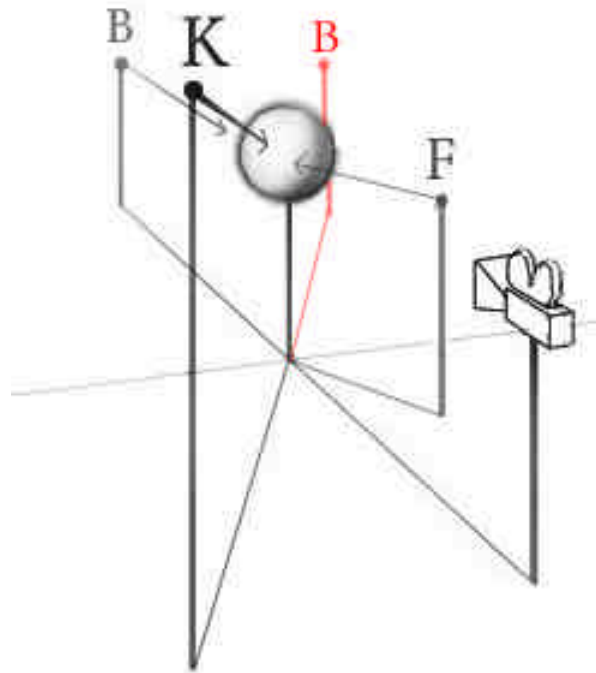


CG Lighting

The basic lighting scheme for film, video and photography is a three-point system, consisting of a key light, a fill light, and a back light. The key light is the primary light in the scene. It is conventionally placed between 30 and 45 degrees from the camera-subject axis and is elevated by 30-45 degrees. Diffuse frontal overhead lighting is the most popular style because it's a fair reconstruction of the general run of natural light and it's efficient. This gives our eyes maximum information about the scene, and is also the most flattering light for people, best showing character and expression. Other more extreme positions might give a dramatic or dreamlike effect, but don't use them indiscriminately. Keeping the key light close to the camera creates a symmetrical lighting scheme which is also quite flattering for portraits (especially for women, together with a high key setup - see below), but which risks looking boring in other cases. Keeping the key light low creates an unusual and unexpected, confusing, maybe frightening, effect. Putting the key light more or less opposite the camera creates a dark, dramatic, mysterious, intimate, "film noir" atmosphere.



The fill light

The fill light is supposed to partially fill in, or soften, the shadows created by the key light. It is a lower intensity and usually more diffuse light than the key light. It is usually placed on the other side of the camera from the key light, at an angle of 30-45 degrees from the camera-subject axis, and at about the height of the camera. If the fill light is too intense, then a low contrast, flat (high key) image may be created. The fill looks good with some color in it, any color if the key light is white, and a contrasting color if the key is colored - but don't overdo it or it'll look cartoon like or kitschy, or contrived. Also check - is there something in the scene that might be throwing colored light into that area, like a strongly colored object with lots of light bouncing off it? In that case, use that color in the fill light - unless you judge it degrades the image somehow (see note below on 'cheating'), like if it creates a sickly green effect on somebody's face. If that happens, you might consider changing the color, or the intensity, or the position etc of that object.

The Back Light

The back light is placed above and to the rear of the subject, so that the light does not come directly into the camera lens (not a problem in cg . It serves to outline the subject, especially the upper portion, and to separate it from the background. This light also looks good with some color, maybe a warm gold or a pale blue, depending on what color dominates the background. The red B in the diagram indicates how the back light usually can and must be adjusted in a cg scene, as opposed to real life.

For large complex scenes, sometimes the background needs extra light, as well as details such as the eyes, certain props, increasing or decreasing focus and contrast in some parts of the image. But avoid having multiple shadows cast from the same object if you can.

That's the basic lighting scheme in the real world, but in cg some changes are necessary. Here's an example of a cg translation of the basic schemes mentioned above, with the key light at intensity 1.1, the fill at 0.4, and the bluish back light at 1. The ambient light is to the right, at 0.5, with it's Ambient Shade left at the default.



In this first image on the left, the key's up and to the right, fill's on the camera's level to the left, and the back light's facing us from the left. Usually, many other lights will be needed - in this example we should probably have several back lights, to spread that nice rim of blue light a bit further and more realistically around her hair. (Also we could split the key light and the fill light up into clusters of several each - more on that a bit later on.)

In this second image on the right, the key is high and centered and the fill's low.



Whereas here in the third image on the left this situation has been reversed. All three have the ambient and the back light in the same positions.

