.

Without Translucence

Here, you can see that the light and the shadows hitting the screens have no effect on the back of the surface. Using an incandescence map would be much more difficult here than on the lamp shade.

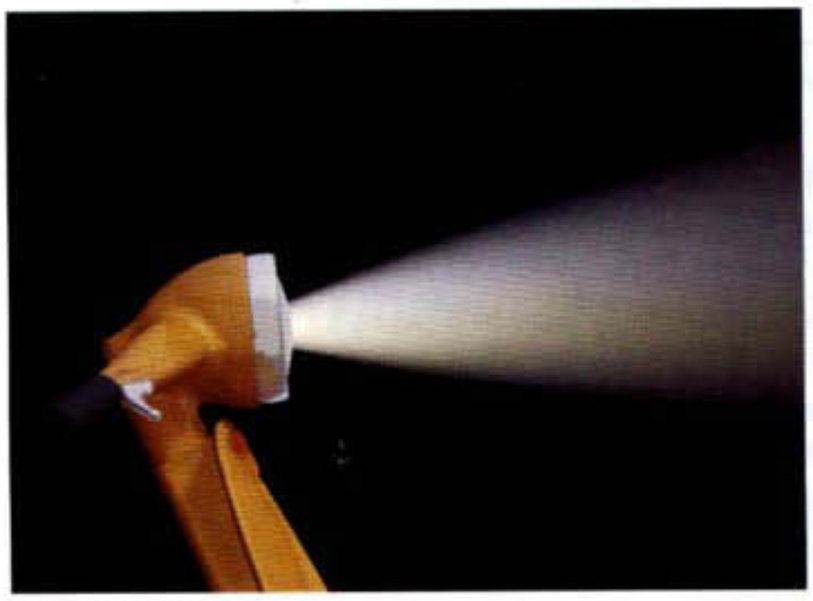
With Translucence

With **Translucence** set on the screen's Material node, you can see the illumination and the shadow cast by the railing. This effect works with Depth Map shadows and does not require Raytracing.

Headlights

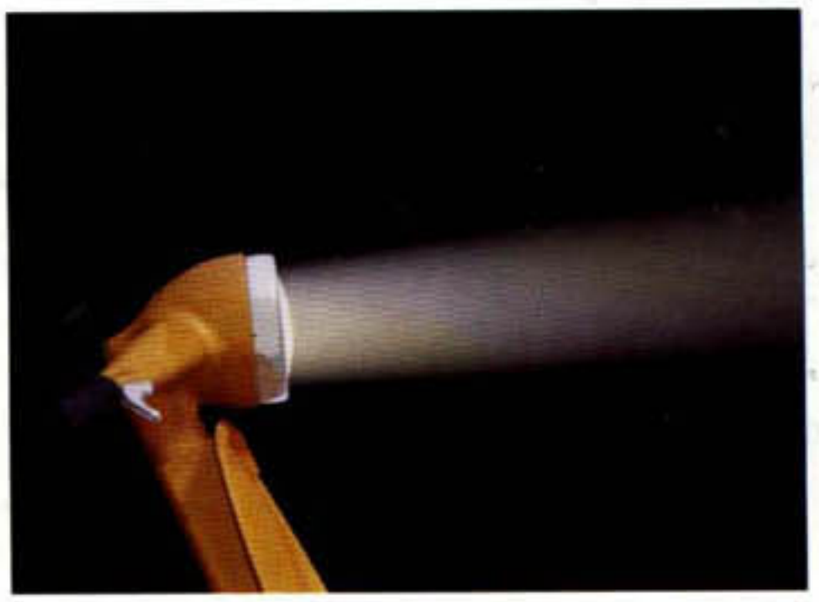
This headlight shows a lighting situation that is not dealt with by a default light. This kind of headlight has a light bulb in its center that is then bounced off a highly reflective surface. This creates a spotlight effect where the beam of light emerges, not from a point, but from the face of the light fixture.

To achieve this effect in Maya, you can use the Decay Regions you learned about in the Light Effects section of this chapter. Put a spotlight behind the light fixture, then make sure that its first Decay Region has no length and the second starts from the face of the fixture. This will create a solid beam of light that looks great with some light fog.



Default Light

Here you can see that a default spotlight radiates from the center of the light instead of from the fixture's front face.

