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Learning to Photograph

Vol. 1: Camera, Equipment, and Basic Photographic Techniques

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»Everything can be altered, deformed, or eliminated by light. It is just as soft as a brush.« Man Ray, American photographer

04 Exposure Metering

One of the technical goals of photography is to create a properly exposed image. There is no way to achieve this other than knowing how much ambient light is on hand and how much creative latitude you have in that light. Exposure metering is how you get this information. By using either an internal or external exposure meter, you can measure the brightness of the subject or its surroundings.

It's important to become familiar with how exposure meters work and the different ways to gather a reading, because an accurate and considered reading is the cornerstone of controlling exposure so your subject appears in just the right light. There are a number of errors and pitfalls you'll want to avoid so you can produce a quality result. Fortunately, there are many tips and tricks for getting an accurate reading and putting it to good use.

This image clearly demonstrates that different objects reflect different amounts of light. The white pants bounce much more light toward the camera than the field of grain. ***120–400mm telephoto zoom 1:4.5–5.6 at 120mm, f/5, 1/800 second, ISO 100, daylight***

4.1 Measuring Brightness

On a technical level, photography involves comparing the ambient light with the amount of light required for a specific photographic purpose, and then controlling the quantity and duration of light so the proper amount reaches the sensor. In simpler terms, the sensor requires a specific amount of light to expose an image properly. How much light depends on the dynamic range of the sensor and the selected ISO value. This ideal value is stored in your camera's electronic system; you won't see it indicated anywhere while you're photographing. At most, your camera will let you know whether your current settings will over- or underexpose the image, or you'll see the improper exposure in the image itself.

This ideal, stored-away exposure value must be reconciled with the actual amount of available light. This depends on the ambient light and the amount of light your camera will effectively absorb for every unit of time that you expose an image.

Light or Subject Metering

There are two approaches to measuring brightness: you can meter the brightness of the light, or you can measure the brightness of light that reflects off the subject. The former method is referred to as light metering. This approach measures the light on its own and is not influenced by the reflective properties of the subject. In general, you can perform this sort of measurement only with an exter-

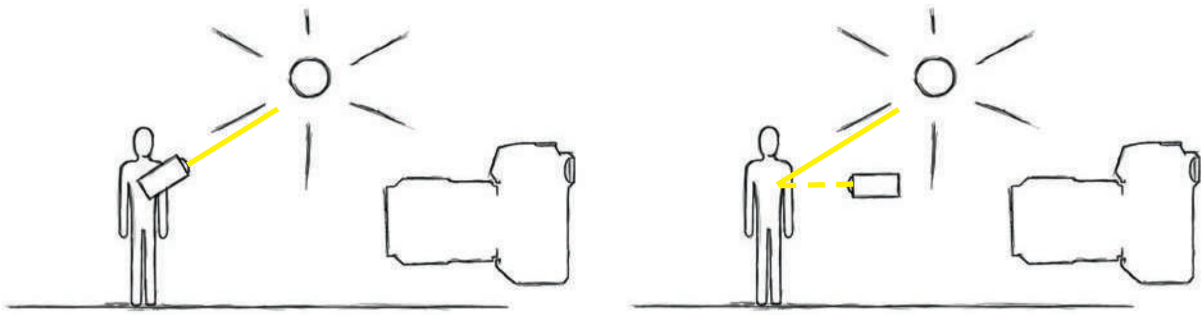


Figure 4.1
You can use an external light meter, such as the one shown here from Gossen, to meter both the incident light that strikes your subject directly and the reflected light that bounces off your subject. Take your readings as close as possible to the subject to minimize the chance of error.

nal light meter. Meters that are integrated into cameras cannot handle such high levels of brightness. The second method, subject metering, measures reflected light. This can be accomplished with metering equipment that is either external or internal to a camera.

External Light Meters

A separate light meter that is external to a camera is more accurate and less prone to error than a built-in light meter. External meters can be held next to the subject or pointed toward the source of light to measure its brightness without consideration for the physical properties of the subject. Depending on the model, external meters can serve as a spot meter and can meter and store the intensity of a flash, which shines for only a brief moment.

With an external light meter, you set the ISO number that you're using on your camera, and the meter gives you an exposure value of the light it measures (p. 88). If you set either your camera's aperture or shutter speed on the meter, it will supply the other value. This metering method is too inefficient and slow for some photographic situations, but it's exceedingly accurate. If you're working in an environment where the lighting conditions will stay constant for several exposures, the slowness is irrelevant. This is why external light meters are used in photography studios, where flash units are used to produce a very precise quality of light, and outdoors, when photographers work with a tripod.

External light meters are indispensable in situations where technical perfection is paramount and the lighting needs to be perfect, such as when you're using the Zone system for product photography or portrait and fashion images for glossy magazines.

A predominantly dark subject, such as this wood grain, will confound any exposure meter that is calibrated to neutral gray. Bright subjects, such as this white flower, confuse meters into thinking there is much more light than there actually is. To avoid this sort of metering error, you can substitute a neutral object to take a meter reading, or you can intentionally over- or underexpose the image somewhat.
Left, 85mm prime 1:1.4 with a 13mm extension ring, f/2, 1/500 second, ISO 100, daylight; right, 105mm macro 1:2.8, f/2.8, 1/200 second, ISO 100, daylight

Internal Exposure Metering

In most cases, you will rely on the integrated light meter within your camera to measure the usable light. A separate sensor is built into your camera specifically to measure the brightness of light (in rare cases, it can also measure color temperature). The sensor for exposure metering covers the entire image area, even if it's equipped with fewer measuring diodes than the image sensor. To conduct the metering, a small fraction of the light that enters the lens is diverted to this sensor. Depending on how the light is diverted, the sensor can be located in different spots in the camera's interior (p. 30). Since the metering occurs within the camera body, the specifications of the lens come into play.

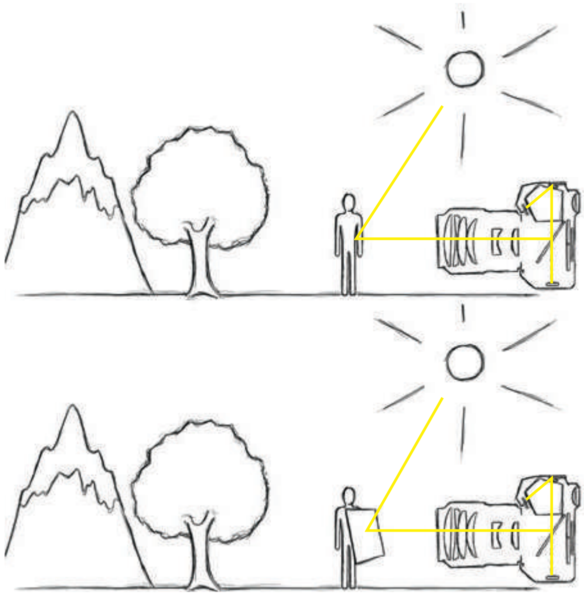
The light meter is an independent, elaborate subsystem of your camera that delivers information about brightness and light color to the central processor. Depending on the metering mode you use (p. 81), the system will use the light from the entire image area or from one specific point within the area to establish a value. Specific points within the measuring area can be weighted differently; for example, the metering method, the active AF field, and the program mode you select influence the weighting.

An integrated light meter measures only the light that reaches it; that is, the light that has already been reflected off the subject. You can still use the measurement of reflected light to achieve a correct exposure if you factor in the meter's functionality.

Neutral Gray

Your camera has no way of knowing how much light is reflected off your subject. Camera manufacturers deal with this by using an average substitute value for neutral gray. Technically defined, neutral gray reflects exactly 18 percent of the light that strikes it. In photographic practice, neutral gray is highly useful as an average value for most subjects and their colors, which is why all light meters are calibrated to this value. Within their internal calculations, cameras assume that every subject reflects 18 percent of the ambient light, which means the ambient brightness is about 82 percent stronger than the measured value.

Figure 4.2
When you are photographing a black or a white subject, meter a gray object to get a better reading.



Substitute Metering

Since your subjects will actually be neutral gray in only the rarest cases, this process has great potential for exposure errors that you need to address. If you base your metering on an area that is too bright or too dark—a snowman, for instance, or a black cat—it will skew your exposure metering. These types of subjects will reflect either much more or much less than 18 percent of the incidental light that strikes them. If you use the problematic reading from your light meter, you'll end up with an image that's either overexposed for a dark subject or underexposed for a bright subject—in both cases the result will be soft gray rather than black or white. These types of subjects make it impossible to perform subject metering to get a usable value with your meter. You have two options: you can rely on the exposure control

In many cases your subject will be too far away to position an external light meter directly next to it, as is the case here with the observatories on the Roque de los Muchachos. In these situations it's easier and makes more sense to use in-camera metering.
105mm macro 1:2.8, f/3.5, 1/1600 second, ISO 100, daylight

Instead of using parts of your subject that are too bright or too dark for metering, substitute objects that exhibit medium brightness, such as asphalt, grass, cardboard, or stone.
24mm prime 1:1.8, f/11, 1/500 second, ISO 100, daylight

settings to correct the image (p. 84), or you can conduct substitute metering, which involves choosing a different surface that better approximates the neutral gray average and using it to measure the light. You can set the aperture and shutter speed manually (p. 107), or you can use your camera's exposure lock feature (p. 110). To minimize the possibility of error, purists carry a standardized gray card in their equipment bag to use for accurate substitute metering—a gray wall, an asphalt street, or a piece of cardboard will also work. Even metering colorful areas of appropriate brightness will produce better results than measuring a black or white surface.

Light that strikes your lens from the side or spills into the viewfinder can throw the metering system off and cause inaccurate meter readings.
24mm prime 1:1.8, f/10, 1/640 second, ISO 100, daylight

Stray Light

Beams of light that directly enter the camera can disturb light metering, such as backlit subjects. You can mount a hood on your lens to substantially reduce this risk. Light that enters your camera through the viewfinder can also cause metering errors. Normally your face occludes the viewfinder while you're shooting, so this problem arises only in special situations. If you're working with a tripod, shooting from the hip (without inspecting the image area), or standing directly in front of a bright light source, the incidental light can affect the metering. In these cases you can take measures to cover the viewfinder, or you can avoid using partially or fully automatic metering methods.

