Chapter 5
Capturing Light & Color

This photo was taken in New York City on a fall afternoon as light filtered down through the changing leaves.

Image sensors in digital cameras are designed to produce colors that match those in the original scene. However, there is a great deal of variation among sensors and among the circuits and software that process raw images into final photographs. The results you get depend, in part, on the accuracy with which you expose the image and the match between the white balance of the sensor and the color of the light illuminating your subject. But differences in results can be even more subtle.

With film cameras, photographers usually explore a wide variety of films before settling on the one or two they like best. This is because each film type has it's own unique characteristics. In some the grain is small, in others it's larger. A film may have colors that are warmer than other films, or slightly colder. These subtle variations among films are slight but noticeable and over time photographers gravitated toward one favorite film. With digital cameras, you don't have the same choice offered by film cameras. The "film", in the form of an image sensor, is built into your camera. Whatever its characteristics are, they are the characteristics you have to live with until you buy another camera.

In this chapter, we explore the world of color and how you manage it in your photos.

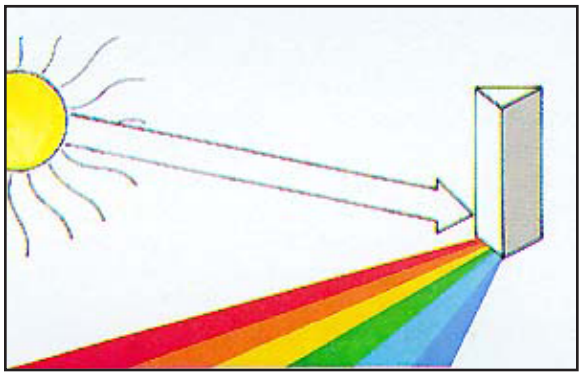
Where Does Color Come From?

Animation

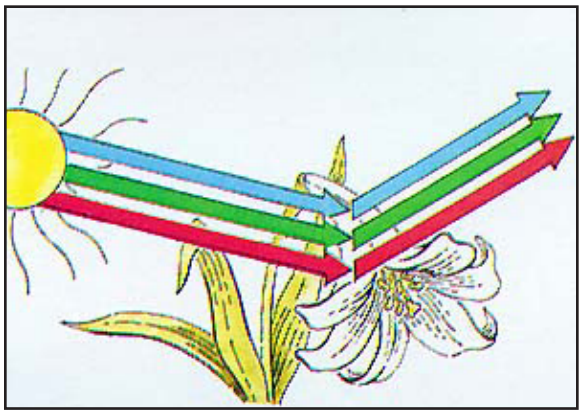
Click to explore color and prisms.

Why do we see colors? Light from the sun or from a lamp seems to have no particular color of its own. It appears simply to be "white" light. However, if you pass the light through a prism, you can see that it actually contains all colors, the same effect that occurs when water droplets in the atmosphere separate light into a rainbow. A colorful object such as a leaf appears green because when white light strikes it, the leaf reflects only the green wavelengths of light and absorbs the others. A white object such as a white flower reflects most of the wavelengths that strike it, absorbing relatively few. A black object absorbs most of the colors and reflects few, if any. Inks, dyes, or pigments in color prints also selectively absorb and reflect certain wavelengths of light and so produce the effect of color.

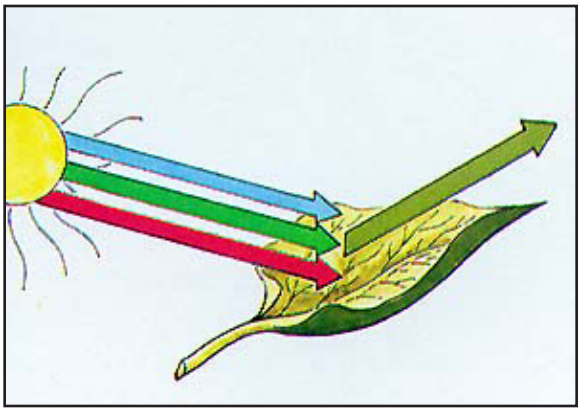
Although light from the sun appears colorless or "white," it actually contains a range of colors similar to a rainbow. You can see these colors using a prism to separate them out.



White objects reflect most of the wavelengths of light that strike them. When all of these wavelengths are combined, we see white. On the other hand, when all of them are absorbed, and none reflected, we see black.