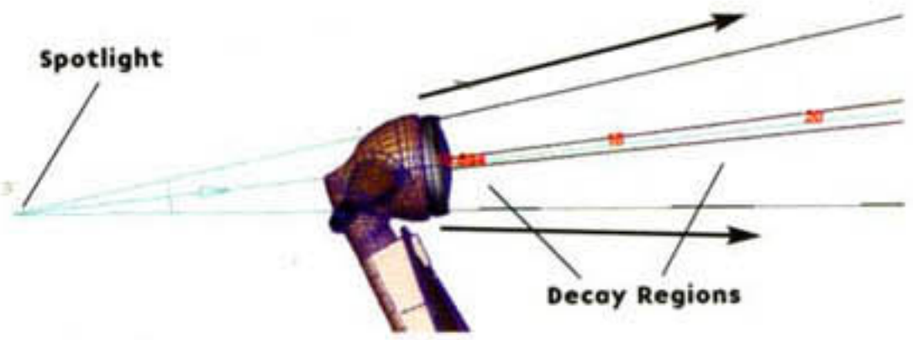


Light with Decay Regions

This image shows the use of Decay Regions to start the illumination from the face of the fixture. The light is actually behind the object.

Decay Regions

The light is positioned behind the fixture, with its cone of light aligned with the edges of the fixture's front face. The Decay Regions control the light so that there is only illumination in front of the fixture. You could also use an Intensity Curve for this, but the Decay Region manipulators make it easier to set up.



Lighting without Lights

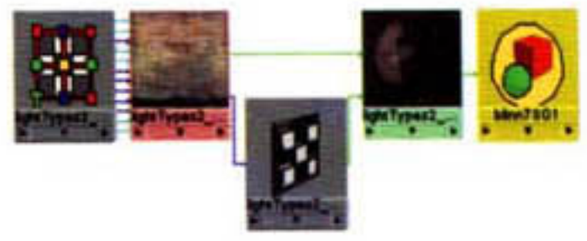
In some cases, you may want to have background elements that use a complex lighting setup, but you don't want to render all the extra lights. In these cases, it is possible to bake the lighting using **Convert to File Texture** found in the Hypershade window. When you select the Shading group node and the surface then convert using the **Bake Shading Group Lighting** option, the complete shading network, including material node and lighting information, is baked into a single file texture that is connected directly into a new Shading group node and automatically assigned to the surface. At this point, lights no longer influence the shading on the surface so they can be deleted.

You could also accomplish this type of effect using hand-painted incandescence maps. If you create a grayscale image that uses white or superwhite for highlight areas and gray or black for darker areas, then this image can be mapped as an incandescence map on top of the existing textures. This gives you a lot of control but it relies on your ability to paint all the subtleties of an illuminated surface. In many cases, the baked lighting method will give you more realistic results.

Incandescence-mapped surfaces will not have shadows cast on them by your characters. You would, therefore, need a shadow pass cast from your character that can be layered onto the background during compositing.

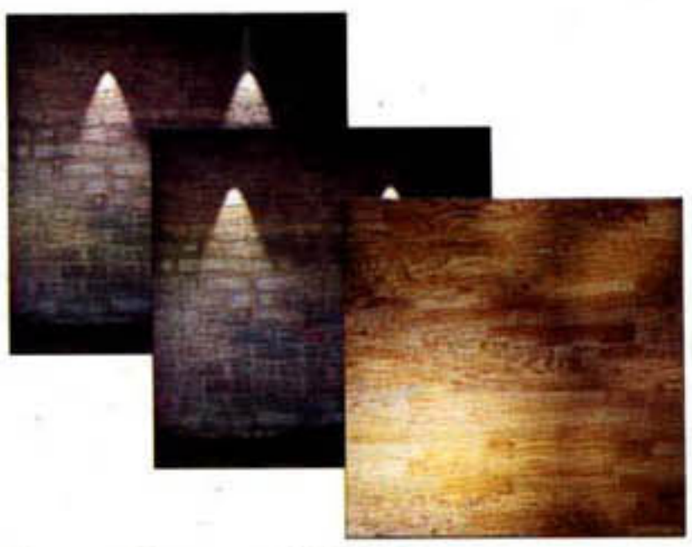
Step 1: Original Scene

Here is a simple background set that is illuminated by a few lights. You can bake this lighting into a file texture so that the lights can be removed to optimize render time. This is a way to optimize complex scenes and is not required for the average Maya rendering.



Step 2: Select the Shading Group Node

Select the Material node that is assigned to the surface you want to bake. Click on **Show Downstream connections**. Select the **Shading Group** node and then press the **Shift** key and select the surface. Select **Edit > Convert to File Texture - options** and set **Bake Shading Group Lighting** to **On**.



Step 3: Converted Textures

When you **Convert to File Texture**, you are able to set a file texture size. Then Maya bakes the complete shading network into a single file texture. This file texture is mapped directly to a new Shading group that has been assigned to the selected surface.

Step 4: Final Scene

With the resulting Shading groups and file textures, the scene renders the same as the original but without requiring the lights. The perceived illumination is instead created by the texture maps. Now you can focus on lighting your characters.

