

Understanding Exposure

By Len Grinke

In this article I am going to explore the basics of exposure and the exposure controls in the camera. There are three components of that control exposure. These are aperture, shutter speed, and ISO. Exposure is controlled by adjusting and controlling these elements.

The **Aperture** is an adjustable hole in the lens that controls the amount of light that passes through the lens. The bigger the hole, the more light is allowed to pass through the lens. The smaller the hole, the less light is allowed to pass through the lens.

The **Shutter** is in the body of the camera and controls how long the light is reaching sensor or film. The longer the **shutter speed**, the longer the exposure. The shorter the shutter speed, the shorter the exposure.

ISO is the sensitivity that the sensor or film has to light. The higher the ISO, the more sensitive the sensor is to light so the less light it needs to record an image. The lower the ISO, the less sensitive the sensor is to light so the more light it needs to capture the image.

When a camera is set on automatic, the aperture, shutter speed, and ISO are calculated and set for you. The problem is, automatic settings give little creative control. So, if your vision of how the image should look is different from the program in the camera, your results will be disappointing. By having a solid understanding of exposure, and how aperture, shutter speed, and ISO relate to each other, you will be in a much better position to express your own artistic view of your subject.

Aperture, shutter speed, and ISO are connected. But how does one affect the other? To help build a visual representation of how they are connected, let's take a look at the following example.

Imagine water coming through a hose. The bigger the hose, the more water can come through the hose. Changing the size of the hose changes the volume of water flowing through it, much like how changing the size of the aperture in a lens changes the amount of light allowed to through the lens.

The tap controls the flow of water through the hose. When you turn the tap on the water flows, when you turn the tap off, the water stops. How long the tap is open for will determine how long water flows through the hose in the same way that the shutter speed controls how long the light is allowed to flow through the camera.

The bucket catches the water when it comes out of the hose. The bucket acts like the sensor in that the bigger the bucket you have, the more water it takes to fill it, just like a low ISO requires more light to expose it. A smaller bucket requires less water to fill it so it acts like a higher ISO which takes less light to fill it.

In order to fill that bucket to just right level, the perfect amount of water has to flow through the hose. Not enough water and the bucket would not be full; too much water and the bucket would be overflowing. When the bucket is filled to the right level, then we have a good exposure.

Now fill the bucket again but this time use a bigger hose. What would happen this time if you left the bucket the same size and kept the tap open the same length of time? Because we used a bigger hose, more water was able to flow through it in the same amount of time so the bucket would overflow. To fill the bucket to the correct level, you would need to shorten the length of time that the tap is open or you could use a larger bucket that would hold all the water that come through the hose. In terms of the camera, to compensate for the larger aperture (bigger hose), you would need to either shorten the shutter speed (close the tap sooner) or reduce the ISO sensitivity (use a larger bucket).

Think of the water passing through the hose as the light coming through the lens of the camera. The aperture controls the volume of light flowing through the lens, the same way that changing the size of the hose changes the volume of water flowing through the hose. The shutter is the tap on the end of the hose. When the tap is open, water flows and fills the bucket; when the shutter is open; light flows and fills the sensor or film. When they are closed, the flow stops. The bucket represents the ISO in that the bigger the bucket, the less sensitive it is to the amount of water flowing into it. With the ISO, choosing a low sensitivity (large bucket) means that the sensor takes more light to fill it up and choosing a high sensitivity (small bucket) means that it takes less light to fill it up.

Let's say that you take a picture and the exposure just right (the bucket is filled to the perfect level). For creative reasons, you enlarge or *open up* the aperture. This affects the exposure by letting more light in. If you change the aperture and nothing else, you will overexpose the picture. Using the water example, the bucket will overflow. Therefore, to get a correct exposure, you need to either shorten the shutter speed (shorten the length of time the tap is open) or decrease the light sensitivity (use a larger bucket).

Now see what happens when you alter the shutter speed (length of time the tap is open). Start with your good exposure but for creative reasons you want to increase your shutter speed. Increasing the shutter speed means making it open and close faster and thus reduces the amount of time that the shutter is open, reducing the amount of light reaching the sensor. What can you do to compensate for this? To compensate, you will need to either increase the

amount of light hitting the sensor or film by opening up the aperture or increase the light sensitivity.

Now pull out your camera and let's take a look at how to make this work.