A green object such as a leaf reflects only those wavelengths that create the visual effect of green. Other colors in the light are absorbed by the leaf.



White Balance

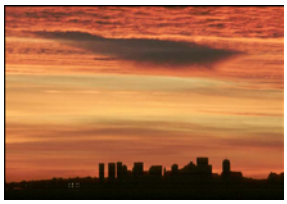
Animation

Click to explore how the white balance setting affects the way images are captured.

Although light from the sun or from a light bulb looks white to us, it actually contains a mixture of all colors, the proportions of which affect the color of a scene it illuminates. We normally don't see the subtle differences because our brains compensate automatically. However, there are times when the effect is so extreme we can't help but notice. For example, when the rising or setting sun casts a warm red glow over everything it illuminates. The color of the light in which you photograph is specified by its color temperature in degrees Kelvin, somewhat like the room temperature is specified in degrees Centigrade.

Fluorescent light has a variety of color temperatures depending on its type. Some bulbs are daylight balanced.

Color Temperature	Type of Light
12,000 K and higher	Clear skylight in open shade, snow
10,000 K	Hazy skylight in open shade
7000 K	Overcast sky
6600 K	
5900-6000 K	Electronic flash
5500 K	Midday
4100 K	
3750 K	
3600 K	
3500 K	Photolamp
3400 K	
3200 K	Sunset, sunrise
3100 K	
3000 K	
2900 K	100 watt tungsten bulb
2800 K	
1900 K	Candlelight, firelight



"White" light actually contains light of different colors. The overall color cast of the light changes as the proportions of the colors change. As color temperature increases, it moves through the colors red, orange, yellow, white, and blue white in that order. To picture this imagine a blacksmith heating an iron bar. It first gets red hot, then as its temperature increases, it becomes white hot, and finally, blue white hot. Daylight contains proportionately more light toward the blue end of the spectrum. Incandescent light contains more toward the red end.

TIPS

- If you like the warm glow of incandescent lights, you can capture that look when shooting under them by setting white balance to *Daylight*.
- The color temperature of most light bulbs changes over time and as they warm up. Be sure to check white balance each time you take pictures, or periodically during a long session.

The warm glow illuminating a scene during a sunrise or sunset is usually welcome, even sought after. However, color casts introduced by other light sources are often objectionable because the colors in the photos don't look like those we remember in the scene. To remove color casts and capture images with colors that look like they were shot at midday, we use the camera's *white balance* system. This system adjusts images so colors are captured the way we see them regardless of the light illuminating them. For example, the fluorescent setting compensates for the greenish light from fluorescent lamps and the tungsten setting compensates for the warmer, more reddish color of tungsten lights.

Many digital cameras offer a number of white balance settings, most for specific lighting situations.

• **Auto** (usually the default) works in a wide variety of lighting conditions.

• **Daylight** is used when photographing outdoors in bright sunlight. When photographing indoors, if you like the warm glow of incandescent lights, you can capture them with this setting.

• **Cloudy** is used when photographing outdoors in cloudy or overcast conditions.

• **Incandescent** or **tungsten** is used when photographing indoors under incandescent lights.

• **Fluorescent** is used when photographing indoors under fluorescent lights.

• **Flash** is used when photographing with flash. Since flash is daylight balanced it's also an ideal way to remove color casts in some lighting situations.

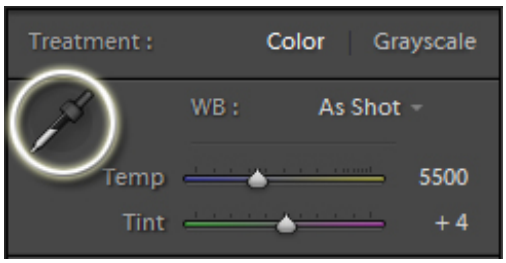
• **Color temperature** lets you select a specific setting from the Kelvin scale. In a studio, where you know the color temperature of the lights, you can set the camera to an exact match. In other settings you can use a color meter to determine the setting you should make.

• **Manual** lets you set white balance manually by aiming the camera at a piece of white paper or a gray card and taking a picture.

Typical white balance icons (clockwise from top) are auto (AWB), manual, flash, fluorescent, tungsten, cloudy, shade, and daylight.