How Cameras Work

When you first start working with Maya, the perspective view offers you a way to tumble, track, and pan using a 3D camera. As you get closer to rendering your scene, you need to start learning more about this camera, especially in terms of how its capabilities relate to traditional cinematography.

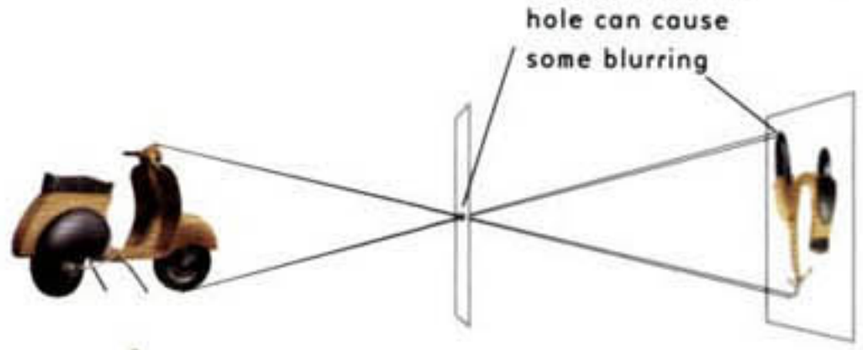
A real-world camera uses controls such as F-stops to control how much light is admitted into the camera. Maya's camera doesn't require these controls for lighting or exposure, but other controls exist to make the Maya camera act as much as possible like a real camera.

From Real World to CG Cameras

To better understand how Maya's CG camera works, it is helpful to compare it to a real-world camera. A real-world camera is designed to take bouncing light and focus it onto the camera's film. In this way, camera controls are closely linked to lighting controls. Maya deals with lighting and cameras separately. Below is a short description of why real-world cameras and CG cameras work differently.

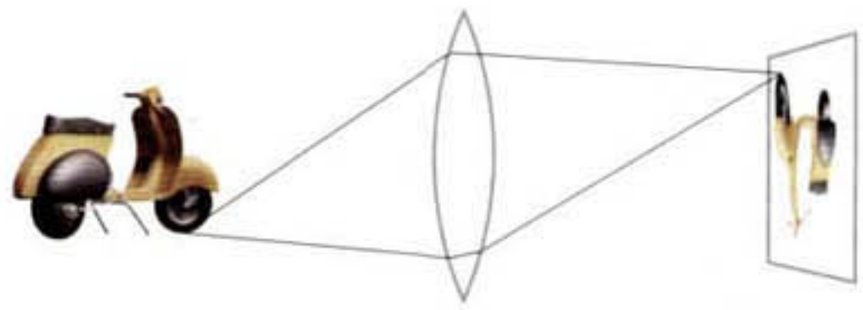
Pinhole Camera

The first cameras used a hole punched in a box to focus the light onto a back plate. This small opening would only allow a little light into the camera and the film required a long exposure to the light. The pinhole camera didn't work well in low-light situations and it could not film moving objects since the long exposure would cause the image to blur. To let in more light, the pinhole camera required a larger opening that would no longer be focused and would result in a blurred image.



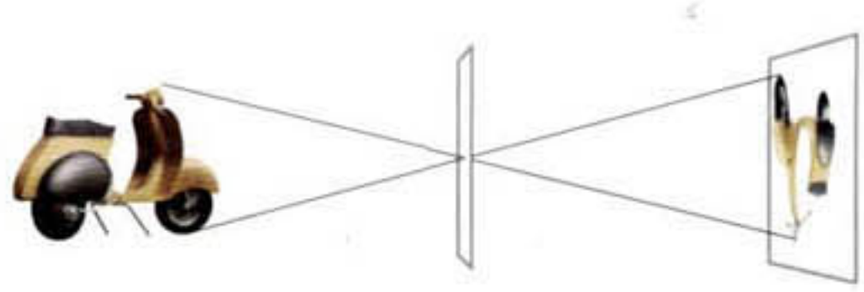
Lens-based Camera

Lenses were developed to allow more light into the camera while still focusing it to a point on the film back. This made it possible to take pictures that were exposed in a fraction of a second, which, in turn, made it possible to film moving subjects. The different lenses have properties that affect the final look of a shot. The cinematographer's job is to manipulate these properties to the advantage of the film.



In Maya

Since CG cameras get lighting information from the surface itself, the pinhole camera model can be used without worrying about lighting levels. The CG pinhole is actually a point that has no diameter, which ensures perfect focus with no blurring in the image. Moving objects can be captured without worrying about motion blur and the camera is always in focus. While this sounds like a cinematographer's dream, in fact it means that some of these effects have to be faked in CG to make the images look real.



Camera Effects

In a real-world camera, the camera causes various effects including motion blur, depth of field, and lens flares. In Maya, these effects are not automatically created. You must consciously turn them on to add them to a shot.

