

# Basic Lighting

## Overview

Most modelling and animation systems provide at least four types of light sources. In the RenderMan system the basic lights are referred to as “ambientlight”, “distantlight”, “pointlight” and “spotlight” – note these are spelt as single words. Although these light sources illuminate a scene in different ways they all share the common ability of being able to set their colour and intensity.

Colour is defined in the usual way ie. by the red, green and blue components, whilst intensity is set by a single value normally between 0 and 1. The following, for example, would form part of the specification of a light source,

```
"lightcolor" [1 1 1]  
"intensity" 0.2
```

In their standard configuration, none of the basic light sources are able to cast shadows but, with the exception of an ambient light, they each have an extended version that includes this capability. However, shadow casting is an advanced topic and will be dealt with separately.

A scene may be lit by any number of light sources. Objects may share a common light source(s) or be assigned their own individual light source(s) - it just depends where in a RIB file a light source statement(s) appears. The ability to differentially illuminate the objects in a scene is unique to computer graphics – a directly equivalent situation does not exist in “real world” photography.

## Defining a Light Source

The renderer creates a light source based upon information passed to it with the RIB command

```
LightSource
```

which is followed by the name of a particular type of light, for example,

```
LightSource "ambientlight" 1
```

and a number that identifies, or tags, the light source. A tag may be any number that is unique to a particular light source.

Lights are adjusted by overriding their default settings. Since in the case of the ambient light created above, specific values for its colour and intensity have not been given it would automatically have the default colour of white and an intensity of 1.0 ie maximum brightness.

Whilst lights can only be created and not destroyed it is possible to switch them OFF and ON via their tag, for example,

```
Illuminate 1 "false"
```

turns the previously created ambient light OFF. When a light is created it is automatically switched ON.

## Types of Light Sources - descriptions

### Ambient Lighting

An ambient light source uniformly adds colour of a certain intensity to each surface in a scene. It is generally used to increase the level of background illumination in order to soften the effects of other lights. For example, the following RIB statement creates a pale yellow ambient light,

```
LightSource "ambientlight" 1 "intensity" 0.3 "lightcolor" [1 1 0]
```

### Distant Lighting

A distant light source acts in much the same way as the sun – it illuminates a scene uniformly in one direction. Objects vary in brightness according to the inclination of their surfaces; their location within the scene has no effect. The values of the “from” and “to” parameters merely specify the direction of the light source and not its ‘true’ location.

```
LightSource "distantlight" 1 "intensity" 1.0 "from" [2 0 4] "to" [0 0 0]
```

### Point Lighting

Like an unshielded electric light bulb a point source radiates light uniformly in all directions. However, unlike the previous light sources, its intensity diminishes over distance – to be precise, brightness varies with the square of the distance. For example, a surface that is three times more distant from a point light source than another surface, only receives one ninth of the light that illuminates the nearer object. The dramatic drop in illumination over distance means that very high values for the intensity parameter are often necessary. Because a point light has a position in space but not a particular direction it does not have a “to” parameter. For example,

```
LightSource "pointlight" 2 "intensity" 30 "lightcolor" [1 1 1] "from" [0 0 9]
```

### Spot Lighting

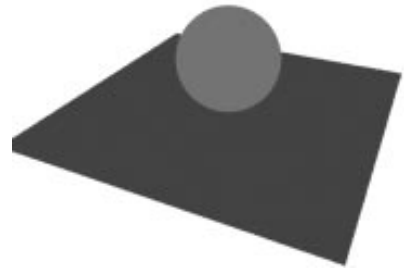
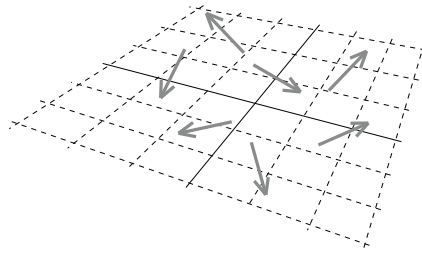
A spot light, on the other hand, has both position and direction – hence it has a “from” and a “to” parameter.

```
LightSource "spotlight" 1 "intensity" 12 "from" [2 0 4] "to" [0 0 0]
```

In addition, spot lights have an extensive range of parameters that control the way they can illuminate a scene. Like a point light their intensity falls off over distance; they have a cone of illumination which by default is set to 60 degrees and they also have control over the light fall-off that occurs at the edge of the cone as well as the distribution of light within the cone itself. As usual with RenderMan, these parameters have default settings and often there is no need to explicitly specify these values.

