Intro to Digital Photography: Exposure Triangle Notes

This presentation and the next, on Exposure, are the heart of the course. If you come out of the class understanding what aperture, ISO, shutter speed, and white balance are, how they interact, and how to control them in manual mode on your camera (if it has that capability), then you have learned the meat of the technical side of photography.

*** Slide 3 The exposure triangle has three sides: Aperture, ISO, and Shutter Speed. Each one of the three can have an affect on the other two elements of the triangle, and most certainly on your photograph.

*** Slide 4 ISO. ISO stands for International Organization of Standards, and as you might expect, there is an ISO for film, which is the basis for what is called ISO on your digital camera. The ISO for film was adopted in the 1980s by Kodak and the other large international film manufacturers such as Agfa (primarily Europe) and Fuji (Asia). Before this time there were two standards in use, one in the United States called the American Standard Association (ASA); and one in Europe called Deutsche Industrie Norm (DIN). Both of these organizations specified the standardization of film speed, thus you would see a roll of film labeled ASA 100 / DIN 21. The ISO picked the ASA standard for film speed, so we have ISOs of 100, 200, 400, etc.

*** Slide 5 In the days of film (and yes, there are many people who still shoot film), different types of film had different speeds. Speed was simply an indication of the sensitivity of the film to light; the higher the ISO value, the more sensitive the film was to light. This results in less exposure time needed, but as a drawback the film itself was grainy due to the size of the grains needed to achieve this sensitivity. Standard film speeds are 100, 200, 400, 800. Slide (color transparency) film has an ISO of 64, so it is very fine grained and allows for enlargements. Black and white film can go upwards of ISO 1600 and 3200, which gives the photos its characteristic grain.

With film you can't really change ISO easily, given that each roll of film has a pre-determined ISO value, and most rolls come in 24 or 36 exposure increments. If you were shooting outside using ISO 100 speed film, then came inside to shoot, you'd either have to make adjustments in your shutter speed and/or aperture, perhaps adding light if needed, or remove that roll of film--even if you only took 1 picture--and swap it out with an ISO 400 or 800 for indoor shooting. One could pull (under-expose) or push (over-expose) a roll of film; for example, if I were to pull an ISO 100 film, I would change the ISO setting on my camera from 100 to 200 or even 400; if I were to pull an ISO 100 film, I would change the ISO setting on my camera from 100 to 64 or 50. If I was in dim light, I would want to push the film, or over-expose it from its base ISO; if I was in bright light, I would want to pull the film, or under-expose it from its base ISO. When you sent the film off to be developed, you would note on the film roll if it had been

pushed or pulled so that when it was developed it could be done so correctly.

*** Slide 6 With the digital camera, you no longer have to worry about changing out rolls of film to change the ISO value; you simply do so, making the sensor more or less sensitive to light. Most digital cameras have a native ISO value that they will default to, for example the Nikon D200 has ISO 100 as is default, while the Nikon D300 has ISO 200.

Comparable to film grain, the higher you set your ISO on your camera, the more likely you'll see sensor noise. Sensor noise shows up on images as colored pixels that are out of place, such as a red pixel in a field of blues. Sensor noise is random in nature, so that two images taken one after another with the same exact settings will show random noise. Most digital cameras do pretty good at controlling sensor noise at ISOs of 800 and lower, and the newer generation do an OK job with ISOs over 1600--many now go to ISOs of 12800 and 25600. You can also use applications such as Adobe's Photoshop or Lightroom or Apple's Aperture to remove digital noise. One trick is that if the digital noise is in one color channel, say blue, by converting the image to black and white you can get rid of this color noise.

Digital noise, being random, is different than a hot pixel--a hot pixel will always be on the same spot on every image. One of the best ways to check you camera for hot pixels and digital noise is, if possible, take a series of images with the lens cap on; if your camera doesn't have a lens cap, like the majority of point-and-shoots, go take a set of images in the darkest room you can. Change the ISO between each image so you can see at what level digital noise is unacceptable for you--you will know then to not go beyond this ISO. Note that this is level of acceptability is going to be different for each person; I may find a higher level more acceptable simply because I know that I can remove most or all of it in post-processing. If you do find a hot pixel on your sensor, and you've just purchased your camera, return it for a new one or send it off to get fixed while under warranty; if the pixel is somewhere where you can live with it, like in a corner that you know will be cropped in post-processing, you may decide to live with it.

Finally, a rule of thumb is that the lower the ISO value, the sharper the image will be. Going below the native ISO value of a camera isn't very productive and you don't gain much. If your camera's native ISO is 200, leave it there unless you have to take it higher (or lower).

*** Slide 7 ISO and exposure. When you change ISO by a full stop (i.e., 100 to 200, 200 to 400), you are either halving (with increasing ISO value) or doubling (with decreasing ISO value) the amount of light needed to get an on exposure image. When you go from ISO 100 to 200, you are cutting the amount of light you need by half, and when going from ISO 200 to 100 you are increasing the amount of light you need by a factor of 2. So higher number = less light, lower number = more light.

When in AUTO mode the camera will meter the scene and determine what ISO, aperture, shutter speed, and white balance to use. In PROGRAM mode, you have the ability to change the white balance (more on this in a later class) and the ISO; if you change the ISO in PROGRAM mode, then the camera will change the aperture and shutter speed to adjust to make an on exposure image. The same also holds true for APERTURE mode and SHUTTER [TIME VALUE for Canon] modes--changing the ISO will alter either the shutter speed in APERTURE mode or the aperture in SHUTTER/TIME VALUE mode. In MANUAL mode changing ISO will NOT automatically change aperture or shutter speed.