4.2 Metering Options

Most cameras offer different methods or options for measuring the brightness of a subject or scene. The name and technical realization of these options varies slightly for each camera manufacturer, but there are three fundamental metering options on which all others are based. Behind each method is a complex algorithm that determines which part of the viewfinder image to base the metering on, which part to not base the metering on, and how to weight the metering of the active areas. The algorithms evaluate thousands of diverse template photos taken by the manufacturer. Test your camera to determine how each metering option suggests different combinations of aperture and shutter speed for the identical image area and lighting situation. The higher the contrast of the image area, the greater the discrepancies among the suggested exposure settings will be for each option.

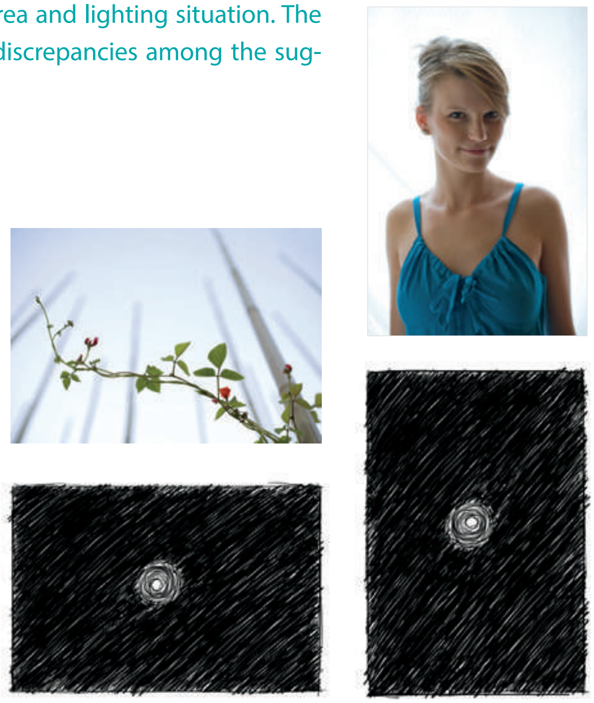


Figure 4.3
Spot metering allows you to control the exposure of small elements within your image, even in backlit situations. For both portrait and landscape orientations, only a small circle in the center of the image area determines the meter reading.

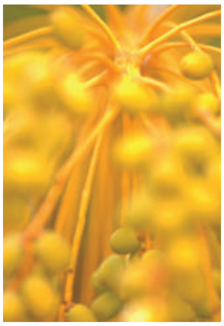
Spot Metering

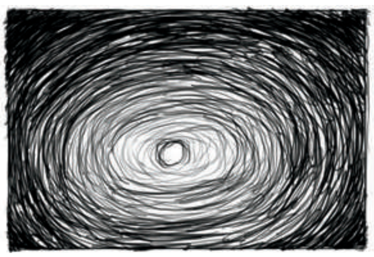
Spot metering allows you to base your exposure metering on a specific point in your image area. Only about 2 percent of the image area is used for metering. This area is usually circular and is located at the center of the image area, but sometimes it is located at the active AF frame. None of the image area outside of this small point influences the metering value. Some cameras have additional or alternate selective metering that uses the same principle as spot metering, but the metering area is about 4 or 5 percent larger.

Several circumstances demonstrate the key benefits of spot metering. A subject that has a marked contrast and large visual areas is one example. Spot metering allows you to collect a value based on the most critical visual element of the image area. Other situations that demand spot metering include taking a portrait with backlighting, photographing a single subject in front of a uniform background, or documenting a subject that is illuminated with a spotlight on a stage.

Spot metering can also be used to figure out the contrast of your image area. You can meter the brightest area, then the darkest area, and compare the aperture and shutter speed combinations to calculate the contrast in terms of f-stops, time intervals, or exposure values. Spot metering is the most precise way to meter, and you should use it anytime the lighting is finicky or when you need to produce an image of the highest technical quality.

Figure 4.4
Center-weighted metering puts the most emphasis at the bottom part of the image, which is appropriate in many cases, especially for landscape photography. If you shoot a portrait-oriented image, however, critical image elements may not factor into the light metering, as is the case here with the tulips. Nevertheless, when you photograph mostly two-dimensional subjects with modest contrast, this metering method still produces good results, even in portrait format.





Center-Weighted Metering

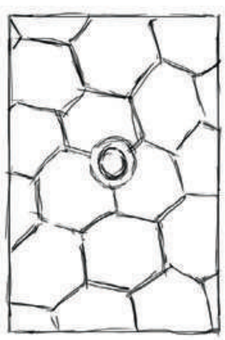
Cameras have been equipped with center-weighted metering for decades. It was developed to accommodate standard landscape images that have one main, centrally-located subject and a uniform, bright sky. Center-weighted metering prevents the brightness of the sky from ruining the exposure by using a metering field—usually an oval, but in rare cases a trapezoid—located just below the centerline of the image. The camera weights the readings from the field more than the corners and edges of the image area. Some systems ignore the area along the top edge completely and weight the lower areas of the image instead. The metering field for some cameras is circular and is located in the middle of the image area. Center-weighted metering can deliver a quality metering value for many exposure situations, including not only landscape and architecture photos, but also images with modest contrast. Even when your image has a lot of contrast in the details, this metering option can produce a useable middle value for the exposure. The problem with center-weighted metering, however, is that it has limited use for portrait-oriented images because it doesn't meter one side of the image.

In this image, the center-weighted metering focused mostly on the stonework on the ground. The person is too small and too close to the edge of the image to have an impact on the metering, which is why the person appears as a silhouette.
150mm macro 1:2.8, f/10, 1/500 second, ISO 100, daylight

Matrix Metering

The metering method with the greatest variety among camera models is matrix metering (also known as multizone metering). It uses the entire viewfinder image to establish a metering value. The image is divided into different-sized metering sensors at different locations, depending on the manufacturer, and they are all used individually, to various degrees, to meter the light. Other camera settings, such as the scene mode or the position of the active AF field, can affect how the sensors are weighted.

Cameras distinguish between portrait- and landscape-oriented exposures by means of a sensor. Matrix metering is the most flexible, comfortable, and engineered metering option that modern cameras offer. It should be the go-to choice for beginners, or people who don't want to worry about metering, and it's a good choice in variable lighting conditions. Matrix metering has one clear and significant disadvantage: it is incomprehensible for photographers. There's no way to know when or why certain visual elements are weighted instead of others. This information is stored away in the camera's internal programming and is beyond the influence of the photographer. Matrix metering doesn't allow you to gain experience and knowledge about how to use it. Matrix metering is less than ideal for photographers who want to control and design every variable of their work, but it is phenomenal for when you need to work quickly and simply.



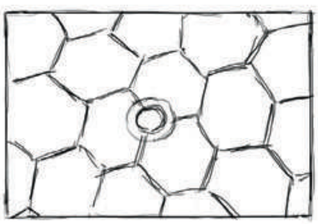


Figure 4.5
Matrix metering divides the viewfinder image into several different areas and weights them all differently. Portrait- and landscape-oriented images are differentiated, too. The number and location of the measuring fields vary greatly among camera manufacturers.

*»Shutters and pupils are meant not to let information in but to shut it out.
As anyone knows who has ever held a camera,
too much information is easily as blinding as too little.«* K. C. Cole, American science journalist

05 Exposure Control

As soon as the light metering process concludes, the camera begins controlling the light sensitivity, aperture, and shutter speed. By adjusting these parameters, the camera can attempt to capture the ideal amount of light for the sensor from a continuous stream of light. This process is called exposure control. You can control it manually, or you can use your camera's partially or fully automated programs.

When we consider the technical elements of photography, exposure control is the central process. The internal path for light opens up completely to create an image on the sensor during the exposure. In addition to achieving a proper exposure, defining the variables of aperture, shutter speed, and ISO sensitivity have implications for the design of an image, whether the photographer intends it or not.

Photographers who leave exposure control up to the camera can produce a properly exposed image. Whether the photo matches the intended design, however, is a matter of chance. In contrast, photographers who understand aperture, shutter speed, and ISO can purposefully adjust those settings to achieve photographic results that match their intentions. Regardless of what type of photographer you are, in this chapter you'll find information about the technical fundamentals of exposure control and its implications for image design.

5.1 Basic Concepts

On a fundamental level, exposure control involves setting three values in relation to a fourth—a simple undertaking, in some ways. But for each variable there is a large range of options, and numerous advantages and disadvantages that must be considered with respect to each photographic situation and your intentions for every photograph. It's important to learn the basics and develop an understanding of the whole process so you'll know how choosing different exposure settings will produce different effects.

Exposure Control: an Overview

Exposure control is a process that includes many steps. You (or an automatic camera system) must determine the right combination of light sensitivity, aperture, and shutter speed settings to produce the light value that is established during light metering. This process unfolds iteratively through the comparison of measured and set values. It involves the following logical steps, even if they are experienced quite differently in practice:

1. The reflected light from the subject is measured through the process of light metering (p. 74) and is used to extrapolate the ambient brightness of a scene. The result of this process is a value that represents brightness.
2. Taking into account the current ISO setting,the camera establishes an exposure value (p. 88) to match the measured ambient brightness. The camera compares this exposure value to the current shutter speed/aperture combination and determines the type and size of adjustment, if an adjustment is necessary.
3. The camera uses the difference between the ambient brightness and the current exposure value to calculate how the aperture, shutter speed, and ISO sensitivity need to be shifted (up or down) and the extent of the needed change.

4. When the ambient brightness and exposure value are in accord, the picture will be properly exposed and you can release the shutter.
5. The goal of step 4 is to create an image that is properly exposed, in a technical sense. This step involves the creative component of exposure control. The photographer deliberately chooses a shutter speed/aperture combination, with respect to the exposure value, that creates certain effects in the final image.

These steps occur regardless of whether you shoot in automatic or manual mode. The key difference is whether you or the camera make decisions and adjustments to the ISO, aperture, and shutter speed settings along the way.