Another real world effect is lens distortion. This distortion is a result of the curve of the lens that causes lines at the edge of an image to bend. In Maya's pinhole camera model, this distortion does not occur.

Motion Blur

In real life, the camera's shutter speed is often slower than a moving object and the resulting frame is blurred.

Depth of Field

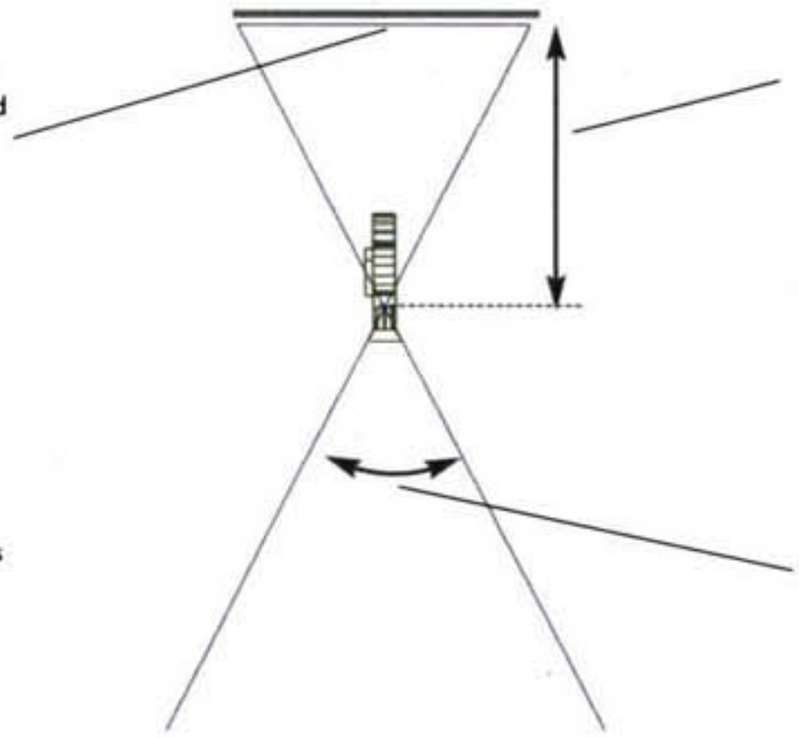
This lens effect blurs objects that are in front of, or behind, the plane of focus based on a Focus Distance and an F Stop value.

Angle of View and Film Back

In a real-world camera, the image is captured, through the lens, on the back of the camera, known as the film back. The film back represents the plate where the film is exposed. The distance between the front of the lens and this plate is the focal length and different lenses are actually designated by this value. In Maya, the **Film Back** and **Focal Length** are used to calculate the **Angle of View** that defines the perspective image seen through the camera. The relationship between these two values mimics what happens in the real world so that you can use your photographic experience to help you with Maya cameras.

Film Back/Film Gate

In Maya, the Film Back is the location of the aperture plate, which is called the Film Gate. Maya includes several default **Film Gates** that match real-life cameras.



Aperture

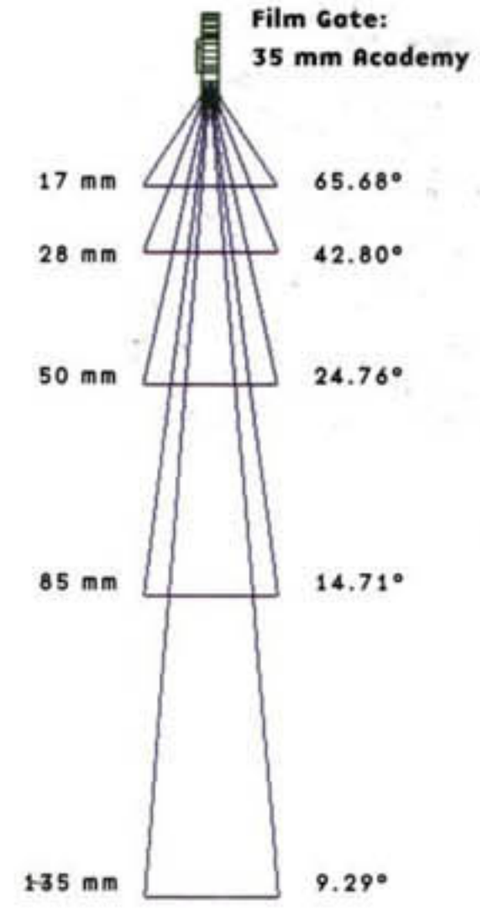
The **Camera Aperture** settings define the length and width of the Film Gate. These measurements along with the **Focal Length** are used to calculate the **Angle of View**.