As you change the white balance, you can check the results on the monitor, during shooting if your camera lets you use it to compose images, or in playback mode after you've captured it. If you examine the images closely you may notice that white areas in particular have some color cast to them. (You may want to zoom the image so you can see enlarged details more clearly.)

If your images do pick up a color cast, it's usually easy to remove it in some photo-editing programs. For example, in Lightroom, you just click a neutral area with the white balance selector tool.



Lightroom's white balance selector tool.

White balance settings on your camera can have a huge effect on the colors you get. Here the same subject has been photographed with two different settings—daylight (top left) gives it a warm look, and auto or tungsten (bottom right) renders the colors more realistically.

These two photos were taken under the exact same light, but with different cameras. Both the gray background and yellow colors differ significantly.

One way to ensure you get perfect color is to use a color meter that measures the exact color temperature of a scene.

The tungsten lights create a pool of light that white balance can capture accurately. However, light coming through the windows will cause shadow areas to have a blue cast.

Ideally, every light source illuminating a subject would have the same color temperature so the camera's white balance system could capture perfect colors. This is how it is done in a studio. However, in other settings mixed light from a variety of sources is more often the case. For example, indoors there is usually ambient light streaming in windows and direct light from tungsten lamps or maybe fluorescent fixtures. Outdoors the subject may be lit on one side by direct sunlight, and on the other by light reflecting off a colored wall. When you set white balance, it can only be set for one source of light falling on the scene. Other sources will cause color casts, especially in shadow areas or parts of the subject farthest from the brightest source of light that the camera is white balanced for. For example, if light reflected from the blue sky is illuminating shadow areas, these areas will appear blue.

In addition to selecting a white balance setting, some cameras give you other ways to ensure you capture the colors you want.

• **White balance bracketing** takes a photo and then processes it using a series of white balance adjustments. At least one image is at the setting you've specified, one is redder, and the other bluer.

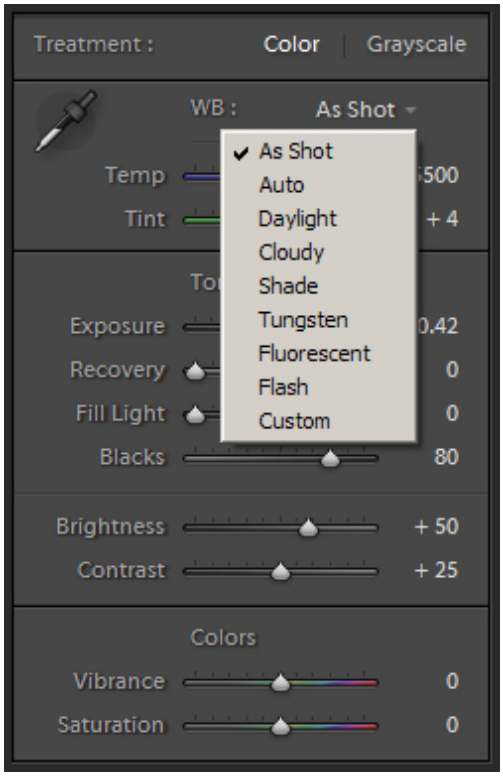
• **Fine tuning controls** let you manually adjust the selected white balance setting to make it slightly redder or bluer.

• **Saturation** controls the intensity of color in an image and some cameras let you increase or decrease it.

• **RAW mode** doesn't use a white balance setting except for thumbnails and preview images. You select one later, while editing the image on your computer. This is the ideal situation since you can change the white balance while looking at the image on the screen and seeing the effect your change has. If you don't like the result, you can just try another setting.

• **Flash** is one way to eliminate color casts because it has the same white balance as daylight.

One way to eliminate white balance problems is to use flash since it has the same color temperature as daylight.