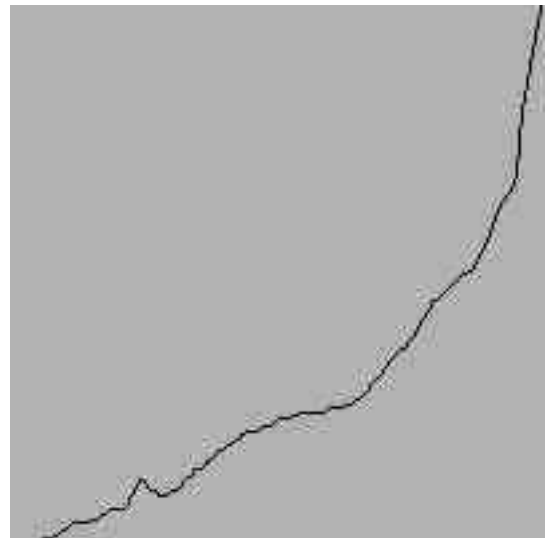


Don't forget to cheat

As I mentioned before, cheat - you should always strive for realistic **LOOKING** lighting, but don't worry about physically based lighting too much, it'll get in the way of the atmosphere you're trying to create. The Rembrandt image "The Holy Family" in the Louvre is a good example - the lighting looks very realistic, and also extremely beautiful, but if you study it, you see it's physically a bit off. The bright spot on the floor, for instance, doesn't seem like it could come from the same source as that lighting up the main figures, although at first that looks correct. The reason he did that, of course, is to create a more pleasing pattern of light and shade. Remove the bright spot by placing your finger on it, and see how important it is to the composition.

There are high-key, intermediate, and low-key lighting schemes. Imagine a diagonal graph representing the distribution of light and dark pixels in the image (like in an image editing tool) - if it's a straight line it would represent the intermediate.

The high-key image has its curve pushed to the high end, and the low-key to the



other. But that doesn't mean that you can change an intermediate image to high or low key in an image editor, by simply editing that curve (changing the gamma for instance) - that usually doesn't work.

Look at this example - it's decidedly low-key.

It usually uses fewer lights than the high-key setup - this one uses the same lights as the examples in the previous section, except the ambient and back light intensity is halved, the fill quartered (position: from the front, high), and the key's raised to 2.



High-key

To light your scene high-key doesn't mean to use the same lights and just pump up the power - you have to add more lights, as well, and carefully place and balance them. You're looking for a light, airy effect without any strong shadows or lots of burned out highlights. Here's an example:



This one has the back light and fill turned off, the key split into 4 spots (centered around the camera: high/left, high/right, low/left, low/right, spread apart about 50 degrees) totalling 1.2 in intensity, ambient raised to 2 with Ambient Shadow off, and in the environment Global Light control up to 1.4 or so, to lighten it even more.

Light can be used to select the parts of the image that are more important to you, that you want the viewer to focus on. For instance, if your image can be divided in fore, middle and background (or even more planes), a similar light on all of them will seem a bit flat. So choose one of them to receive more light than the others. Again, Rembrandt and many other classical painters are prime examples of this.

The spotlight

The spotlight is the best and most versatile cg light, because it's the most complex. Almost always use it instead of a directional, area, linear or point light (2 spots with Spread 180 set back to back will behave like a pointlight, plus give you the faster Raycast shadows - see below). An ambient light in each scene is normally a good idea. To begin with better settings than the default gives you in Alias, for the spot turn Shadows on, set the Decay to 0, start with a Spread of 50 degrees, set the Penumbra to +4 and to Show, and maybe a touch of Dropoff (3- 5). If the spot is the only one, or if its the main spot and no other spots are overlapping it much, it should be intensified to about 1,3, more if you have a lot of Dropoff.

Position it so it shines where it's supposed to, scale the spot so you can see it, then move the pivot point to the target to make future rotation easier - if you get "gimbal-lock" and it doesn't seem to respond properly to rotation anymore, either Zero Transform or Group it to itself (then you must redo the pivot move of course). And to translate it back and forth along it's cone, just scale it. Remember to size the spread of the cone so it just barely covers what it's supposed to.

Ambient

For the ambient light, turn it down at least 50%, keep the "ambient shade" the same, and place it to start with as if it was the fill light, maybe even below the floor or inside some geometry, to darken them. Another good standard position for the ambient light is near the camera. Test render. Play with the "ambient shade" setting and placement of the light for more edge-definition - if the light is close to the camera and the "ambient shade" is high, you will see darker edges on all rounded objects.