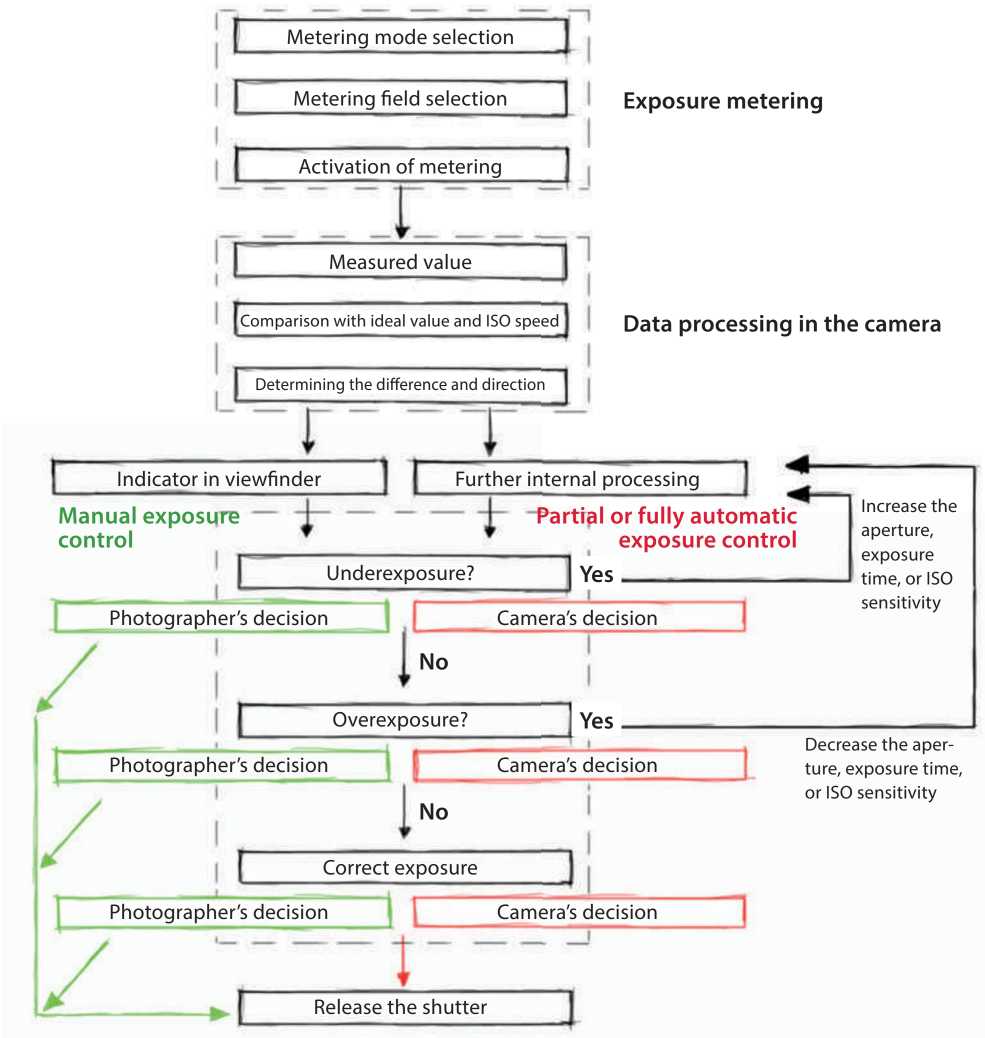


Figure 5.1
The process of exposure control includes many individual steps that often happen so quickly it seems that everything happens at once. Exposure metering produces a brightness value, which in turn results in an exposure value based on the ISO setting. The aperture and shutter speed must then be selected so that, as a pair, they correspond to the exposure value. You can do this manually by checking the viewfinder for the current values and to see if the image with the current settings will be overexposed or underexposed. If a partial or fully automatic exposure mode is used, the camera takes over and reveals the aperture/shutter speed combination in the viewfinder.

Exposure Value

There are multiple combinations of aperture and shutter speed that produce the same exposure, if all other factors remain constant. The amount of exposure for these combinations is mapped to an exposure value (EV). An EV of zero describes the situation when an aperture of 1 paired with an exposure time of 1 second produces a properly exposed image. All other aperture/shutter speed combinations that produce the same exposure correspond to this EV. Since the EV describes the amount of light that reaches the sensor when the shutter is open, it also depends on the brightness of the subject. Moreover, the programmed light sensitivity of the sensor influences the EV and the corresponding aperture/shutter speed combination. On the scale of EVs, steps are normalized in such a way that one step, or stop, doubles or halves the quantity of light or brightness when the aperture, shutter speed, or ISO settings are adjusted.

The EV is not displayed anywhere on your camera for you to see, but internally this number plays an important role because it represents an entire band of aperture/shutter speed combinations that produce the same exposure. In grouping the EV with light sensitivity and brightness, you have the three values that need to be defined with respect to one another. Two of those values—brightness and light sensitivity—are available after you set the ISO and meter the light, so the third value, EV, can be derived. This is how the camera knows what aperture/shutter speed com-

EV	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000	1/2000	1/4000
f/32	9	10	11	12	13	14	15	16	17	18	19	20	21	22
f/22	8	9	10	11	12	13	14	15	16	17	18	19	20	21
f/16	7	8	9	10	11	12	13	14	15	16	17	18	19	20
f/11	6	7	8	9	10	11	12	13	14	15	16	17	18	19
f/8	5	6	7	8	9	10	11	12	13	14	15	16	17	18
f/5.6	4	5	6	7	8	9	10	11	12	13	14	15	16	17
f/4	3	4	5	6	7	8	9	10	11	12	13	14	15	16
f/2.8	2	3	4	5	6	7	8	9	10	11	12	13	14	15
f/2	1	2	3	4	5	6	7	8	9	10	11	12	13	14
f/1.4	0	1	2	3	4	5	6	7	8	9	10	11	12	13
f/1	-1	0	1	2	3	4	5	6	7	8	9	10	11	12

Figure 5.2
An EV is defined as all combinations of apertures and shutter speeds that result in the same effective exposure. An aperture of 16 and an exposure time of 1/15 second amount to EV 12, as does an aperture of 2 with a exposure time of 1/1000 second. Using a slow lens means that certain combinations will be unavailable in certain lighting conditions. Zero on the EV scale is defined as the amount of light that enters a lens with an aperture of 1 for 1 second. The EV steps are normalized so that one step up doubles the light, and one step down halves the light. The values are based on a light sensitivity of ISO 100.


These two images of the same flower were taken one right after the other—both at EV 12. They look different because the aperture and shutter speed were shifted for each exposure. A smaller range appears in focus in the left image, and the longer exposure time on the right produced a blur effect. ***Left, 35–210mm zoom 1:2.8–4.8 at 35mm, f/2.8, 1/500 second, ISO 80, daylight; right, 35–210mm zoom 1:2.8–4.8 at 35mm, f/11, 1/30 second, ISO 80, daylight***

binations will produce a properly exposed image. However, there are some restrictions. Not all combinations are possible to use, or even make sense. The aperture range and the shortest possible exposure time make some combinations impossible, and exposure times that are too long may result in unwanted camera shake.

Exposure control includes two main tasks: the first concerns fundamental technology and the second concerns the creative design of an image. The former involves coordinating the brightness, ISO sensitivity, and EV. The latter involves your decision about which aperture/shutter speed combination will create an image with a design that best suits the content of the photo. With a little experience, you'll execute these two steps quickly and simultaneously, or you'll leave the decisions up to a partially or fully automatic exposure mode.

One way of thinking about exposure control is to consider that aperture, shutter speed, and ISO sensitivity have a minimum and a maximum value; if you change one setting, you'll need to change another setting in the opposite direction to achieve a constant exposure.

Exposure Scale

Since your camera reveals neither the brightness value it meters nor the EV itself, you need another indicator to let you know if your image is properly exposed. This is the purpose of the exposure scale, which indicates an overexposure or an underexposure of up to two stops (less commonly, five stops). An inadequate exposure may be indicated by a flashing point or arrow. Within the two stops on the scale, the exposure is indicated in 1/3 EV steps so you can gauge the accuracy of your exposure settings and adjust the aperture or shutter speed accordingly.

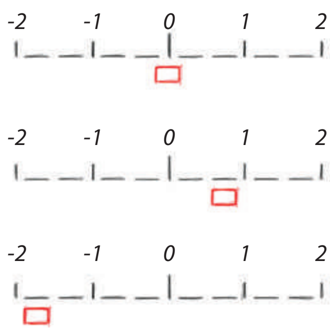


Figure 5.3
The viewfinder of an SLR camera indicates whether an image is properly exposed (above), overexposed (middle; here at 2/3 stop), or underexposed (below; here at 1 2/3 stops). The exposure scale or an arrow typically flashes to signal a larger over- or underexposure.

Sharpness and time are the key design elements of these two images, respectively. ***Left, 50mm prime 1:1.4, f/8, 1/320 second, ISO 100, daylight; right, 85mm prime 1:1.8, f/8, 1/500 second, ISO 100, daylight***

Coordinating Aperture, Shutter Speed, and ISO Sensitivity

The interplay of aperture and shutter speed is the central action of photography. Both of these variables are controlled by electromechanical devices in the camera, which you can use to regulate the quantity (aperture) of light that reaches the sensor and the duration (shutter speed) in which it is allowed to do so. In addition to their technical roles, these variables also play a vital role in the creative process.

The relationship between aperture and shutter speed can be compared to a water spigot. A stream of water with continuous pressure pushes against the spigot, which is analogous to the ambient light outside the camera. Suppose you want to fill a glass with water, which, in photographic terms, is similar to exposing the film or sensor to the right amount of light. You can open the water spigot all the way, which will fill the glass in the shortest amount of time. Or you can barely open the spigot and allow drops of water to trickle into the glass, which will take longer to fill it. The same principles apply to photography. If the light is constant, you can permit the same amount of light to reach the sensor by using a fast shutter speed with a large aperture or a slow shutter speed with a small aperture.