Focal Length

In Maya, **Focal Length** is the distance between the pinhole of the camera and the Film Back. The **Focal Length** describes the focal properties of a lens and is used to define the **Angle of View**. If you increase the **Focal Length**, you decrease the **Angle of View**.

Angle of View

This attribute offers an alternative method of changing the **Focal Length**. If you change either of these, the other updates automatically. In the end, the camera stores the **Focal Length** value and uses a built-in expression to generate the **Angle of View**. Artists who don't have a photographic background might find this attribute easier to work with but when you animate, only **Focal Length** can be keyed.



Focal Length Chart

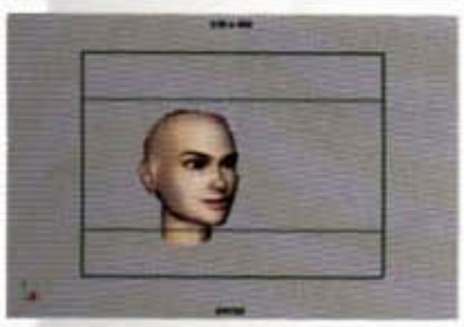
Shown here are different **Focal Lengths** and the resulting **Angle of View**. Note that the Angle of View would be different depending on your **Film Gate** and your **Film Fit**.

Film Fit

The **Film Gate** is a metal frame that sits over the film and determines the size and shape of the exposed area of the film. In Maya, the film is actually the rendered image which has its aspect ratio defined in the **Render Resolution** section of the Render Globals window. The **Film Fit** defines the relationship between the **Film Gate** and the **Resolution Gate**. Ideally, your gates should be the same aspect ratio, but if they aren't, you can match them horizontally or vertically. To view both gates, go to the **Display Options** section of the *cameraShape* node.

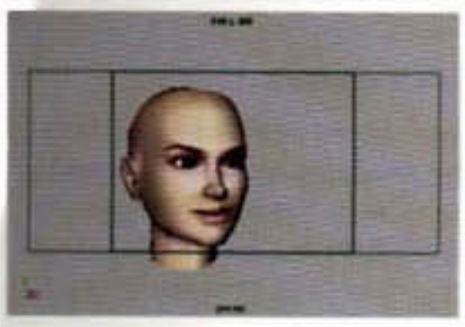
Matching Gates

In this view you can see a **Film Gate** of 35mm Academy and a **Render Resolution** of 640x480. Because the aspect ratios are similar the gates match closely.



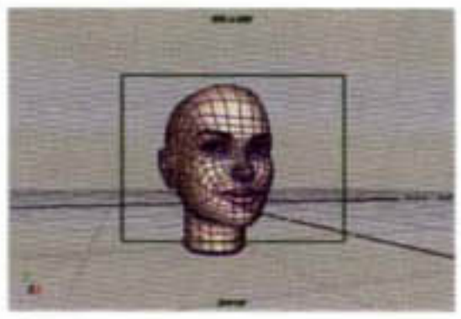
Horizontal Film Fit

Here the **Film Gate** is 70 mm Projection while the **Render Resolution** is 640 x 480. The Horizontal **Film Fit** creates a "letterbox" relationship between the two aspect ratios.



Vertical Film Fit

The **Film Gate** is 70 mm Projection while the **Render Resolution** is 640 x 480. The Vertical **Film Fit** creates a "Pan-and-Scan" relationship between the two aspect ratios. **Film Offset** can be used to pan the Film Back.



Overscan

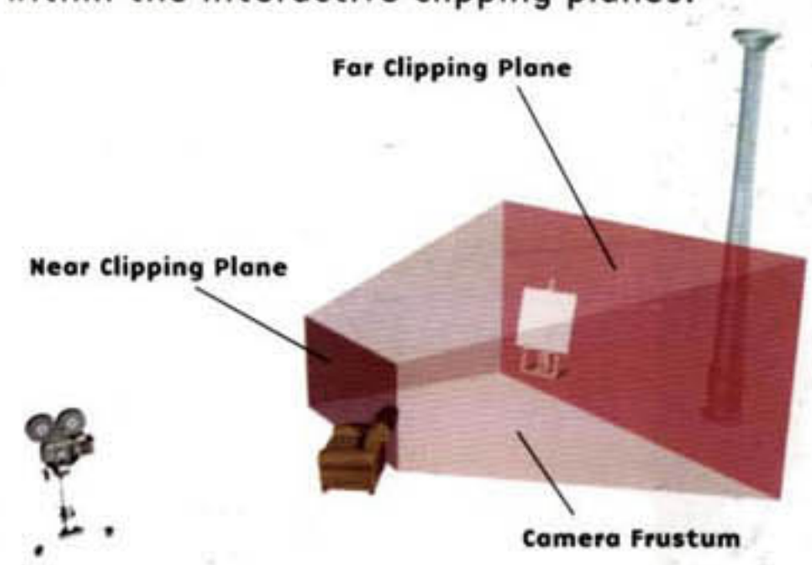
If you select either **View > Camera Settings > Film Gate** or **View > Camera Settings > Resolution Gate**, an **Overscan** is set. This value shows a border area around either of the gates. If you want a smaller border, you can adjust the **Overscan** value in the *cameraShape* node.