Workflow

After placing the lights in a good basic setup, and setting a first ballpark intensity, you can continue setting up the objects in your scene, and adjusting the shading. When you feel the scene is almost finished, you can start thinking about the lighting again. Check out different setups. When you've settled for one (although you may want to save other setups to disk) you can start the fine tuning: adjust diffuseness, color, whether or not a particular spot casts a shadow, or what objects it lights up, the color of it's shadow, fine tune the spread, penumbra, and dropoff if they are visible in the scene.

Diffuse

Adjusting the diffuseness can be done in several ways. In raycasting, one way is to lower the resolution of the shadows, another is to raise the quality of the shadows - obviously the first is preferable for speed reasons as long as you don't start seeing low-shadow-res artifacts on anything (staircase edges on shadows, and if the Blend Offset is too low as well, blurry spots arranged in a grid on lit surfaces). When you start to see them, raise the resolution, and the Blend Offset, and work with the quality instead. Another way to diffuse the light is to use the spot cluster method - see below. In raytracing, you can switch on Soft Shadows in the spotlight, and adjust how soft you want them, and the quality, but be warned - rendering speeds can suddenly become a 100 times slower if you're not careful.

Raytracing and raycasting

The difference between Raytracing and Raycasting (using Dmap, in Maya) is very important. Raytracing traces the light rays backwards from the camera to each light source in the scene pixel by pixel. The default settings give you realistic reflections, refractions and sharp shadows. It is normally slower rendering than Raycasting. To get extremely realistic soft shadows you can simulate an arealight by specifying a radius to your light source, but this quickly gets very slow in rendering.

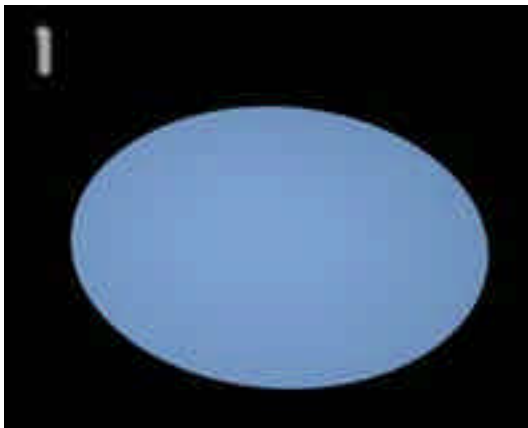
Raycasting creates Depth-maps, gray-scale images of the environment as seen from each spotlight in the scene, where black is closest to the spot, and white is furthest from it. These Dmaps are then used to calculate all shadows - that's why only spotlights can throw shadows in Raycasting. These shadows can easily be made blurry without speed-penalty, but the realism isn't optimal, since the blurriness doesn't vary according to the distance from the shadow-casting object.

Penumbra

You can project a black and white ramp in the spots color channel to create an improved custom penumbra - the default penumbra has a linear falloff, and setting your ramp interpolation to "smooth" or "bump out" will noticeably improve it. You can also project other custom images and/or ramps to create textured spots, like the uneven circles of light you get from a flashlight, or light filtering through blinds or tree branches, or the cliched church window..

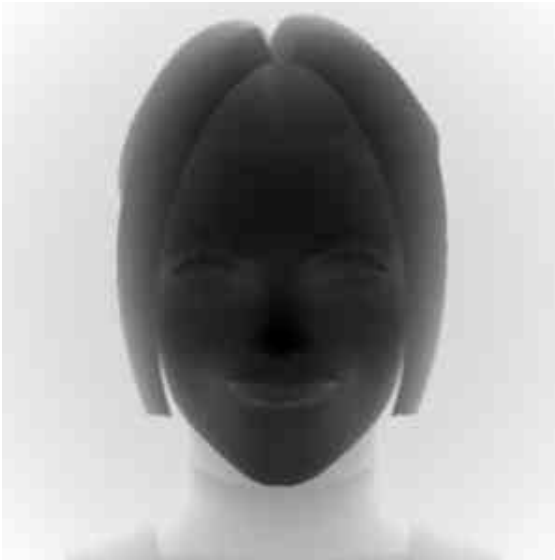
The first image shows the default look of a spot (Spread 50). No. 2 has Penumbra set to 6. No. 3 also has Dropoff at 5. No. 4 goes back to default values but with a Ramp mapped in the color channel ("Bump Out", black at position 0.71, white at about 0.5). No.5 adds some noise and extra banding in the ramp, but this is also by far the slowest to render.