First, let's take a look at the ISO. Think about ISO as a measurement of light sensitivity. The more sensitive the ISO setting, the less light you need to make and exposure. The ISO scale is 50, 100, 200, 400, 1600, 3200. Many cameras will move up the scale in $\frac{1}{2}$ or $\frac{1}{3}$ steps, but for the sake of simplicity, let's just stick to the basic scale. The higher up the scale, the more light sensitive the sensor is, the lower down the scale, the less light sensitive the camera is. So, at ISO 1600, you will need less light to create an exposure than at ISO 200.

Did you notice how each number in the scale is double that of the number before it? Every time you go up one number in the ISO scale, you double the light sensitivity. Vice-versa, every time you go down one step in the ISO scale you halve the light sensitivity. This is a very important concept in photographic exposure and you will see this pattern repeated.

The shutter speed is the how long the shutter is open during the exposure. The longer the shutter is open, the more light is allowed to pass through, the shorter the shutter is open, the less light is allowed to pass through. Standard shutter speeds 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000, 1/2000, 1/4000. Shutter speeds are fractions of a second and in many cameras can be adjusted in half or third steps, but again, for simplicity we will just stick to the basic steps. The faster the shutter speed, the less light is allowed to hit the film or sensor, and the slower the shutter speed, the more light is allowed to hit the film or sensor.

Did you notice how the shutter speed, as you go up the scale the speed doubles and as you go down the speed halves. In essence, every step you go up the scale, you halve the amount of light going into the camera. As you go down the scale, you double the amount of light going into the camera.

The aperture is an adjustable hole in the lens that controls the amount of light passing through the lens. The bigger the hole, the more light is allowed to pass through, the smaller the hole, the less light is allowed to pass through. The aperture is represented on your camera as an f-number or f-stop (two different names for the same thing).

F-stops are a ratio of the size of the aperture to the focal length of the lens. The scale goes f-1.4, f-2, f-2.8, f-4, f-8, f-16, f-32, f-64. This scale is a little counter-intuitive. As the F-number gets bigger, the aperture gets smaller. In other words, f-2 will let in more light than f-2.8; f-2.8 will let in more light than f-4 and so on. Every incremental step in the f-stop range halves the amount of light going through the lens when going from f-1.4 to f-64. Moving in the other direction,

from f-64 to f-2.8, each incremental step doubles the amount of light going through the lens.

When the ISO, Aperture, and shutter speed are correctly set, a good exposure will be obtained. What is interesting is that for almost any circumstances, there are many different settings that will create the same exposure. Yet, these different settings can have a huge impact on the look of the image.

The term Stop is used in photography to define the doubling or halving the exposure. ISO, shutter speed, and aperture have been set up so that changing the settings one increases or decreases the exposure by one stop. So, to reduce your exposure by one stop, you need half the amount of light. In order to increase your exposure by one stop, you need to double the amount of light. Refer back to the ISO, Shutter Speed, and Aperture scales. When you went up or down each scale, the amount of light passing through the camera or the ISO sensitivity was either doubled or halved. By changing one of them, you change the exposure by a Stop.

Now let's work through some examples. First let's pick the bucket size. It's a little overcast out so we choose a bucket size of ISO 200. From the light meter in the camera, we determine that the shutter speed we need is 1/30 and the aperture is f-8. We take the picture and the exposure turns out to be correct. However, for artistic reasons, we want to use a larger aperture, say f-5.6. By increasing the aperture from f-8 to f-5.6, we have opened up or increased the exposure by one stop. To compensate for the one stop overexposure we will need to change either the shutter speed or ISO.

Increasing the shutter speed will reduce the time the light is allowed to enter the camera. By changing it from 1/30 of a second to 1/60th of a second, we have halved the amount of light entering the camera. In other words, we have reduced the exposure by one stop. The exposure is once again balanced.

So, an exposure of 1/30th @ f-8 is the same as an exposure at 1/60th @ f-5.6. When changing an element in the exposure, to maintain the same exposure, you must change one other element in the opposite direction and by the same amount.

Here are some examples, note which ones change and by how much.

1/250th @ f-8 ISO 100 is the same as 1/500th @ f-5.6 ISO 100

Increase shutter speed by one stop, opened up lens to compensate

1/250th @ f-8 ISO 100 is the same as 1/125th @ f-16 ISO 100

Reduced shutter speed by one stop, closed down lens to compensate

1/250th @ f-8 ISO 100 is the same as 1/250th @ f-16 ISO 200

Closed down lens by one stop, increased sensitivity to compensate

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