Ignore Film Gate = Off

In this letterbox example, the **Film Gate** has a different aspect ratio than the **Render Resolution**. By default, the Film Gate will be ignored and the complete **Render Resolution** will be rendered. You can turn **Ignore Film Gate** to **Off** in the **Render Options** section of the Render Globals window if you want to achieve the letterbox look.

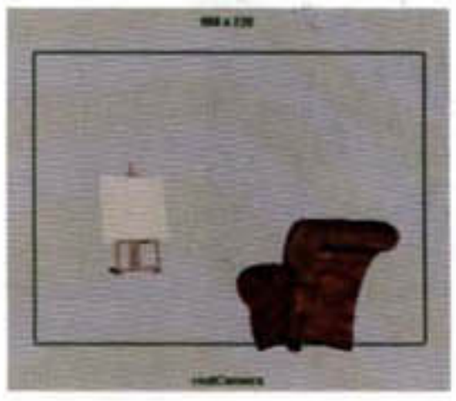
Clipping Planes

In Maya, the near and far clipping planes define what objects are visible in a camera's 3D view. However, by default, **Auto Render Clip Plane** is **On**, which sets the two clipping planes to include all the objects in your scene during a rendering. This can create very large distances between the clipping planes if you have objects close to the camera and far back in your scene. You can turn **Auto Render Clip Plane** to **Off** if you want to limit your rendering to objects within the interactive clipping planes.



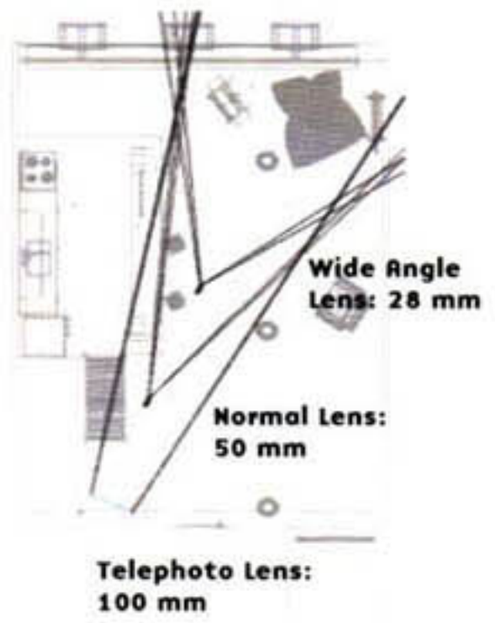
Clipped Objects

When **Auto Render clip** is **Off**, the chair that crosses the near clipping plane is partially rendered, the easel that crosses the far clipping plane is fully rendered, and the column outside the clipping planes is not rendered at all. When **Auto Render clip** is **On**, all objects are rendered.



Camera Moves

The way you position your camera and set up your lens has a big effect on the composition of a shot. Whether the camera is sitting still or being animated, you must understand the choices you can make to enhance the cinematic qualities of the shot. By going beyond the default values, you can begin working like a real-life cinematographer.



Camera Positions

To frame the scene in a similar manner for each lens, the camera is moved closer for wide angle and farther away for telephoto lenses.

Framing the Shot

When you frame a shot, you must choose how far the camera is from the scene and which angle-of-view or Focal Length to use. These decisions will change how the objects in the foreground, mid-ground, and background relate visually, which in turn, affects the framing. Learning to use different focal lengths is an important part of driving a CG camera to get the shot you need.

Normal Lens: 50 mm focal length

This lens is closest to the human eye. Using it as a starting point, you can explore how changes in Focal Length and distance create different relationships between foreground and background elements.

Wide Angle Lens: 28 mm focal length

The wide angle lens offers a stronger sense of perspective. You can get close and still see a wide area of the scene, which can be helpful in an interior space. Moving objects appear to move very fast.

Telephoto Lens: 100 mm focal length

This lens tightens the perspective. You see less of the scene and can focus on a particular area. Since the depth is flattened, distance is harder to read. Moving objects appear to move slowly.