Aperture and shutter speed are calibrated so that one aperture stop corresponds to one shutter speed stop, and a change of one stop either doubles or halves the amount of light, as long as the other parameters are constant. A two-stop decrease in shutter speed can be balanced with a two-stop increase in aperture, and vice versa. This is true in terms of regulating the quantity of light that reaches the sensor, but not the design implications. Furthermore, aperture and shutter speed settings have maximum and minimum limits, so they are not perfectly relative to each other.

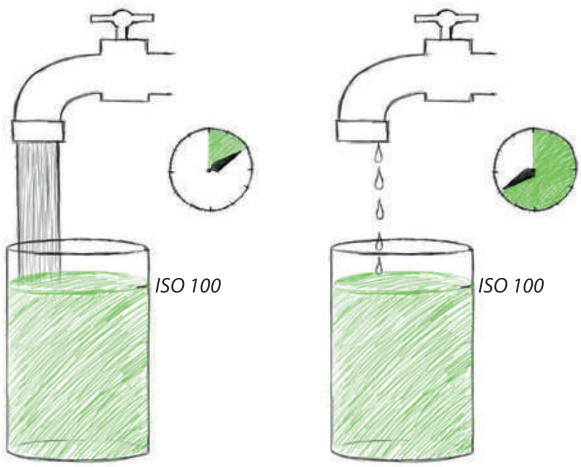


Figure 5.4
In the water spigot analogy, the same quantity of light (water) reaches the sensor (glass) if the aperture (spigot) is open all the way for a short time or if it is open a small amount for a longer time. The duration of the exposure (the filling of the glass) is shorter or longer, respectively.

The third related variable is the light sensitivity of the sensor or film. The higher the sensitivity, the less light is needed to expose an image properly. In our example of the water spigot, light sensitivity corresponds to the size of the glass. The smaller the glass, the quicker it will be filled.

Even though aperture, shutter speed, and ISO can be changed, the ISO value is usually established first at the lowest possible setting. Photographers usually increase the ISO setting only when the light conditions are so poor that it's not possible to take blur-free images at a particular setting. The lower the ISO setting is, the better the image quality will be: this means there will be no visible grain for film exposures and no distracting noise (p. 130) for digital exposures.

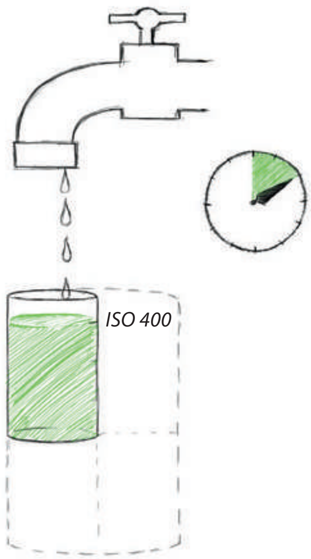


Figure 5.5
Using a higher light sensitivity for the sensor is akin to using a smaller glass in the water spigot analogy. A smaller aperture (spigot) can fill the sensor with adequate light in a shorter time. Aperture, exposure time, and ISO are all standardized so a step up doubles the light, and a step down halves it.

Light Sensitivity (ISO)

The light sensitivity of a camera sensor is described with an ISO value, which is standardized in the same way as aperture and shutter speed: every whole step doubles or halves the previous step. The sequence of whole ISO steps is 25, 50, 100, 400, 800, 1600, 3200, 3400, 12800, 25600, 51200, 102400, and 204800, but you can usually set them at half or third steps between these values.

One of the interesting aspects of digital photography is that you can alter the light sensitivity for every exposure. This is possible because the sensitivity of the sensor does not actually change. What changes is the degree to which the sensor signal is electronically amplified after the sensor absorbs light. This amplification is accompanied by a reduction of image quality in the form of noise (p. 130). Modern cameras generally produce acceptable results, without significant noise, up to ISO 6400.

You can create technically sound images even in poor lighting conditions, which opens new realms of creative possibility. Test your camera to see how high an ISO you can use before noise becomes problematic. If you're in a situation where it's too dark to use that ISO setting, you won't be able to capture images without a significant quality compromise.

The light just before the sun sets is too dark for many sensors. The only way to use a short enough shutter speed to avoid camera shake is to use a higher ISO setting, which produces unsightly image noise. It manifests as bright and colorful points in dark areas of the image.
35–210mm zoom 1:2.8–4.8 at 50mm, f/4, 1/200 second, ISO 800, daylight

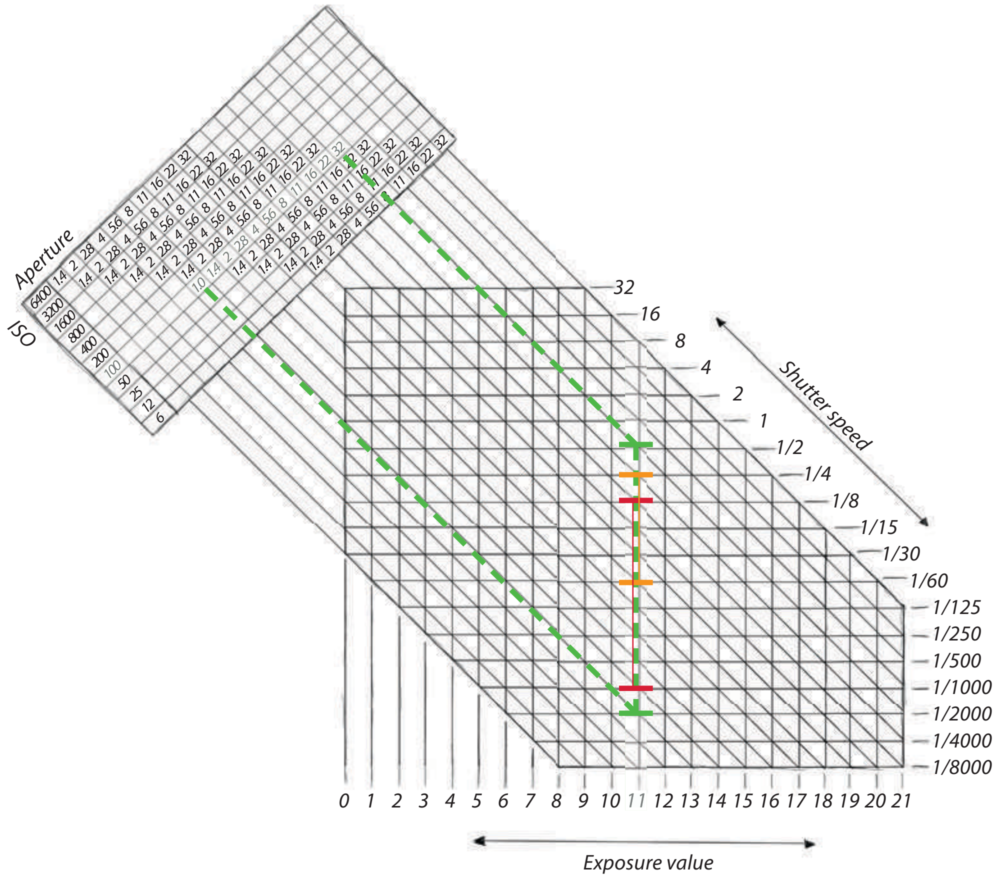


Figure 5.6
Every ISO speed—with respect to the EV, which corresponds to the metered brightness—opens up a specific number of aperture/shutter speed combinations. In this example, EV 11 matches the brightness of the subject, so ISO 100 is used. In theory this means that you can select a combination from f/1 and 1/1000 second to f/32 and 1/2 second to suit your design intentions. Your lens, however, has a limited aperture range, and your camera has a limited range of shutter speeds, which restrict the range of options. For example, theoretically there are 11 combinations (green); with a fast prime lens there are eight combinations (f/1.4–16; red); and with a slow standard zoom lens there are only five combinations (f/5.6–22; orange).

Range of Contrast

The general goal of exposure control is to make sure the critical elements in an image are exposed well. Another goal is to capture as much visual information as possible so you can use it later during post-processing. This requires a working understanding of contrast, which is defined as the difference in brightness between two points. The exposure should not be based on a subject or a part of an image that exhibits a minimal range of contrast because the overall image typically exhibits more marked contrast. What's more important is the range of contrast (also called dynamic range), or the ratio of brightness at the darkest and brightest points in an image. This range can describe the physical appearance of a subject or the imaging performance of a sensor, and it can be defined in three different ways that convey the same information: a simple ratio of numbers (e.g., 1:1000), a logarithmic difference of density (e.g., 3 log D), or a number of stops (e.g., 10 stops).

Every sensor can absorb and reproduce a finite dynamic range, which is not included in the product specifications of your camera; it can be gleaned only from actual camera tests. The maximum limit of the dynamic range is defined by the sensor's ability to store light, and the minimum limit is defined by the sensor's noise

performance. When the values are graphed as a tone curve, the line is straight. Digital sensors behave differently than film, which is why the highlights in digital images become oversaturated faster. You should expose conservatively, especially if you're not sure how large the dynamic range is. The dynamic range is dependent on the ISO setting. The higher the ISO sensitivity, the narrower the dynamic range; in extreme cases this can reduce the range by four stops.

Any visual information that is brighter than the upper limit of the sensor's range will appear pure white and will not contain detail. Areas that are too dark will appear black and will be crushed by image noise (p. 130). Modern DSLR cameras vary in terms of their dynamic range; with a sensitivity setting of ISO 100, the range averages between 9 and 12 stops, which is often as good as, if not better than, color film. Nevertheless, even common lighting conditions produce scenes that exhibit a much larger contrast range, especially with unfiltered daylight.