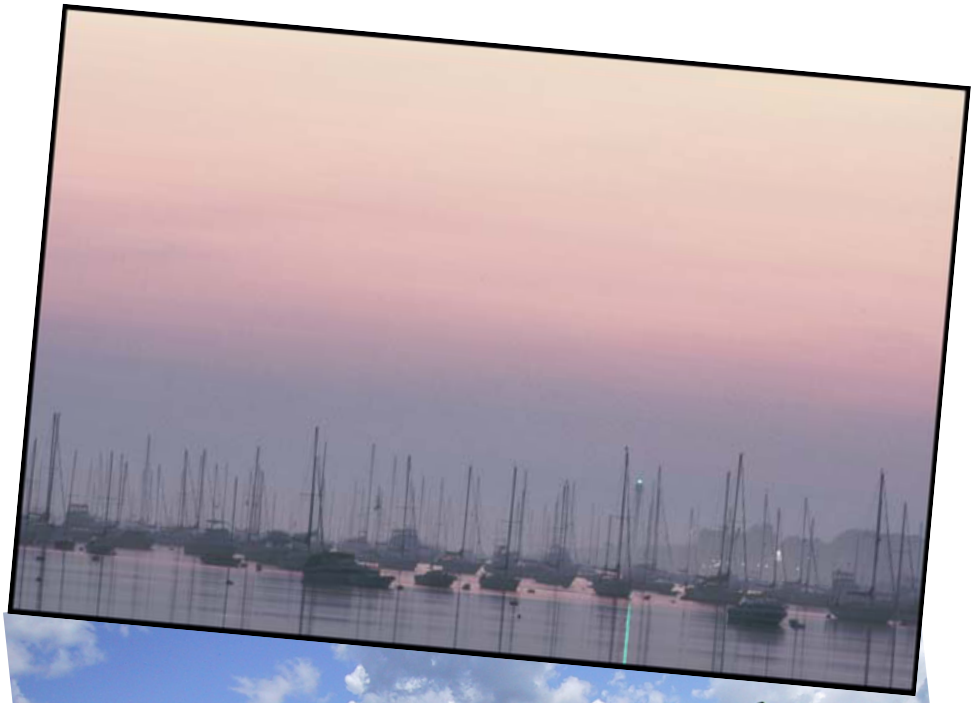


Using a program such as Lightroom you can set the white balance of a RAW image after you've taken it.

Color Balance and Time of Day

In photography, there is a color of light called "daylight." However, over the course of the day, the light can change from a warm red at sunrise, to a cold blue at noon, and then back to a warm red or orange at sunset. "Daylight" on the color temperature scale is really set for midday sun between 10 A.M. and 2 PM on a clear day. During these hours, colors appear clear, bright, and accurately rendered in a photo.

Before and after midday, light from the sun is modified by the extra distance it travels through the Earth's atmosphere. Some of the blue light is filtered out, giving the light a more reddish cast than at midday. This is easily seen very early or late in the day when the light is often quite red-orange in tone. The change in color will affect your pictures strongly, but this reddish cast is a wonderful light to photograph in.



Just before dawn and at dusk, colors often appear muted or monochromatic. During these hours when light is relatively dim, you often have to use an extra-long exposure time.

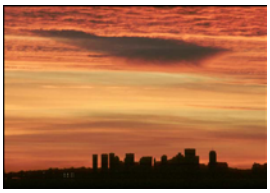
Midday light on a sunny day produces colors that appear natural and accurately rendered.

Early morning and late afternoon light outdoors produces a warmer, more reddish color balance than you will get at midday.

Sunsets and Sunrises

Sunsets and sunrises are relatively easy to photograph because the exposure is not as critical as it is with some other scenes. If you underexpose the scene slightly, the colors will simply be a bit richer and darker. Slight overexposure will make the same scene slightly lighter.

The sun often takes on a flattened appearance as it rises above the horizon. When partially obscured and softened by a haze, its warm, red glow illuminates the foreground.



Sunrises and sunsets by themselves aren't very interesting. It's objects in the foreground, such as the skyline, or unusual atmospheric effects such as this dark cloud that give them some punch.

The colors in the sky are often richest in the half hour before the sun rises and the half hour after it sets. It pays to be patient as you watch the sky change during these periods. For one thing, the sun itself is below the horizon and not in the image so exposure problems are greatly reduced. Also, clouds in the sky often light up dramatically and in some cases, reflect the light to other clouds until you find yourself under a wonderful canopy of reflected color.

WARNING!

Never look at the bright sun through the viewfinder. You can seriously damage you eyes.

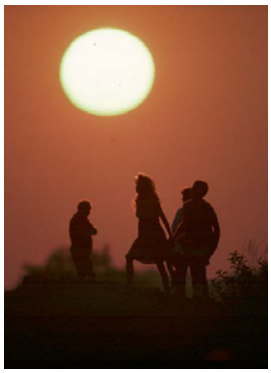
With the bright disk of the sun included in a sunset or sunrise, key elements in your picture may be underexposed and darker than you expected them to be. Add 1 or 2 stops of exposure to a sunset or sunrise that includes the disk of the sun.