*** Slide 8 Shutter speed. This is the duration of how long the shutter remains open, exposing the sensor to light. The majority of commercial digital cameras have shutter speed increments ranging from 30 seconds to 1/8000 second in full stop increments. There is also a special setting known as bulb that keeps the shutter open for as long as it is depressed; this bulb setting goes back to the early days of photography when the shutter release was a bulb of air that you squeezed to open the shutter and then count off the number of seconds needed for the exposure, and letting the bulb fill with air caused the shutter to close. Today, this bulb setting is used for long duration photography such as capturing star trails or light painting. There are a variety of shutter released available for cameras, the most common being a cable that connects to the camera or a wireless trigger; some cameras with built-in WiFi (or an attached WiFi module) can be triggered via a smart phone app, and computer applications such as Lightroom have the ability to trigger the shutter on a camera via tethered shooting (the camera is connected to the computer via a USB cable).

*** Slide 9 Common shutter speeds. This is a list of the shutter speeds, in full stop increments, that most digital cameras have available. From 30 seconds down to 1/60 second you will have to do something to stabilize the camera for the exposure, by either bracing it (or you) against a wall or on the ground, or by mounting the camera onto a tripod. From 1/125 to 1/8000 second the exposure is fast enough that camera shake is minimized. Camera shake comes from a wide variety of sources, including your motion back and forth or side to side, the movement of the body from breathing, and from the inadvertent downward motion of the camera as the shutter is depressed (this happens to a lot of people). Slow shutter speeds are also prone to environmental factors such as wind.

*** Slide 10 As with ISO, changing the shutter speed changes the amount of light hitting the sensor. If you go slower with the shutter, from 1/125 to 1/60 of a second, you are doubling the amount of light you're allowing to hit the sensor; if you go faster with the shutter, from 1/125 to 1/250, you are cutting the amount of light hitting the sensor by half.

*** Slide 11 Aperture. Aperture and f/stop are inexorably linked, used interchangeably (example: my f-stop is f4, my aperture is at f4). Aperture is the diameter of the aperture stop of a lens, which is controlled by the diaphragm. Because lenses have different focal lengths, apertures are lens dependent values. The diameter of an f4 aperture on a 50mm lens is going to be different than the diameter of an f4 aperture on a 100 mm lens--but both will provide the same amount of light to pass through an hit the sensor; the exception, which will be discussed later, are macro lenses.

*** Slide 12 For each full stop (f/stop) of aperture the diameter of the opening is either doubled or cut in half, resulting in either twice the amount of light (doubling) or half the amount of light (halving) passing through the opening. In theory there are an infinite number of fractional f/stops in that you can move, again in theory, the diaphragm by minute amounts. In practice, however, the only fractional f/stops that you are likely to see and use are ½ f/stops and ⅓ f/stops.

*** Slide 13 Here is a visual example of how the diameter of the aperture controls light. As you go smaller, less light is allowed through the opening. For each full stop there is a doubling / halving of light. So in this example, from left to right, if you drop down two full stops you only allow ¼ of the light in at the far right hand side. Going from right to left, moving 2 full stops, you quadruple the amount of light coming in.

*** Slide 14 Aperture is expressed in full stop (f/stop) increments starting from 1. A list of common f/stop values found on some lenses are as follows: 1, 1.4, 2, 2.8, 3.5, 4, 5.6, 8, 11, 16, 22, 32, and 64. Most lenses go from 3.5 (a fractional f/stop) to 22. Typically the faster the lens the larger the maximum f/stop number; a 50mm f1.4 is a considered to be a pretty fast lens and is very useful in low light situations. Many zoom lenses have an f/stop range such as 3.5 - 5.6; this means that at the lowest zoom value the maximum aperture available is f3.5 (a fractional f/stop) and that at the highest zoom value the maximum aperture is f5.6--this would not be considered a fast lens. A zoom lens that has listed something along the lines of "28-200 f2.8" means that across the entire range of focal lengths (28mm to 200mm) the maximum aperture is f2.8; because of the optics that are involved in making a lens like this, they tend to be expensive ($1000+).

It may help you to think of the aperture values as fractions, since the larger the number the smaller the opening of the diameter. You may hear two terms in photography: stopping down or opening up. Stopping down is making the aperture smaller while opening up is making the aperture larger. Aperture diameter also has an affect on depth of field (DoF) which will be addressed later.

*** Slide 15 There is an intrinsic relationship between shutter speed and f/stops; the faster the shutter speed the smaller the f/stop number, the slower the shutter speed the

larger the f/stop number. If, for example, you want to take a photo at 1/500th of a second shutter speed, you'd better have a fast lens for you'll need an aperture around f2.8; however, you can adjust the sensitive of the sensor to make it more responsive to light so that you can have an equivalence:

1/500 @ f/2.8 @ 100 ISO = 1/500 @ f4 @ 200 ISO

So if I have a lens where the maximum aperture is f3.5, I can shoot at 1/500 @ f/4 with an ISO of 200 and get an image that would be the same as one shot at 1/500 @ f/2.8 with an ISO of 100; by doubling the sensitivity of the sensor (100 to 200) I only need half of the light (f/2.8 to f/4) and this aperture falls into the range of what is available on my lens. If you keep your camera in full AUTO mode it will take care of all these for you by setting up the aperture, shutter speed, and ISO to get an on exposure image. Going outside of AUTO mode, though, allows you to control the camera and not the other way around; you might decide that a slightly under/over exposed photograph is more artistic or conveys the message that you want to send to the viewer than an image that is "on exposure." There is absolutely nothing wrong with using your camera in AUTO mode, it does allow you to work more on composition without having to worry about f/stop or shutter speed or ISO value. But if you have the time, stop, take a deep breath, and move the dial to Aperture Priority, Shutter Priority (Time Value for you Canon shooters), or Manual. Play with the settings, for that is the best way to learn.