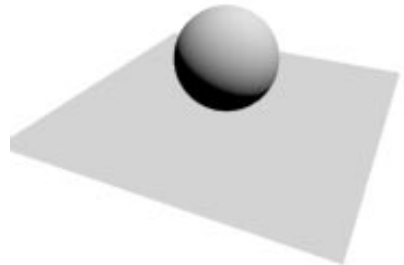
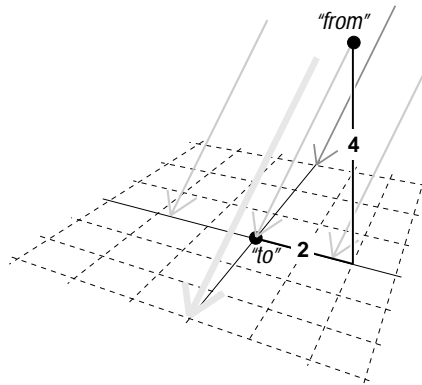
## Types of Light Sources - examples

ambient light



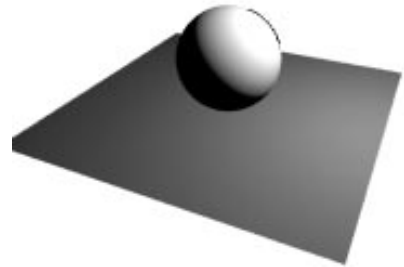
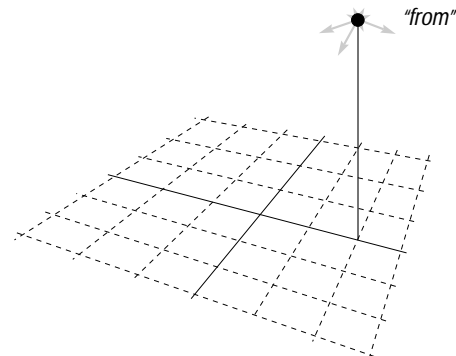
LightSource "ambientlight" 1 "intensity" 0.3

distant light



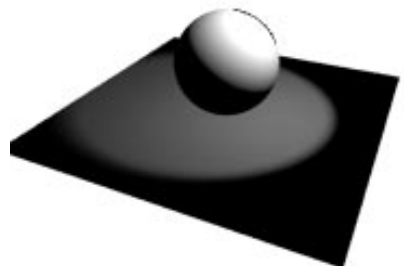
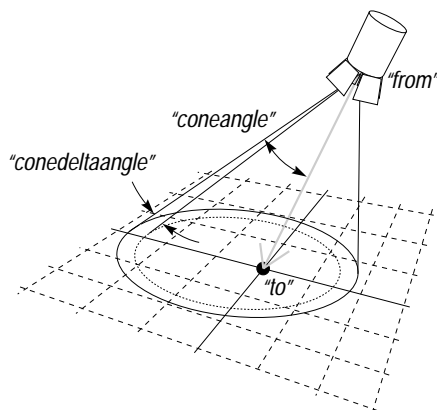
LightSource "distantlight" 1 "intensity" 1.0 "from" [2 0 4] "to" [0 0 0]

point light



LightSource "pointlight" 1 "intensity" 12.0 "from" [2 0 4]

spot light



LightSource "spotlight" 1 "intensity" 12.0 "from" [2 0 4] "to" [0 0 0]

## An example script

In the following RIB file the LightSource statement may be substituted by the examples shown on the previous page. The corners of the polygon have been given arbitrary colours so that if you change the camera angle you will be able to orientate yourself more easily – red marks the 'positive' corner.

### RIB

```
##RenderMan RIB-Structure 1.0
# Experiments with a single distant source
# 2nd Dec 1993

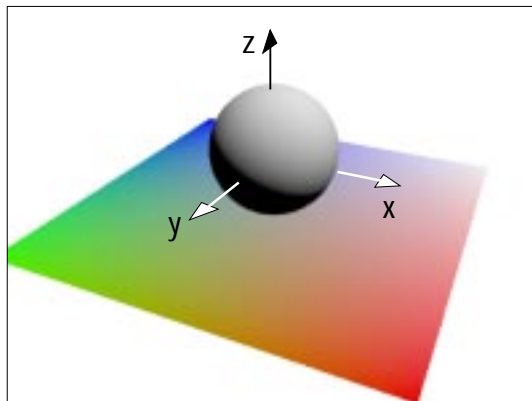
Display "distantlight" "framebuffer" "rgba"
Format 200 150 1
Projection "perspective" "fov" 40

ObjectBegin 1
  Polygon "P" [-3 3 0 -3 -3 0 3 -3 0 3 3 0] "Cs" [0 1 0 0 0 1 1 1 1 0 0]
ObjectEnd

ObjectBegin 2
  Sphere 1 -1 1 360
ObjectEnd

Translate 0 0 9
Rotate -120 1 0 0
Rotate 25 0 0 1

WorldBegin
  LightSource "distantlight" 1 "intensity" 1.0 "from" [2 0 4] "to" [0 0 0]
  Surface "matte"
  ObjectInstance 1
  Translate 0 0 1
  Color 0.8 0.8 0.8
  ObjectInstance 2
WorldEnd
```



## Reference

The optional settings for each of the standard RenderMan light sources are shown in italics and their corresponding default values, as well as their settable range, is also given. Each is followed by an example of the way they could be used in a RIB file.

