Unit 9
79 Lynch Lane
Weymouth, UK
DT4 9DW

Phone: +44 (0) 1305 831752
Mobile: +44 (0) 777 333 2504
Email: info@chrisweston.uk.com
Website: www.chrisweston.uk.com

Managing light

The fundamental role of a camera body is to provide a mechanism for holding a light-sensitive device (or material) and to control the amount of light passed through the lens for a specified period of time. That's it. Everything else is just an add-on (the lens is responsible for focus). So, when taking control of the camera the most important step is learning how to quantify light and the relationships between light and the mechanisms that control how it's recorded – the shutter and lens aperture.

In photography, light is measured using a unit-based system, each unit being referred to as an exposure value (EV) – sometimes referred to as a stop. Adding stops of light will increase the amount of light received by the sensor (or film), and subtracting stops will reduce it. The two mechanisms for adding and subtracting stops of light are the shutter and the lens aperture.

The shutter

The shutter controls the duration of the exposure, that is, the length of time the sensor is exposed to light. Timing is measured in seconds and fractions of seconds, denoted by shutter speed values, which, in a typical camera, range from between 30 seconds to 1/4,000 second (additional settings, such as bulb and up to 1/8,000 second may be possible). Each doubling or halving of shutter speed equates to a 1-stop change in exposure. For example, by reducing shutter speed from 1/250- to 1/125-second, exposure duration is doubled. Conversely, increasing shutter speed from 1/250 to 1/500 second reduces exposure duration by half.

Most cameras these days enable shutter speed to be changed in increments of 1/3- or 1/2-stop. Where this is the case, then the effect on exposure duration is not a doubling or halving but relative to the incremental change. For example, reducing shutter speed from 1/60- to 1/45-second increases exposure duration by a factor of 1.5 times.

Lens aperture

Lens aperture controls the quantity of light passing through to the sensor by increasing or decreasing the size of the hole created by the diaphragm in the lens. Like shutter speed, a doubling or halving of the area of the hole equates to a 1-stop change in exposure. And again, like shutter speed, modern cameras and lenses enable aperture adjustments to be made in 1/3- or 1/2-stop increments.

The numbers used to denote aperture size appear at first glance to be meaningless. They aren't. The numbering system, referred to as f/numbers, is a ratio relating the focal length of the lens to the diameter of the diaphragm opening. For example, the f-number 2 (f/2) equates to a ratio of 2:1, that is, the focal length of the lens is double the diameter of the diaphragm aperture (or, in other words, the diaphragm aperture is half the focal length of the lens).

Unit 9
79 Lynch Lane
Weymouth, UK
DT4 9DW

Phone: +44 (0) 1305 831752
Mobile: +44 (0) 777 333 2504
Email: info@chrisweston.uk.com
Website: www.chrisweston.uk.com

Lens aperture is adjustable, ranging from around f/2 to f/32. The larger the aperture (i.e. the smaller the f/number), the greater the amount of light passes through the lens.

The f/number scale relates to the area of the aperture. For example, a 50-mm lens set at f/2.8 has an area of 250 mm^2, while at f/4 the area is 123 mm^2, essentially half the area. At f/2 the area is 491 mm^2, or in other words, double that of f/2.8. In these terms, the f/number system becomes more apparent: a 1-stop change in f/number equates to a doubling or halving of the area of the aperture and, by association, the quantity of light reaching the sensor.

Where do the f/numbers come from?

The area of a circle is calculated using the formula πr^2. Doubling or halving the area requires multiplication or division by the square root of 2, which is approximately 1.4. For example, $2 \times 1.4 = 2.8$ (f/2.8), $2.8 \times 1.4 = 4$ (f/4), $4 \times 1.4 = 5.6$ (f/5.6), and so on.

Lens aperture and image quality

Lens performance is diminished when very small or large apertures are set. So, for example, while it may seem an ideal solution to set an aperture of, say, f/22 or f/32 to increase depth of field, a better solution for increased depth of field would be to use a larger aperture (e.g., f/11) along with the hyperfocal distance–focusing technique. Lens performance is at its maximum when mid-range apertures, such as f/8 through f/16, are used.

Reciprocity law

Knowing that a 1-stop change in either shutter speed or lens aperture equates to a doubling or halving of the exposure value, makes understanding the reciprocity law a matter of common sense. Simply, reciprocity means that if you double the quantity of light reaching the sensor (by increasing lens aperture) then you must halve the duration of the exposure (increase shutter speed) to maintain the same exposure value, and vice versa.

The same rule applies when making fractional increments. For example, if you make the lens aperture smaller by a 1/2-stop (reducing the quantity of light), then you must make shutter speed longer by the same 1/2-stop value (increasing duration) in order to preserve the exposure value.