The contrast in black-and-white images is especially high. Although the image with less contrast shows more detail, the image with more contrast reveals a more powerful opposition of light and dark.
Left, 35–210mm zoom 1:2.8–4.8 at 35mm, f/5, 1/500 second, ISO 100, daylight; right, 28mm prime 1:2.8, f/3.5, 1/1600 second, ISO 100, daylight

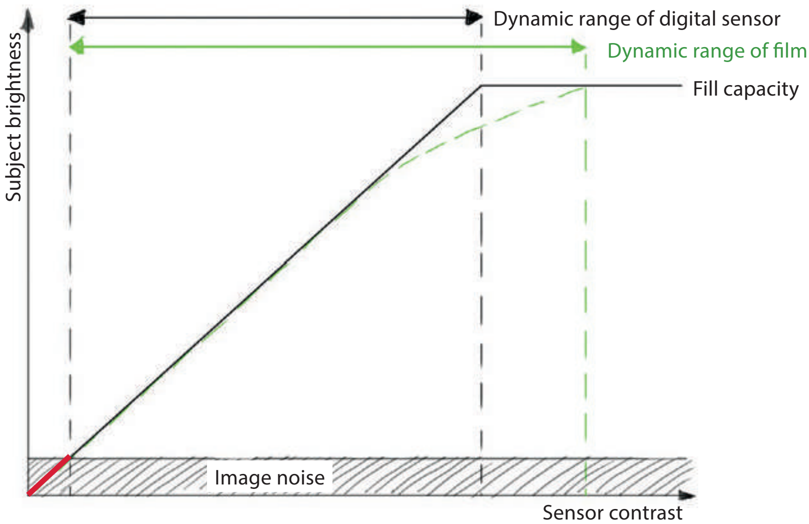


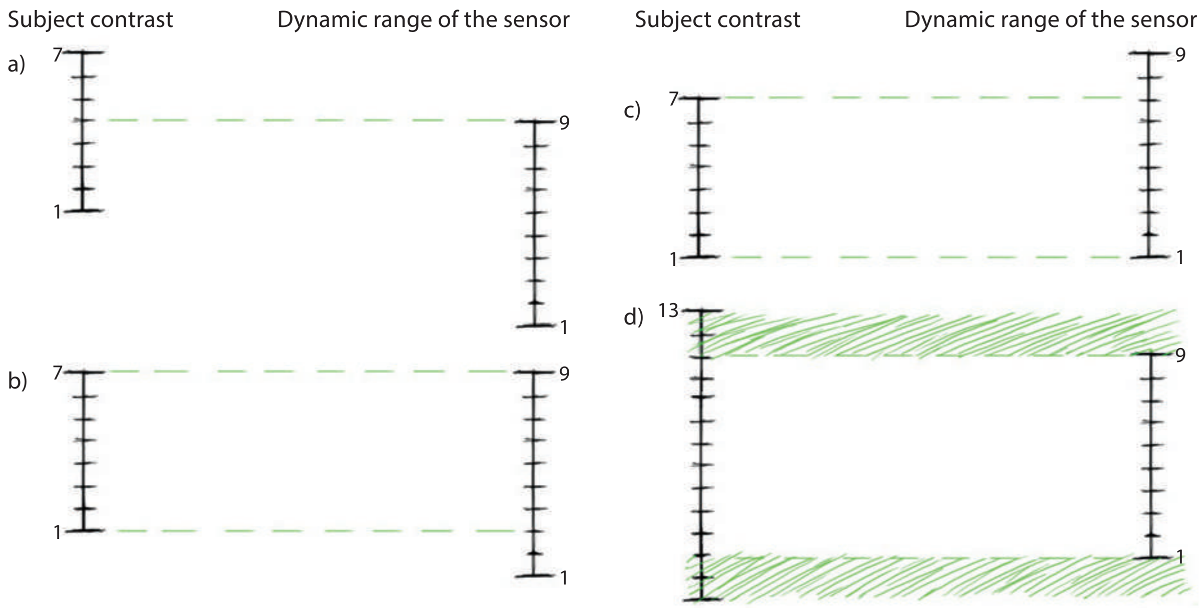
Figure 5.7
The tone curve with digital sensors (black line), unlike film (green line), is linear. When there is not enough light, the exposure of the sensor is so minimal that it can't be distinguished from the sensor's baseline image noise (red line). The digital tone curve reaches the sensor's fill capacity faster in the highlights, and no definition will be displayed—it will be pure white. It makes sense to expose film differently than digital sensors for this reason. With digital, modest underexposure produces more detail than slight overexposure.

Targeted Contrast Control

There are three ways that your subject's contrast range can stack up against your camera's ability to capture it: the subject's contrast range can be smaller than, equal to, or greater than the capacity of your sensor. Each situation requires specific and targeted action:

- When image area exhibits a smaller contrast range than your sensor, your task is easy. You simply control the exposure so both the brightest and the darkest points in the image are within the dynamic range of the sensor. With normal exposure metering based on a mostly neutral gray part of the subject, you'll stay within this range. When in doubt, opt for slightly more exposure to avoid noise in the dark areas. Or if you want to avoid the lighter, desaturated colors that result from a brighter exposure, you can slightly underexpose the image to get more saturated and intense colors.
- Things get a little more complicated when the dynamic range of the subject more or less matches the dynamic range of the sensor. Here your goal should be to regulate the exposure so the contrast of the subject is exactly captured. Base your metering on a medium brightness and take a close look at the histogram to make sure the brightness values range from the extreme left to the extreme right sides of the graph. When there are no dark values, reduce the exposure; conversely, if there aren't any bright values, increase the exposure.

When the subject's range of contrast matches the dynamic range of your sensor, make sure to adjust the exposure so you can use the full breadth of that range. That way, your image will contain all the visual information from the RAW file. Uncompromised images that receive fine-art processing always look impressive.
28mm prime 1:2.8, f/5.6, 1/500 second, ISO 100, daylight



- When the contrast of your subject exceeds your sensor's dynamic range, it's impossible to capture the entire range of contrast. You will lose detail and visual information in either the light or dark areas of your image; you must decide which option compromises your image the least. Alternatively, you could attempt to decrease the contrast range of your subject by, for example, brightening the dark areas with fill light or shielding light from the brightest areas.

Figure 5.8
As long as the contrast of the subject is not larger than the dynamic range of your sensor—which is usually about nine stops—you can capture all the image information. If you don't expose your image incorrectly (a), you can target your exposure either on the highlights (b) or the shadows (c). Many times, however, you will encounter a subject whose contrast exceeds the dynamic range of your camera. In these cases at least some of the image information will be lost in the highlights or shadows (d). Your job is to determine the sacrifices that are least harmful to your overall image.

You can use spot metering to measure the contrast range of an image. Meter the brightest and darkest points in your image and calculate the difference between the aperture/shutter speed combinations in whole stops. This process is somewhat laborious, but it can be helpful with studio photography and architecture or landscape images. You can produce digital negatives that contain a maximum amount of image information, which can be used to produce high-quality, fine-art images.

Range of Contrast for Other Media

Other media have their own dynamic ranges. When you compare a monitor, a projector, and paper, you can see that paper is the most limited in terms of dynamic range. This makes it impossible to represent all the levels of brightness you see on a monitor in a print. When a photo is printed, the tonal values are adjusted as much as possible. The difference between the huge dynamic range of the human eye and the limited dynamic range of a camera sensor is why the sky above your subject may appear rich with color when you take a picture, but it looks like a blown-out white area in the final image.

5.2 Aperture

The aperture, which controls the size of the opening through which light enters the camera, affects the appearance of an image in a profound way. The term aperture is used to discuss the electromechanical apparatus that controls the opening, but it's also a unit of measure that expresses the result. In the following pages, we explore the connections between the physical, technical basics of aperture and how it influences the formal and compositional aspects of photography.

The Basics of Aperture

The aperture mechanism is made of flexible, overlapping slats that move and control how much light reaches the sensor in precise steps. The language used to describe the value of aperture is, unfortunately, somewhat imprecise. The value of an aperture opening is calculated as a ratio of its diameter to the focal length of the lens, such as 1:2.8 or f/2.8 (p. 43). People usually refer only to the denominator of the ratio (2.8 or f/2.8), so a larger f-number corresponds to a smaller aperture opening, and a smaller f-number corresponds to a larger aperture opening. Colloquially, an f-number is often used to describe the aperture opening, but most commonly it's referred to simply as aperture, which increases the confusion and can lead to misunderstandings in technical discussions.

Since the aperture opening describes an area, each stop is calculated by multiplying the square root of 2 ($\sqrt{2}$) by the previous value. The following sequence represents the f-numbers for whole aperture stops: 1, 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 22, 32. Half- or third-stop increments are usually available for fine-tuning your exposure. Aperture stops are stan-

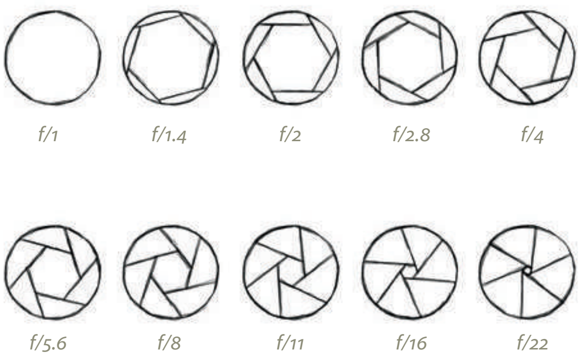


Figure 5.9
The slats of the aperture slide together to occlude the light path to varying degrees. Every full aperture stop doubles or halves the opening.

dardized, just like shutter speeds and ISO values, so stopping down or opening your lens by one step doubles or halves the area of the aperture opening and the quantity of light it allows into the camera, assuming other variables remain constant. The smallest f-number (i.e., the largest aperture opening) of a lens corresponds to its speed (p. 47).

When you use the maximum aperture, the depth of field becomes so shallow that you can completely isolate objects from their surroundings.
105mm macro 1:2.8, f/3.5, 1/250 second, ISO 100, daylight

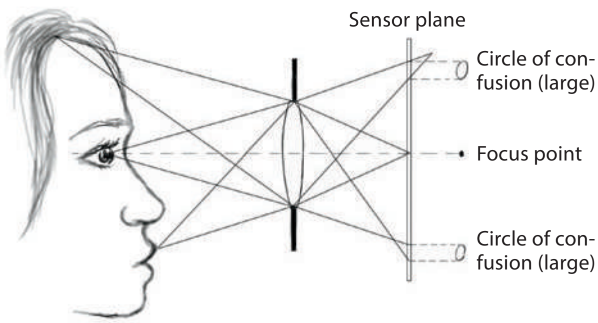
Depth of Field

The main way that aperture is apparent in pictures is the depth of field, which describes the distance in front of and behind the focal plane (p. 54) in which objects appear sharp to the human eye (even though they aren't entirely sharp, from a technical standpoint). When you work with a short distance between the camera and the subject, the depth of field is larger in front of the focal plane. The greater the distance between the camera and the subject is, the more the depth of field shifts to behind the focal plane.