### LightSource "ambientlight"

*"intensity"* default 1, range 0 to 1,  
*"lightcolor"* default [1 1 1], range 0 to 1 for each component.

*LightSource "ambientlight" 1 "intensity" 0.5 "lightcolor" [0.5 0.5 0.5]*

### LightSource "distantlight"

*"intensity"* default 1, range 0 to 1,  
*"lightcolor"* default [1 1 1], range 0 to 1 for each component,  
*"from"* default [0 0 0], unlimited range from positive to negative,  
*"to"* default [0 0 1], unlimited range from positive to negative.

*LightSource "distantlight" 5 "intensity" 0.5 "lightcolor" [0.5 0.5 0.5] "from" [2 0 4]  
"to" [0 0 0]*

### LightSource "pointlight"

*"intensity"* default 1, range 0 to an unlimited upper value,  
*"lightcolor"* default [1 1 1], range 0 to 1 for each component,  
*"from"* default [0 0 0], unlimited range from positive to negative.

*LightSource "pointlight" 2 "intensity" 25 "lightcolor" [0.2 0.5 1.0] "from" [2 0 4]*

### LightSource "spotlight"

*"intensity"* default 1, range 0 to an unlimited upper value,  
*"lightcolor"* default [1 1 1], range 0 to 1 for each component,  
*"from"* default [0 0 0], unlimited range from positive to negative,  
*"to"* default [0 0 1], unlimited range from positive to negative,  
*"coneangle"* default ? (30), range from 0 to ?,  
*"conedeltaangle"* default ? (5), range from 0 to ?,  
*"beamdistribution"* default 2, range from 2 to ?.

*LightSource "spotlight" 4 "intensity" 12 "lightcolor" [0.2 0.5 1.0] "from" [2 0 4]  
"coneangle" 0.349 "conedeltaangle" 0.017 "beamdistribution" 3*

Note: cone angle and cone delta angle are measured in radians – one degree equals 0.01745 radians.

## Positioning Lights in Space

The world is orientated with respect to the camera by a sequence of rotations and translations, for example,

```
Translate 0 0 9
Rotate -120 1 0 0
Rotate 25 0 0 1
```

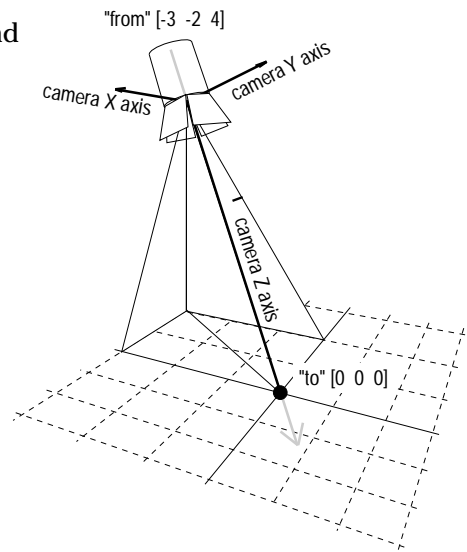
... whilst lights are positioned by their “from” and “to” parameters.

The spot light shown opposite is positioned at  $x = -3, y = -2, z = 4$  units, and is aimed at the world origin **only** if it appears within a RIB file **immediately** before or after `WorldBegin`, for example,

```
Display...
Projection...
Format...

Camera transformations...

LightSource "spotlight"... (here)
WorldBegin
  LightSource "spotlight"... (or here)
  Objects...
WorldEnd
```



Light sources created **before** the statement `WorldBegin` have their “from” and “to” locations positioned within the camera coordinate system and NOT the world coordinate system. Consequently, rotations and translations applied to the camera are also applied to the lights – in effect, the lights are attached to the camera in much the same way as a flash gun can be fixed to a real camera.

Since our RIB files are ‘hand made’, positioning lights in the way shown above is very convenient. It is possible to perform rotations and translations on lights – they behave just like other object. But for now this added complication will be avoided.