Use negative lights (strength below zero) to remove light in overexposed places, or deepen certain shadows (although the "shadow-surface" method - see below - is faster for rendering).

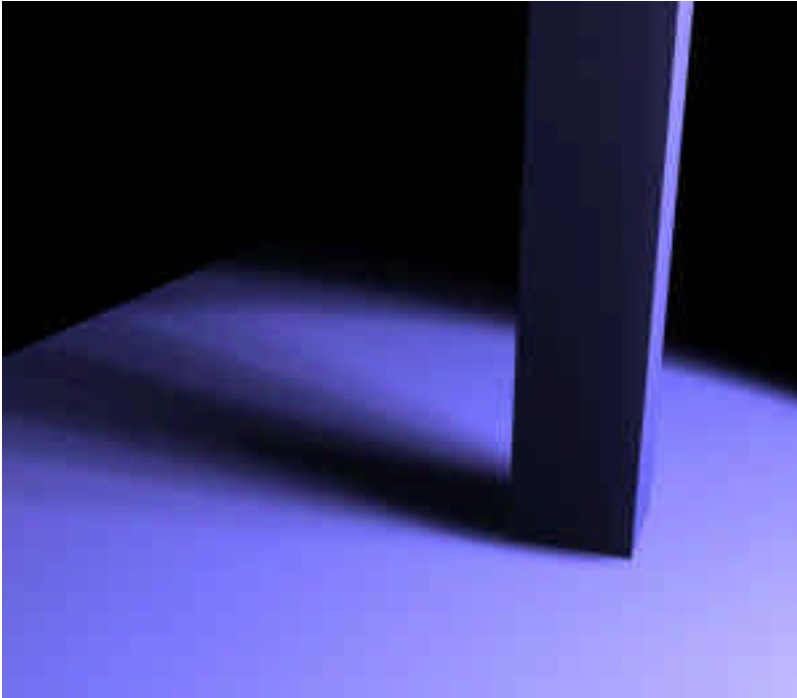


Depthmap

The Depthmap can be used to create very intricate and/or subtle custom bump or displacement maps. You build your bumps with geometry, put a background plane through it, then aim a camera at it, and check the dmap box in Render Globals. Aim the camera carefully, if it's not normal to the background plane it'll render as a tilted plane, and it won't repeat smoothly. Don't include any geometry around the edges that is not meant to be in the bump-map, because the 256 gray tones used in the dmap will be scaled to fit the nearest and farthest object, and if an unnecessary object stretches that range then the already too-narrow (if you use it as a displacement map on a high resolution surface you will see ridges between each gray tone) gamut will be even less. Then you save the dmap created by the spot, and convert this image file to 8-bit alias-format using the Alias utility "depthmap". It's now ready to use in a bump or displacement map. To retouch it convert it again and crop it (like in Photoshop®), make it tileable/repeatable, raise the resolution, add noise or blur, play around with filtering etc.



Speaking about 2D post-processing, such as retouching in Photoshop® - here's something to remember about glow colors, the saturated overheated overexposed colors you might find in or around strong lights, halos, caustics, highlights, incandescent and/or translucent materials, etc. These colors must never be darkened with grey (unless you want the image to look like a dirty photo). Use gamma correction or Curves, anything that bends the distribution curve in a nonlinear manner, preferably with masking on the particular area in question.



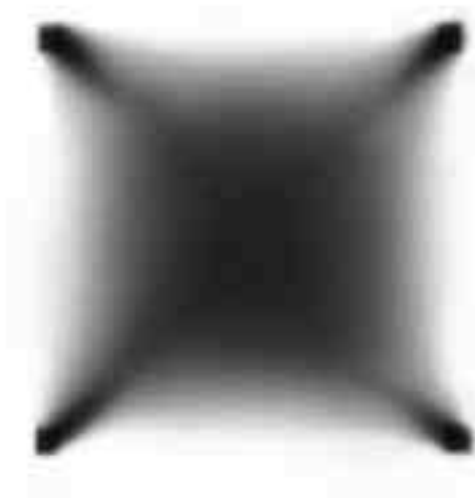
For more realistic lighting (in Alias) use clusters of spots instead of one - 3, 4, 5 or 9 next to each other, aiming towards the same point (place 1 spot, move its pivot point to the center of the main object to receive the shadow, make x duplicates, rotate 10 - 20 degrees), with their strengths lowered (divide original strength by number of lights) and shadows blurred enough to merge them (usually shadow resolution about 50 - 150, make all of them a slightly different resolution to smooth the 'jaggies' out). Beware of flickering shadows in animation, and shadow artifacts, keep their resolutions not too low, and raise the Edge quality. This mimics an arealight, but it's usually faster to render.