Here the camera was positioned so the rising sun was behind one of the grain elevators and wouldn't burn out the image with its glare.

Every sunrise and sunset is unique and the variations can be truly amazing. It's certainly not true that "if you've seen one sunrise or sunset, you've seen them all." If you want the sun in the photo, it's best if it is softened and partly obscured by a mist or haze. If it rises or sets as a hot white or yellow ball, find another subject, or turn around and photograph the scene it's illuminating.

It's tempting to take all of your photos of a rising or setting sun, but it often pays to turn around. The rich, warm light changes the colors of everything it hits. This is a magic time to capture images that will really stand out. Colors take on a warm, soft glow that can't be found at any other time of the day.

When planning to integrate the sun or moon into an image it helps to know when it rises or sets and what phase the moon is. This information is available in almanacs, and also on the Web at the U.S. Naval Observatory Web site at http://www.usno.navy.mil.



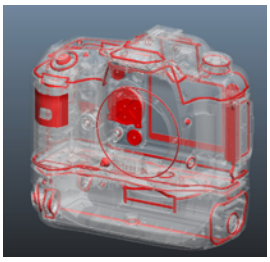
A long-focal-length lens will enlarge the disk of the sun so that it becomes a more important part of the picture. Foreground objects silhouetted against the bright sky, can add interest.

Instead of shooting into the sun at sunrise or sunset, shoot with it behind you to capture rich, warm colors of scenes bathed in the sun's light.

WEATHER

There's no need to leave your camera home just because the sun hasn't come out. In fact, rain, snow, fog, and mist can add interest to your pictures. Objects at a distance often appear diffused and gray in such weather, with foreground objects brighter than normal because they are seen against a muted background. Remember to take a little extra care in bad weather to protect your camera against excessive exposure to dampness.

Snow covered scenes are not only beautiful to look at, they make great photographs.



One of the things you pay for in better SLR cameras is sealing against dust and water. Courtesy of Pentax Imaging.

A light fog or mist subdues colors and softens objects in the background.

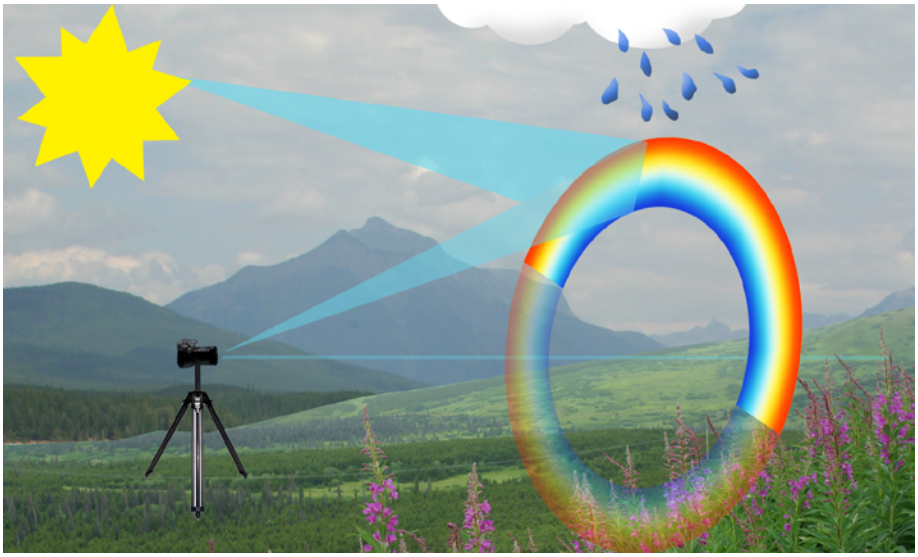
A very light mist can dim the sun enough to include it in a photograph. If it weren't partially obscured by the fog, it would appear as a white dot against a very dark background.

Rainbows always make good pictures. The problem is, you rarely find them where you want them, when you want them. To get better at capturing them, you should know how they form so you can anticipate them. Rainbows are formed when sunlight is refracted by raindrops. You'll usually find the combination of rain and sun at the leading or trailing edge of a summer storm. You

CAMERA CARE

In the cold, the monitor may be slow to come on or suddenly change color. Batteries also run down a lot faster. To prevent these problems, keep the camera under your coat so it stays warmer.

can't see rainbows at all times of the day. To understand why, visualize the way the rainbow works.