If all other factors remain unchanged, the smaller the aperture opening (or the larger the f-number), the greater the range will be in which objects in the photo appear sharp; conversely, a smaller f-number (or a larger aperture opening) will produce a more shallow depth of field. This relationship is based on the resolution limits of the human eye.

A lens reproduces every point on the object's focal plane as a sharp point on the sensor. Every point in front of or behind the object's focal plane will be focused either in front of or behind the plane of the sensor. Since all points in a scene are translated to points in the camera, the process of focusing fans the points out into a cone. Since the sensor plane is fixed and the lens is focused at the distance of the object, the sensor slices through the cone of points that are located in front of or behind the focal plane. The sensor doesn't capture a single point of data; it captures a cross section of the cone on the sensor.

Wide aperture



Narrow aperture

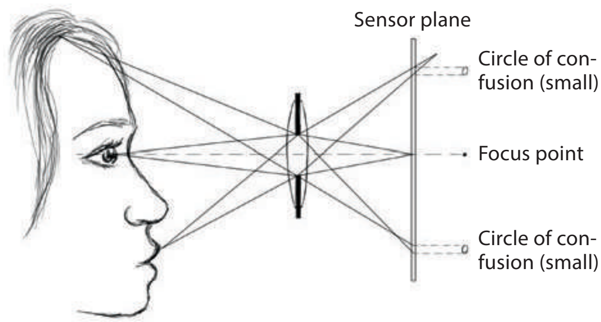


Figure 5.10
Focusing your lens means that any point on the focal plane (eye) will be focused sharply as a point on the sensor. Any visual points that lie in front of the focal plane (lips) or behind it (hair) will appear as a point behind or in front of the sensor plane, respectively. In front of or behind this point, they fan out into a cone of light, which is traversed by the sensor plane. This causes the point to appear as an unfocused circle or oval on the sensor. The aperture opening plays a role in the size of these circles of confusion. Small circles are perceived as points by the human eye, meaning they look sharp. The larger the circles are, the stronger the blur.

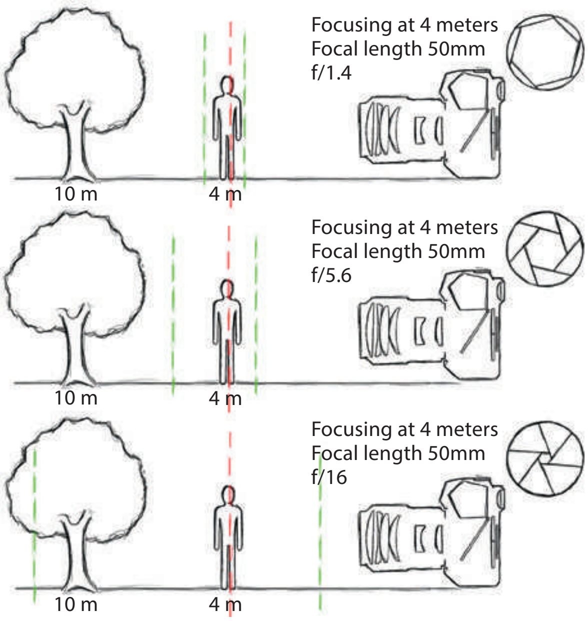


Figure 5.11
The aperture influences the range on either side of the focal plane in which objects appear sharp (green). The smaller the aperture, the broader the range. The more you open the aperture, the smaller the depth of field becomes, assuming all other factors remain constant.

Every point that is captured as a small circle on the sensor, rather than a point, is technically out of focus. The human eye, however, is limited in terms of the size of details it can perceive and distinguish. In other words, if the circle captured on the sensor is small enough, the eye perceives it as a point. This means that part of your image will look sharp, even when the points are located in front of or behind the focal plane.

When the aperture is open as wide as possible, this effect is maximized because the beams of light that enter the lens are very wide. This means the light cone forms at a very broad angle. By stopping down, you narrow the entryway for the light, which reduces the angle of entry and makes the light cone more pointed. With a narrow aperture opening, the cross sections of the light cone are smaller and are more likely to be perceived as points by the human eye. There are two other technical factors that influence the depth of field: focal length and object distance. The shorter the focal length, the larger the depth of field, and vice versa. In practice, this means that a wide-angle lens reproduces greater distances in focus than a telephoto lens, assuming other factors remain constant. The distance that separates the camera and the focal plane has a similar effect. If you are focusing on an object that is relatively close, the depth of field is shallower; when the subject is farther away, the depth of field is deeper—again, assuming other variables remain constant.

These images clearly demonstrate the influence of aperture on the depth of field.


f/2.8


f/4


f/5.6


f/8


f/11


f/16


f/22

These three values—aperture, focal length, and focus distance—affect the depth of field. They can each be altered to increase or decrease the depth of the region in which objects appear sharp. The depth of field in any given image is established by a combination of these three variables. The size of the sensor also has an indirect influence on the depth of field. For example, smaller sensors with a crop factor lead to a larger depth of field than full-frame sensors (p. 127), assuming a correspondingly shorter focal length but constant aperture and focus distance.

Using a narrow aperture can increase the depth of field to extend several meters in front of the focal plane and to infinity behind it. This compositional choice allows viewers to see details clearly throughout the image area.
28mm prime 1:1.8, f/14, 1/125 second, ISO 400, daylight

Designing Images with Aperture

Aside from controlling the exposure, you can also adjust the aperture to suit your creative intentions. Any object that appears sharp will immediately have greater importance to a viewer than an object that is out of focus. When you open the aperture all the way, you reduce the significance of most elements in your image and focus the viewer's attention on elements that are located in the focal plane. This is one effective way to highlight some elements and push others to the wayside. This is also a way to guide a viewer's gaze through your images in a calculated way.

Increasing the depth of field is a fitting design choice when you want to emphasize a broad range of detail. This compositional choice allows you to balance the weight of multiple elements within an image. Don't forget that you can use intermediate apertures to emphasize or tone down the depth of field. The easiest way to evaluate the effect of altering the aperture is to use your camera's depth of field preview.

Depth of Field Preview

When you look through your viewfinder to select an image area and compose the photo, you need as bright and clear an image as possible. For this reason, SLR cameras function at the maximum aperture for all steps leading up to the actual exposure, including while your camera meters the exposure. Immediately before the shutter opens, and right as the mirror springs upward, the aperture closes to the

The depth of field preview button allows you to stop the aperture down to your current setting before you actually expose the image. This causes the viewfinder to darken, but it allows you to examine the distribution of sharpness in your image before you take the shot. ***Above, 50mm prime 1:1.4, f/2.8, 1/100 second, ISO 100, daylight; below, 50mm prime 1:1.4, f/14, 1/100 second, ISO 100, daylight***

value you specified and creates your desired effect. Most cameras feature a depth of field preview that allows you to evaluate the effect of a smaller aperture while you look through the viewfinder. Pressing the depth of field preview button, which is usually located near the lens mount, stops the aperture down to the setting you selected. The viewfinder image darkens and allows you to see the areas of sharp focus. It takes a little practice, but this is one of the most important tools for composing images by altering the aperture.

Bokeh

Another way the aperture influences the look of your image relates to the appearance of blurred visual points. When the sensor captures the cross section of the light cone, it doesn't reproduce a perfect circle or oval; it reproduces a shape that corresponds to the outline of the aperture opening. In other words, the physical construction of the aperture influences the bokeh. Bokeh does not describe a measurable quality; it refers to the aesthetic way that a lens renders blurred points in an image. Whether a lens exhibits good bokeh or bad bokeh is highly subjective. A mirror lens (p. 69), which lacks an aperture due to its unique construction, produces perfectly round circles of blur, which is particularly conspicuous, distracting, and unattractive.

The bokeh for every lens is unique, and the effect is subjective. If the shape of the blurry points is too conspicuous, it can be distracting for the viewer. The blurry points are emphasized in this picture because they're quite light. ***85mm prime 1:1.8, f/1.8, 1/100 second, ISO 400, daylight and artificial light***

5.3 Shutter Speed

The second critical value in photography is the window of time during which light is permitted to reach the sensor. The shutter mechanism, which regulates this variable, is controlled electronically but functions mechanically. It sits directly in front of the sensor and shields it entirely when the camera is inactive. When you press the shutter button, the shutter opens a direct path so light can reach the sensor.

The shutter speed also plays a central role in image design because the amount of time the shutter is open determines how long light can influence the sensor. For every exposure there are two types of movement, in addition to the shutter, that influence the appearance of an image: movement of the camera and movement of the subject. The relationship between these variables and their respective speeds dramatically affects what you see in the final image.

The Operation of the Shutter

Nowadays, most cameras feature a plane shutter with two curtains that are positioned horizontally in front of the sensor. When they are at rest, the shutter curtains overlap to make sure the light path is completely occluded. When you press the shutter button, the first curtain drops from the top down and reveals the sensor. After the duration of the preset shutter speed, the second curtain drops to occlude the sensor again. This process is critical to ensure that every part of the sensor receives the same amount of light. If the second curtain were to travel from the bottom up, the bottom part of the sensor would receive less light than the top. This shutter construction allows for extremely fast speeds. For exposure windows of about 1/1000 second and shorter, the second curtain starts moving before the first one has completely dropped. This means the entire sensor area does not absorb light at the same time: a narrow open slot travels across the sensor from top to bottom to expose the whole sensor in a quick sequence. The duration of the exposure takes longer than the shutter speed suggests, since each part of the sensor is

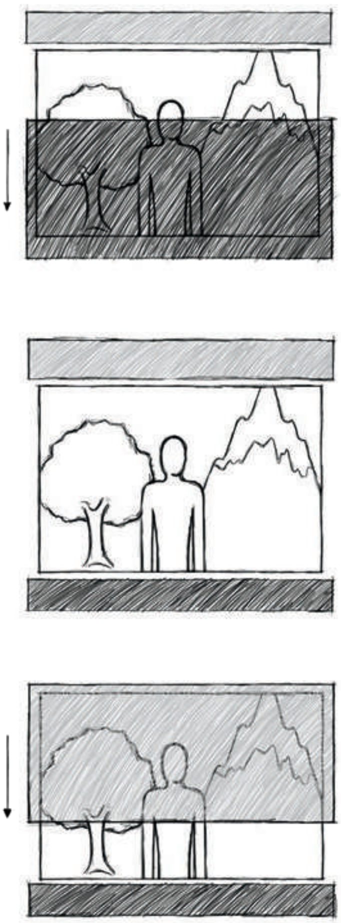


Figure 5.12
A shutter has two curtains, one in front of the other, that move in the same direction in front of the sensor. The duration of time between when each curtain passes in front of the sensor corresponds to the shutter speed. The entire exposure, however, takes longer than the shutter speed itself. With extremely short shutter speeds, the second curtain (light gray) follows the first curtain (dark gray) before it reaches the other side of the sensor, so a small slot permits light to traverse the surface of the sensor and expose the image section by section.

exposed in succession. This mechanism sometimes causes very fast-moving subjects to look distorted.