The above image shows a cluster of nine, all aiming at the same point, the nearer left bottom corner of the cube. The cluster has been twisted about 45 degrees. The spots are spaced at roughly 20 degrees from each other, and positioned just outside the upper right-hand corner of the image. The Shadow Resolutions range from 90 to 130, the spreads are 45 degrees, the Edge Quality 1, Decay 0, Penumbra 2, Intensity 1,2.

Faking radiosity and arealights

Raytracing and raycasting only include primary light paths in their algorithms, not secondary light, and uses a constant ambient light as a simplified substitute. (For instance, sunlight through a window is the only light source in a room - the sunlit patch on the floor will in turn act as an area light and illuminate the rest of the room.) Radiosity calculates these secondary bounces; it's a way to calculate the global illumination in a scene, and the results are very realistic, rich and beautiful. But it is very slow if you want high quality, even if it only needs to be calculated once for the first frame in an animation. And faking radiosity using area lights will be even slower. (An area light is not emitting light from a single point like the spotlight and pointlight do, but from a rectangle or circle (that can be scaled). This creates shadows that become blurrier further away from the shadow-casting object, which is often much more realistic than what a single spotlight can do. Alias does this, but it's very slow to render.)

So here's how to make your renderings look a bit more radiosity-like: paint more realistic shadows in the color channel of your shaders, or apply extra "shadow-surfaces" on top, and maybe place extra lights (not arealights!) in the scene - basically, PAINT with light. In reality usually at least one part of any surface is lighter or darker than the rest, and if you stop and think for a while (from where is the secondary light coming?) you should be able to figure out which, and how much. Then you either light it, paint it, or use a linear or circular ramp, or a combination of these, either straight on the surface itself, or for more flexibility, apply it as a transparency map in a black Lambert shader on a second surface. I call this a shadow-surface. Here's an example of a painted one that can be used under any table, chair, bed or cupboard etc with four legs:



Advantages to the last method: you can move it easily and interactively (you can see it in the modelling window) at any time, you can reuse the lower surface's shader on other geometry, and you can reuse the shadow-surface's shader on other shadow-surfaces.

Remember to switch shadows OFF for the shadow-surface, and, if applicable, for the object getting its shadow faked. For interior walls, floor and ceiling, a faint circular ramp (darker at the periphery) layered into the color channel almost always looks great. If you deem one side of the room to be much lighter than the other, another straight ramp can be layered on the circular one, and so on.

Here's an example of a good way to imitate sunlight. Use one huge spot very far away, with very high shadow resolution. If a large vista is visible in the image, you can't use that spot for it all - instead, render the distant horizon separately with a no-shadows light, or paint it, or use a photo, and put it in the background of your final image.

The ambient light can be used as the scattered blue light from the sky - place it high, opposing the main spot, with Ambient Shade 0.5 and intensity close to the default, and make it slightly bluish. The main spot then has to be made slightly warmer in a corresponding degree, to compensate and keep the sunlit surfaces neutral.

More realistic alternative: use the ambient light for light bounced back from the ground (no blue, a bit darker, placement below the ground), and use either:

1. One or two large spots placed away from the main one, and angled in to shine on the same area, with very low shadow resolution, very low intensity and quite bluish, or
2. one large arealight, low intensity, bluish, placed above so that it seems to come from where the brightest patch of sky visible from the target, where it's going to shine. (Not recommended for animation.)

Faking caustics

Caustics are the bright spots and streaks created by the focusing of refracted and reflected light rays, like for instance the orange highlight on a table underneath a glass of brandy, or the wave pattern on the bottom of a pool on a sunny day, or the highlight inside a crystal ball, or the bright spots on the street created by chrome hubcaps reflecting sunlight etc. (Any curved shiny or transparent object with a strong directional light on it.)

Alias (and most other software) can't do this, but it can easily be faked by an appropriately colored spot placed inside the object. Look at the image below right - the main light is coming in from the upper right corner. The caustics for the brandy glass can be approximated by an orange spotlight, with position inside the glass and direction like the key light. It should be grouped to the glass for animation, and should always point in the same direction as the key light (this can be fixed dynamically with an expression). The spot should have Decay set to 2 or 3 so it doesn't shine too far, shadows Off for speed, and maybe even an image file mapped in its color channel, for more realism. For a glass of brandy, perhaps something like this (turn it so the circular part points away from the object):