If you stand with your back to the sun while looking at a rainbow, imagine a line from the sun passing through your eye, through the Earth, and out into space. (This is called the antisolar point.) The rainbow forms a complete circle around this imaginary line, however from ground level part of it is always below the horizon. A line drawn from your eye to the top of the rainbow forms a 42-degree angle with the imaginary line from the sun through your eye. (If there is a secondary rainbow, it forms an angle of 51-degrees.) Because these angles determine the position of the rainbow in the sky, it will sink as the sun rises and rise as the sun sinks. At some points, the entire rainbow, not just the bottom half, will be below the horizon where you can't see it. That's why you'll never see a summer rainbow at midday.

Here a rainbow dramatically appears in a New England seascape.

Photographing at Night

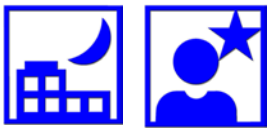
TIPS

At night, turn off the flash unless you want to illuminate nearby subjects. Leaving it on may throw off your exposure.

You can photograph many different things outdoors at night, so don't put your camera away just because the sun is gone for the day. Light sources (street lights, automobile lights, neon signs, or fires) or brightly lit areas (illuminated buildings or areas under street lights) will dominate pictures at night because they stand out strongly against darker backgrounds. Plan to use these bright areas as the dominant part of your picture. A tripod will support your camera during long exposures and prevent blur caused by camera motion during the time the shutter is open.

Urban areas are full of bright lights that can be used to illuminate nighttime scenes.

Some cameras have a button you press to illuminate the control panel at night.



Many cameras have night landscape and night portrait modes for taking photos at night.

Many cameras have a night portrait scene mode that uses flash to capture a foreground subject against a night sky or cityscape. The night landscape mode is also used for night scenes, but doesn't fire the flash.

Fireworks can be dramatic, but are difficult to capture. You need to experiment and a digital camera is perfect for that because you can instantly review your results.

To capture interesting images of fireworks, put people or water in the foreground. It also helps if there are identifiable objects in the image such as an illuminated building or monument to give the viewer a sense of place. Get upwind from the show since fireworks generate smoke and it can become a problem if you are downwind. If you are upwind, the smoke will become part of the image, illuminated by the fireworks. Try a series of exposures of different bursts because there is a certain amount of luck involved. You might also use flash or slow sync to illuminate foreground figures. Set your exposure for fireworks by switching to aperture or shutter-priority mode and use a setting of f/2.8 at 1/30. You might also want to try increasing sensitivity, use exposure compensation, and try different combinations of aperture and shutter speed as well as those mentioned here.

At night you often use long exposures and some cameras have a *bulb setting in* manual exposure mode, for this purpose. In this mode the shutter remains open as long as you hold down the shutter button. This is a great way to capture light trails, but if the shutter opens for more than 1 second, noise in the form of randomly-spaced, brightly-colored pixels may appear in the photograph. To reduce noise at slow shutter speeds, turn on noise reduction.

A typical bulb icon.

The moon, especially when full, adds a lot to an image. The best time to capture the moon is when it's near the horizon. Because it is close to foreground objects at that time, it looks much larger than when it's higher in the sky.

Keep in mind that the moon is relatively dim and usually requires long exposures. Since it's moving relative to the Earth, longer exposures can actually blur it, giving it an oblong shape. To reduce the chances of this happening, shoot just before sunrise or just after sunset when there is still some light in the atmosphere from the recently set sun. (It bends around the Earth's curvature due to refraction in the atmosphere.)

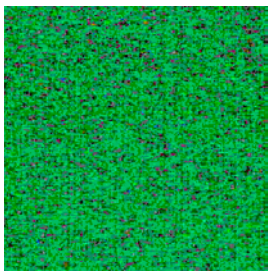
Long exposures on bright moonlit nights can be very attractive. Just keep in mind that the moon does move so exposures longer than a minute or so may show it elongated.


Candlelight provides a very warm glow to whatever it illuminates.


The U.S. Constitution lies floodlit in Marblehead Harbor.


This picture of Chicago was taken just after sunset through an airliner window. A few minutes later the scene was too dark to capture without blurring due to long exposure times.


There is a time at twilight and dawn where there is enough light in the sky so it has the same tonal value as the foreground.


Noise appears in an image as grain or multicolored random pixels.