Only a few medium-format cameras feature a central shutter, which functions in much the same way as the aperture, except it blocks the path of light entirely. Central shutters allow for exceptionally fast flash synchronization times (p. 159). The sequence of possible shutter speeds is normalized, just like aperture and ISO settings. Every alteration of a full step means the quantity of light doubles or halves, depending on whether the shutter speed is increased or decreased by a step. Most cameras feature whole-step shutter speeds of the following times (measured in seconds or fractions of a second): B (bulb), 30, 16, 8, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000, 1/2000, 1/4000, and 1/8000. Shutter speeds can usually be adjusted in half-step or third-step increments to give you more control. The B setting stands for bulb, which means the shutter stays open for as long as the shutter button is pressed. This is a practical feature for nighttime photography or astrophotography and is best used with a remote trigger (p. 157).

Some digital SLR and rangefinder cameras feature a so-called electronic shutter, either in addition to or in place of a mechanical shutter. These systems require a special sensor (p. 123) that absorbs light continuously. The charge that accumulates during the exposure is stored in the pixel cells and then transferred to another special storage cell from which the image data is eventually read. The exposure time for the entire surface area is regulated electronically, which allows shorter flash synchronization times. Keep in mind that like an image sensor in a video camera, these sensors constantly absorb light, which can lead to technical defects such as blooming and smearing (p. 131).

If you want to depict a moving subject sharply, the exposure time must be shorter than the time it takes the subject to move to a new position.
50mm prime 1:1.4, f/3.5, 1/250 second, ISO 320, daylight and artificial light

Blur-Free Images

Most photographers want to create images that are free of the blur caused by camera shake. Images with camera shake are generally considered flawed and get negative reactions from most viewers. The main way to create shake-free images is to prohibit any camera movement during the exposure window. This may be difficult since your body is always moving to some degree. It's impossible to hold a camera perfectly still in your hands, and even the light press of the shutter button introduces movement. This last problem becomes more significant if the camera is lightweight.

If you're photographing a stationary object, you can use a longer exposure time. Just make sure it's not so long that the movements of your own body cause the camera to move during the exposure window and cause unwanted blur. ***100mm macro 1:3.5, f/3.5, 1/250 second, ISO 200, artificial light***

Holding the Camera

There are a number of ways you can avoid camera shake, but the first step is holding your camera securely. Set the bottom of your camera on the palm of your left hand, and grasp the lens between your thumb and index finger, which you can use to manually focus or adjust the focal length of a zoom lens. The entire weight of the camera should rest on your left hand while your right hand loosely grips the camera for added stabilization and to press the shutter button. This position will help you hold your camera relatively still, especially if you exhale just before you release the shutter and if you support your left arm against your torso.

Holding your camera in this position offers the most stability. Your left hand supports the weight of the camera and lens, and your right hand stabilizes the camera and presses the shutter button. (Photo: Ute Kynast)

This method has limited effectiveness if you use shutter speeds longer than about 1/125 second. Longer focal length lenses are also more difficult to hold still than shorter ones, because the increased magnification turns the smallest movements into large, conspicuous traces of blur in the image. A general rule of thumb is that you shouldn't handhold your camera with an exposure time that's longer than the reciprocal of the focal length you're currently using. Any crop factor should be considered when you make this rough calculation, since the size of the sensor affects the level of magnification. When you use a 200mm telephoto lens with a full-frame camera, you wouldn't want to use an exposure window longer than 1/200 second. Long telephoto lenses that are particularly heavy tend to push the limits of this rule. Also, using a lens or camera that has built-in image stabilizers can make it possible to handhold your camera with shutter speeds up to four stops longer. The most sensible approach is to know the individual limits of your own equipment (p. 242).

Long exposure times will unavoidably result in camera shake and traces of movement, which will be visible in the final image. ***38–114mm zoom 1:2.8–5.1 at 38mm, f/2.8, 1/10 second, ISO 400, daylight***

Use a tripod on a stable surface or set your camera on a steady object for long exposures when you don't want blur to appear in your image. You can also use the self-timer as further insurance against blur.
35–210mm zoom 1:2.8–4.8 at 35mm, f/7, 2 seconds, ISO 400, artificial light

Tricks for Stable Exposures

Tripods (p. 165) and remote trigger systems (p. 157) are ideal aids for exposing blur-free images. These devices aren't always on hand, of course, which is why you may need to improvise from time to time. It helps to lean your torso against something, such as a wall. Another time-honored method is to set your camera on something stable so the image area is framed how you want it, then use the self-timer to avoid causing shake when you press the shutter button. Many cameras have an option for a two-second window for the self-timer for this very reason.

Image Stabilization

Manufacturers have developed methods for counteracting camera shake by using flexibly mounted optical elements in their equipment. Depending on the manufacturer, these image stabilizers are built into either the camera itself or the lens. In cameras, the entire sensor is affixed in a mechanism that allows it to move. In lenses, the elements float to negate camera movement. The advantage of an image-stabilized sensor is that you can use this feature with any lens, including shorter ones, which are rarely equipped with image stabilizers. Furthermore, you'll pay for the technology once, rather than with each new lens you purchase. There is no noteworthy difference between the effectiveness of the two methods; both have worked effectively in various quality tests.

Image stabilizers make it possible for you to use exposure times that are three or four stops longer for handheld shots. Rather than being limited to 1/250 second with a 200mm telephoto lens, you'd be able to shoot handheld for 1/30 second without camera shake.

This image was shot with the camera handheld. Without image stabilizers, the weight of the camera, the long focal length, and the relatively long exposure time would have caused this image to look like a blurry mess—not an airplane.
120–400mm telephoto zoom 1:4.5–5.6 at 400mm, f/5.6, 1/400 second, ISO 100, daylight

Motion Blur

When you want to photograph a moving subject, you need to pay attention to the relationship between the subject's speed and the shutter speed. Photographing a subject that is moving relatively quickly during the exposure will produce multiple, continuous, and overlapping impressions. Since the background doesn't move, however, it will still be sharp. When viewers examine this type of photo, they will interpret the blur of the subject as movement, even though photography is a still medium.

Determining how long to make the exposure time in order to capture a clearly recognizable subject (without allowing it to turn into a vague splotch) depends on a number of factors. In addition to the speed, the outline, colors, and shape of the subject come into play, as does the direction of the subject's movement and its distance from the camera. To figure this out, you'll need to rely on a bit of experimentation, practice, and experience, but exposure times between 1/60 second and 1/250 second are good starting points. Keep in mind that these types of images work only when the background appears sharp; using a tripod can help when you use a slow shutter speed.

The speed of a moving object in relation to the shutter speed determines whether motion will appear as a blur or be frozen. In this example, you can see that the model's arms and legs were moving faster than her body. Both motion blur and frozen motion are visible.
50mm prime 1:1.4, f/6.5, 1/160 second, ISO 200, daylight

Capturing Motion

Exposing a fast-moving subject with an especially short exposure time produces a photo similar to a single frame from a video. The exposure time needs to be short enough that the subject does not move through the entire image area, so you need to consider the direction of the subject's movement and its distance from the camera. To freeze motion, you generally need either an abundance of light or an increased ISO sensitivity because using the smallest possible aperture opening helps reduce focusing errors that tend to occur in tricky exposure situations. For this reason, photographers usually work with a flash, which emits a burst of light for an extremely short period of time and emphasizes the effect of frozen motion. When an exceptionally quick subject requires a very fast shutter speed, using a flash is the only option to freeze the motion. Using a flash with a long exposure time results in a sharp representation surrounded by a cloud of blurred movement.

Panning

When you want to freeze movement and avoid camera shake, your goal is to hold your camera as still as possible. With panning, the opposite is true; it involves deliberate camera movement during the exposure window. Moving your camera parallel to the motion of the subject produces a mostly sharp main subject in front of a totally blurred background. This technique works only when the subject moves parallel to the sensor plane. One trick to avoid unwanted vertical movement at the start of the exposure window is to start panning before you release the shutter. Then, while you're already tracking the subject, you can capture the frame and get a more even result.

To pan an exposure correctly, the distance between the subject and the camera must be constant throughout the duration of the movement. This wasn't difficult on a carousel because the models and the photographer were spinning in unison and held their positions during the exposure window.
50mm prime 1:1.4, f/22, 1/6 second, ISO 200, daylight
(Small photo: Ute Kynast)

Designing Images with Shutter Speed

Various shutter speeds depict subjects differently, regardless of whether the camera or the subject is moving. The shutter speed, in other words, plays a key role in the creative process of designing an image. Exposing an image so it's completely in focus works well for subjects that have a rich level of detail. Motion blur and panning are the only techniques available in photography to capture movement and convey it to viewers. Freezing a quickly moving object doesn't convey a sense of movement; it documents something that viewers would never be able to perceive with the naked eye.

5.4 Exposure Control Modes

Cameras offer several different exposure modes that can help you control the exposure, or they offer technical assistance for certain shooting situations. Depending on the type of photographer you are, you will probably use some modes more than others, and you might not use some modes at all. However, it makes sense to be familiar with what each mode offers, the advantages and disadvantages of each, and their limits so you can make an informed decision about using them.