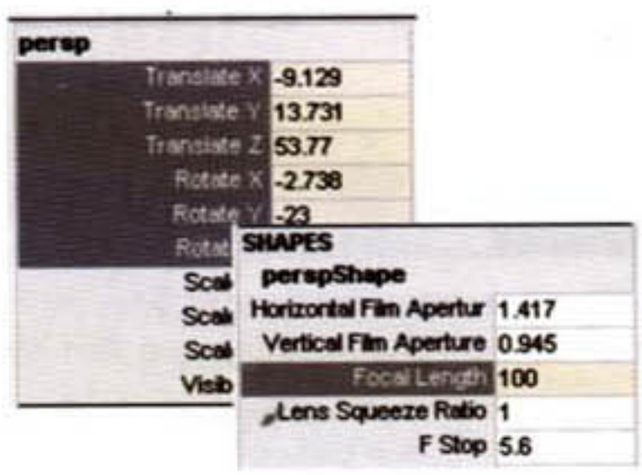
Animating Cameras

Animating the camera is a great way to add a sense of motion to your animation. This means that you can use traditional camera moves such as tracks and dollys to focus on a character and enhance the 3D qualities of your scene, or your camera can fly around in a less controlled manner.

In Maya, you can animate a camera using its Transform node, which is useful but not as intuitive as aiming the camera at a locator or creating a two-node camera which lets you control the eye point and look at point of the camera separately.

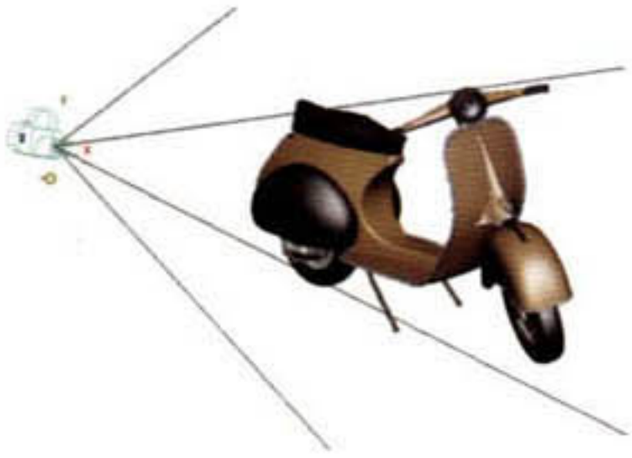
Extra Nodes

If you create a camera by selecting **Create > Camera** options, you can choose a one-, two-, or three-node camera from the **Animation Options**. If you create a camera with **Panels > Perspective > New**, you don't have this option.



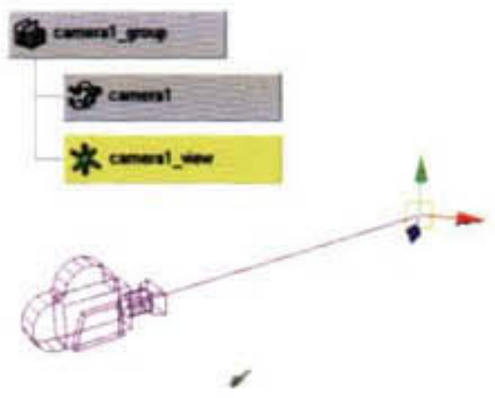
Setting Keys

You can animate a camera's position, orientation, and lens properties by first framing shots in a 3D panel. Next, choose **View > Select Camera** and set keys on attributes such as **Translate**, **Rotate**, and **Focal Length**.



Aiming the Camera

If you want your camera to follow an animated object, you can aim constrain the camera to the object. Be sure to set the **im Vector** to **-1** in **I** and the **Up Vector** to **1** i Y. This will point the camera correctly.



Two-node Camera

With a two-node camera, you can animate the eye point and look at point separately. Each has a Transform node that can be keyed, parented to another object, or sent down a motion path.

Zooming and Dollying

When you want to animate the camera getting closer or farther away from the scene, you can choose between zooming, by changing the camera's Focal Length, or dollying the whole camera. These two approaches yield quite different results and it is a good idea to explore each technique.

Initial View

The purpose of this shot is to get closer to the street front. Using both a zoom and a dolly, you can see the different ways in which the perspective reacts.

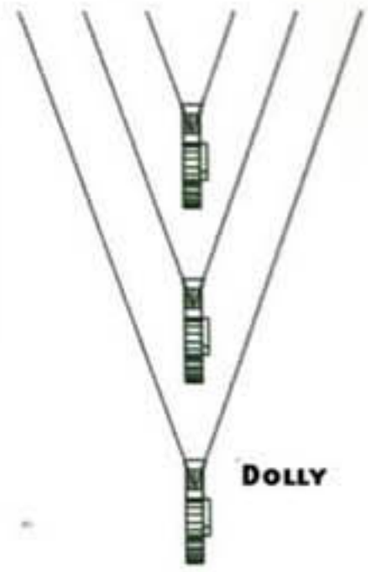
Zoom

Changing the camera's Focal Length creates a zoom effect. All parts of the scene get bigger equally, which results in a static relationship between elements in the foreground, mid-ground, and background. Our eyes cannot make this kind of view change.