The Direction of Light

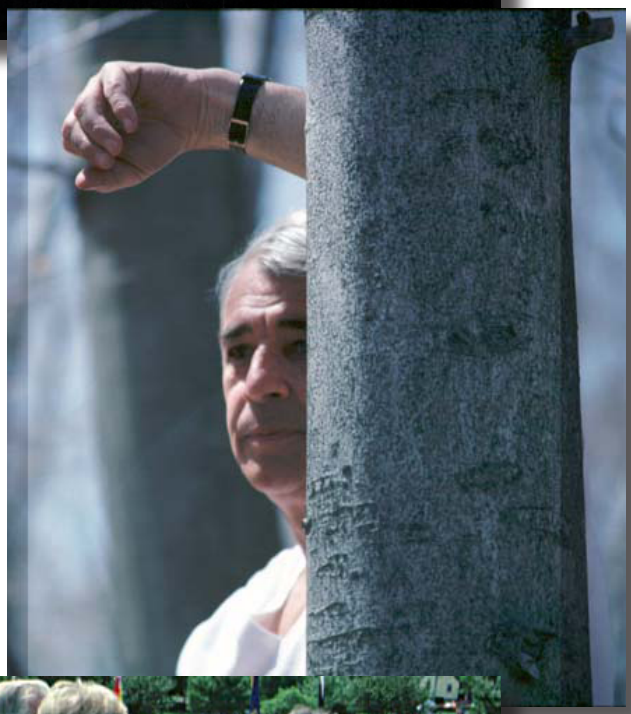
The direction that light is coming from relative to your camera's position is important because it affects the shadows that will be visible in your picture. Four main types of lighting are illustrated here: side-lighting, front-lighting, backlighting, and top-lighting. Notice the position of the shadows in these photographs and how they affect the subjects.

The direction of light can also affect your automatic exposure. Backlighting, for example, can leave your subject silhouetted against a background so bright that your automatic exposure system will assume the subject is much brighter than it actually is, and so underexpose the scene and make the subject even darker. This is fine, if you want a silhouette. If you don't, you should use exposure compensation or flash to lighten the image.

Side-lighting increases the sense of texture and volume because such cross-lighting casts shadows visible from the camera's position that emphasize surface details. Landscape photographers often prefer to work early in the morning or late in the day because the sun while low in the sky will sidelight scenes and add interesting surface textures.

Front-lighting decreases visible shadows and so minimizes surface details such as skin texture. Front-lighting also tends to minimize the apparent roundness or volume of the subject.

Backlighting puts the side of the subject that is facing the camera in shade. Automatic exposure tends to make backlit scenes too dark. You can use this effect creatively or add exposure to lighten the picture, especially those parts that are in shade.



Top-lighting can occur outdoors at noon or indoors where ceiling lights predominate. If you are photographing a person, you will notice that top-lighting tends to cast shadows in eye-sockets and illuminates the top of the nose brightly. To avoid this effect, you might try moving the person into the shade.

Top-lighting can selectively illuminate things, such as this flag in the man's back pocket, that would be in shadow with light coming from a lower angle.

The Quality of Light

Animation

Click to explore hard and soft light.

Light not only has direction, it can be direct or diffused. Direct light, light coming mainly from one direction, produces relatively high contrast between bright highlights and dark shadows. Diffused light bounces onto the subject from several directions, lowering contrast. Contrast, in turn, affects the brilliance of colors, the portrayal of visible texture and detail, and other visual characteristics.

In direct light you may have to choose whether you want highlights or shadows to be correctly rendered because image sensors can accurately record only a limited range of contrast between light and dark areas. If this creates a problem because both highlights and shadowed areas are important, you can sometimes add fill flash or use a reflector to lighten shadows and decrease contrast or adjust the camera's contrast setting. In diffused light, colors tend to be softer than in direct light and textures are also softened because shadow edges are indistinct.

Direct light comes from a point source, such as the sun on a clear day. Direct light produces dark, hard-edged shadows that crisply outline details. Here the light and shadows almost form an abstraction.

Diffused light comes from a light source that is so large relative to the subject that it illuminates from several directions. On a hazy or overcast day, illumination comes from the entire dome of the sky, not from the brighter, but smaller, sun. Indoors, light bounced into an umbrella reflector or onto a wall or ceiling creates a broad source of light that wraps around the subject.