Manual Exposure Control

The most complicated option for setting the aperture and shutter speed is selecting both values by hand with an eye toward the current brightness. There are different controls for altering these settings. Depending on your camera, these may be knobs and buttons, or menu options, which are slightly more cumbersome. You can use these controls to set the aperture and shutter speed in whole, half-stop, or third-stop increments, and the current settings will be visible in the viewfinder and on the camera display. The exposure scale (p. 89) shows whether the aperture/shutter speed combination you chose will produce a properly exposed image.

To achieve a correct exposure in manual mode, you need to internalize the effects of adjusting the key exposure settings to work

Difficult lighting situations, such as the scene here, are sometimes beyond the capabilities of automatic exposure modes, which is why you should set the exposure manually in these types of situations.
12–24mm wide-angle zoom 1:4.5–5.6 at 12mm, f/13, 1/1000 second, ISO 100, daylight

continuously and quickly. For this reason, manual exposure mode is the best way to learn the fundamentals. No other mode will permit you to make so many mistakes and to hone your instincts about different settings. When you work manually, you are conscious of all the exposure-related decisions. After you gain some experience, working manually can also be a fast and accurate option. Automatic methods are simpler and faster, which is why manual exposure control lends itself to targeted photography and to circumstances in which the lighting conditions are constant.

These two autumn pictures demonstrate how the shutter speed (above) and aperture (below) can be altered to produce specific stylistic qualities in your images. The goal here was to reveal two different aspects of the same theme: driving and the fall.
Above, 35–210mm zoom 1:2.8–4.8 at 70mm, f/8, 1/5 second, ISO 200, daylight; below, 35–210mm zoom 1:2.8–4.8 at 35mm, f/2.8, 1/250 second, ISO 200, daylight

Shutter Priority

The settings for shutter speed and aperture can be automatically controlled by the camera. Shutter priority is a semiautomatic mode; the photographer manually sets the shutter speed, and the camera selects an appropriate aperture to match the metered brightness value. Shutter-priority mode may also be referred to as time value, and cameras usually indicate it on the mode dial with S or Tv. This mode is most valuable when you have specific creative or technical needs with regard to the shutter speed, but you would prefer to rely on quick, automatic functionality for the aperture.

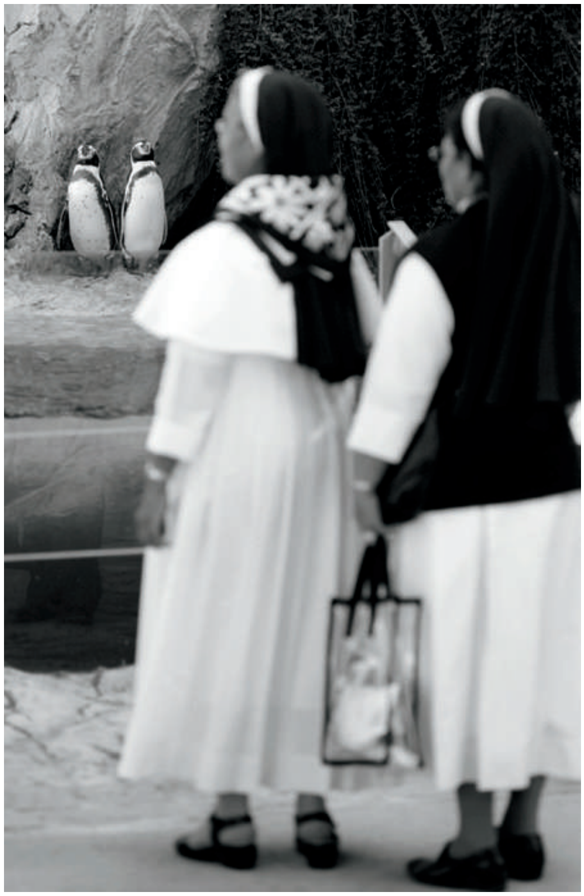
Aperture Priority

The counterpart to shutter priority is another semiautomatic mode, aperture priority. In aperture priority mode, you manually define the aperture, and the camera automatically selects the appropriate shutter speed. This mode is usually shown as A or Av (for aperture value) on the camera's mode dial. Like shutter priority mode, aperture priority mode is well suited for quickly-changing lighting conditions, and situations when the aperture plays a key role in the design and exposure of an image. In such rapidly-changing light situations, proper light metering is the decisive factor in correctly exposing an image. Both semiautomatic modes offer a good combination of targeted control for image design, and the peace of mind that you can shoot comfortably and quickly, and still achieve a good exposure in difficult lighting conditions.

Fully Automatic Modes

Cameras also feature fully automatic modes, often called program automatic, that enable carefree, quick, and simple photography. In these automatic modes, the camera selects both the aperture and the shutter speed. These modes make use of algorithms based on a database of thousands of example images. They select exposure settings by taking into account everything from the measured brightness, to the lens currently in use, to the focus distance. Depending on the manufacturer and the specific mode, some fully automatic modes allow the photographer to have some input, and others prevent the photographer from intervening at all.

There's a specialized subgroup of fully automatic modes. They are often called scene modes, and are designed for specific situations. Scene modes control the exposure parameters to best suit the photographic theme at hand. The specific details of these modes are different from camera to camera, and you can usually discover more about them in your camera manual. The variety of scene modes cater to common photographic subjects, such as portrait, macro, sports, and landscape, but also to specific lighting situations, such as night or flash. These automatic modes are usually indicated on the mode dial with unique pictograms.



In situations when the lighting conditions or the exposure may change at any moment, you need to work quickly and habitually to set up your exposure manually. Semiautomatic and fully automatic exposure modes are designed for these circumstances because they are fast and allow you to pay attention to your quickly changing subject.
85mm prime 1:1.4, f/5.6, 1/1000 second, ISO 100, daylight

In terms of the technical aspects of creating an image, fully automatic modes guarantee an uncomplicated photographic process when it comes to party pictures, snapshots, or memento photos, or any time when the goal is to capture a situation rather than actively design an image. Professional photographers reach for these automatic modes in some circumstances, especially when timing is critical, as it often is in sport photography and photojournalism. However, if you want to design your work consciously, you should avoid using automatic modes because it eliminates the learning curve by giving critical design control to your camera.

Shift

Some fully automatic programs include an additional function that allows you to have some input regarding the aperture and shutter speed. This function, usually called shift or program shift, allows you to use a rocker switch or a dial to cycle the aperture/shutter speed combinations that have the same exposure value (p. 88).

Subjects with high contrast, such as this poppy, require you to work with spot metering to get a useful exposure reading. If you recompose your image without storing the value or your exposure settings, they will update and you'll end up with a poorly exposed image.
105mm macro 1:2.8, f/8, 1/320 second, ISO 400, artificial light

Exposure Lock

Any time you recompose your shot, the area that the camera uses to meter the exposure also changes (along with the exposure value). This isn't a problem when you use manual exposure mode (p. 107) because you set the aperture and shutter speed by hand. As soon as you start working with a semiautomatic or fully automatic mode, however, the camera will automatically balance the current metered value and the current exposure settings. If you first use the center AF field to focus, then adjust your camera's perspective to your desired image area, it may lead to an exposure problem. Cameras offer an exposure lock button for these circumstances; it allows you to store the current light metering value and the current aperture/shutter speed combination. The combination is locked until you release the button or until you expose a frame. Many cameras allow the lock to stay active for several exposures. In some cases the exposure lock is linked with the focus lock or the shutter button being pressed halfway down.

Bracketing

Bracketing means that your camera exposes three or five images of the same subject in short succession, rather than only a single image. Each image in the series features a different exposure. The goal of this function is to make sure you get at least one useable image. You can decide if the bracketed images are exposed in whole-stop, half-stop, or third-stop increments. These values alter the exposure with respect to the actual metered value. Since the exposures happen one after another, bracketing is designed for stationary subjects instead of portrait, sport, or animal photography.

Some lighting conditions are particularly difficult to meter and expose correctly, especially when you're photographing a high-contrast subject. To play it safe, take a series of images at different exposure levels. The bracketing function on your camera can execute this process automatically.
35–210mm zoom 1:2.8–4.8 at 35mm, f/16 (left), f/11 (middle), f/8 (right), 1/250 second, ISO 100, daylight

Exposure Compensation

Exposure compensation allows you to manually influence the exposure of an image in automatic exposure modes. This feature usually has its own dial or button, with a plus and minus symbol, so you can deliberately overexpose or underexpose an image. You decide how much exposure shift to use, which generally can be up to two stops in half and third stops. Exposure compensation works in all partial and fully automatic modes, and it gives you an additional way to control your images. It is particularly useful when the metering process results in an imprecise value or when the automatic exposure control system produces an imperfect result.

Intentional Overexposure and Underexposure

Sometimes it is practical to deliberately overexpose or underexpose your images. These situations arise when the exposure metering is based on a subject that is nowhere near the reflectance of neutral gray (p. 78). Bright subjects reflect a great deal more light than neutral gray; they confuse the exposure meter and produce an exposure that's too dark. You can counteract this error by deliberately overexposing your image. If you're trying to photograph a polar bear on an ice floe during your trip to the Arctic, for example, you'll want to overexpose your image by 1 to 1 1/2 stops. The same goes for other white subjects or high-key photos.

Dark subjects have the inverse problem, so you will need to compensate by underexposing them. A black cat on a dark brown comforter will result in an exposure that's too bright, so you'll want to reduce the exposure by a good 1 1/3 stops. This process will become second nature for you after a bit of practice with manual exposure mode.

Subjects that are predominantly bright or dark pose a problem for automatic exposure modes because the exposure metering system is calibrated to the reflectance of neutral gray. Light or dark subjects naturally reflect light differently, so you need to set the exposure manually. Images that are almost entirely bright or dark are called high-key and low-key images, respectively.
Above, 70mm macro 1:2.8, f/5.6, 1/125 second, ISO 100, flash; below, 85mm prime 1:1.8, f/4, 1/160 second, ISO 200, daylight