Zoom

Dolly

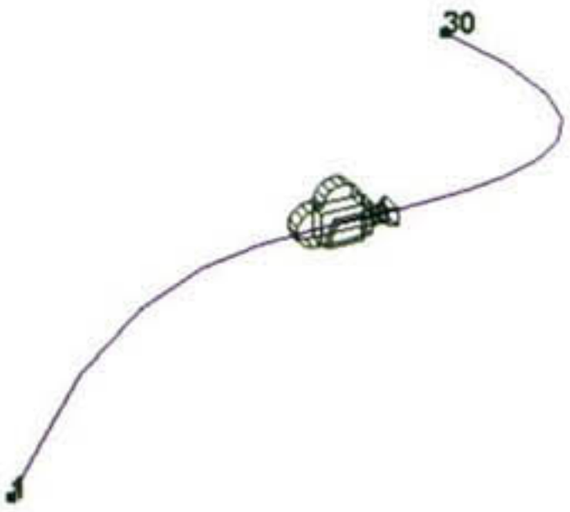
Changing the camera's position with a dolly gives you a stronger sense of the space. Objects pass by the frame, creating a more dramatic movement through space. This is the approach used most often with real-life cameras. This is how our eyes would get closer to an object.



Dolly

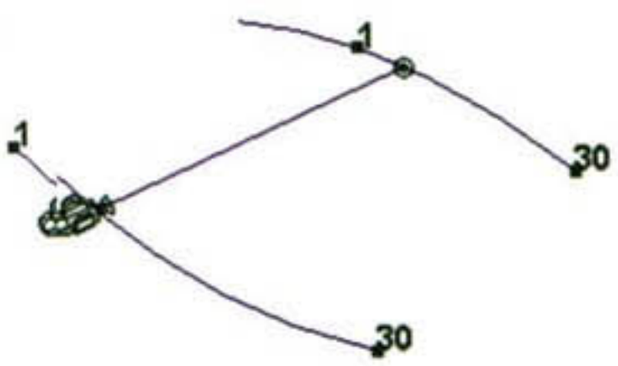
Cameras on Motion Paths

In cases where you know the path you want your camera to take, a path animation can be used. You can choose to assign a one-, two-, or three-node camera to the path and you can use multiple paths for even more control. If you want to have your camera go around a roller coaster loop, be sure to use a three-node camera and send the Up-vector node down its own path that is offset from the eye's path. This will keep the camera from flipping at the top of the loop.



One Node

To place a one-node camera on a motion path, you must make sure the **Front Axis** is **Z** and **Inverse Front** is turned **On**. This will aim it correctly down the path.



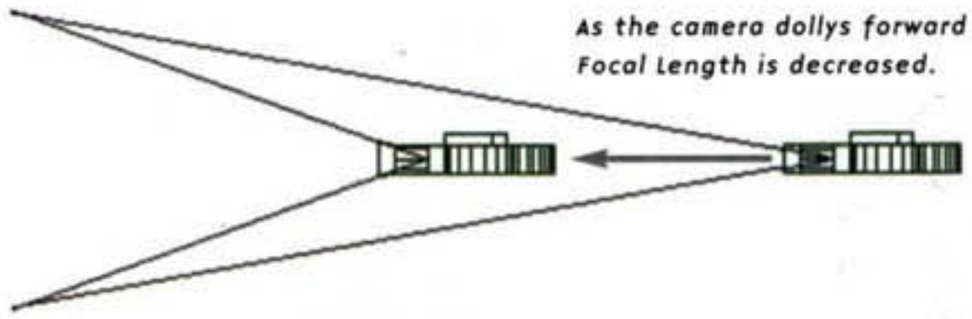
Two Nodes

Witth a two-node camera, you can have thee eye point and look at point on differentt paths. You can now control the cameraa's tracking using these two curves.

Combining Zooming and Dollying

One camera move used in many horror films is the simultaneous zoom and dolly. As the camera gets closer to a character, the Focal length is lowered so that the character remains about the same size in the shot. At the same time, background elements change dramatically and there is almost a sense of vertigo that can heighten a scary scene or a moment of surprise.

You can set up this camera move using **Set Driven Key** to create a relationship between the camera's **Z-axis** position and the *cameraShape* node's **Focal length**. Dollying the camera along Z will create the sense of forced perspective that can create a dramatic moment for your character.



As the camera dollys forward the Focal Length is decreased.

Perspective changes

As the camera zooms and dollys, the perspective will become more pronounced and the perceived distance between your foreground and background elements change. A character at the camera's focal point would remain about the same size throughout the camera move.