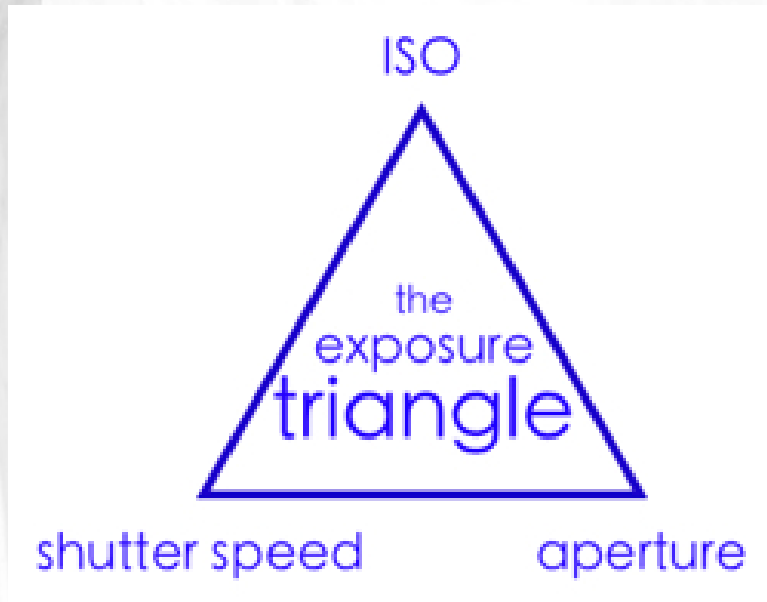


The Exposure Triangle

With Acknowledgement to an article at the Digital Photography School
<http://digital-photography-school.com>

- **ISO** (International Standards Organisation)
 - The measure of the sensitivity of the Film or Digital Sensor
- **Shutter Speed**
 - How long you expose your film or sensor to the light from the lens.
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The Exposure Triangle

- Understanding the digital photography exposure triangle:
 - Many people describe the relationship between ISO, Aperture and Shutter Speed using different metaphors to help us get our heads around it. Here are two..
 - **The Window** Imagine your camera is like a window with shutters that open and close.
 - **Aperture** is the size of the window. If it's bigger more light gets through and the room is brighter.
 - **Shutter Speed** is the amount of time that the shutters of the window are open. The longer you leave them open the more that comes in.
 - Now imagine that you're inside the room and are wearing sunglasses (hopefully this isn't too much of a stretch). Your eyes become desensitized to the light that comes in (it's like a low ISO).
 - There are a number of ways of increasing the amount of light in the room (or at least how much it seems that there is. You could increase the time that the shutters are open (decrease shutter speed), you could increase the size of the window (increase aperture) or you could take off your sunglasses (make the ISO larger). It's not the perfect illustration – but you get the idea?

The Exposure Triangle

Another Metaphor.....Sunbaking

You could think about digital camera exposure as being like getting a sun tan.

- In a sense, your skin type is like an **ISO** rating. Some people are more sensitive to the sun than others.
- **Shutter speed** here is like the length of time you spend out in the sun. The longer you spend in the sun the increased chances of you getting a tan (of course spending too long in the sun can mean being over exposed).
- **Aperture** is like sunscreen which you apply to your skin. Sunscreen blocks the sun at different rates depending upon its strength. Apply a high strength sunscreen and you decrease the amount of sunlight that gets through – and as a result even a person with highly sensitive skin can spend more time in the sun (ie decrease the Aperture and you can slow down shutter speed and/or decrease ISO).
- You may also hear the metaphor concerning hose pipes and water (the wider the hose, the less time it takes to drench something/somebody). There are others.

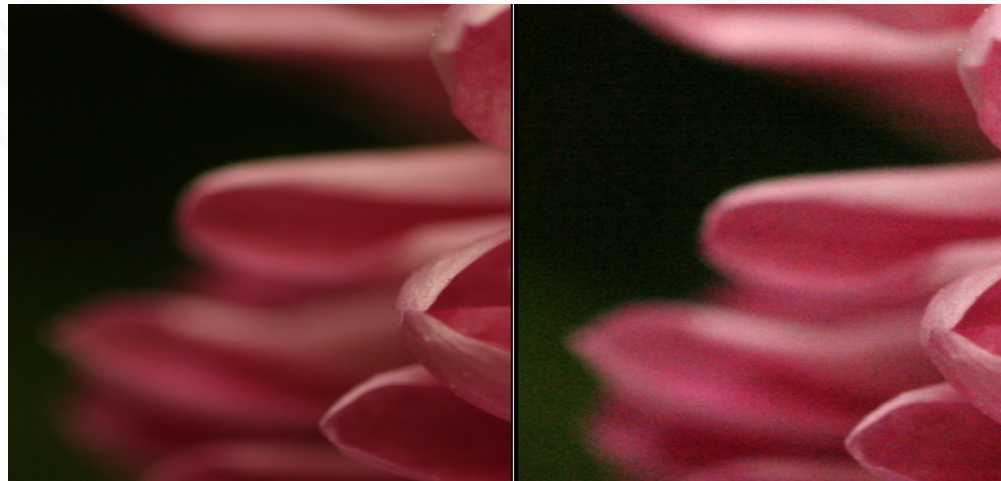
The Exposure Triangle

Bringing It All Together

- While an automatic-metering camera can give you 'perfect' exposures every time, **mastering** the art of exposure is something that takes a lot of practice. In many ways it's a juggling act and even the most experienced photographers experiment and tweak their settings as they go. Keep in mind that changing each element not only impacts the exposure of the image but each one also has an impact upon other aspects of it - Each element of the triangle has 'side effects' that we can use to our advantage.
- Digital cameras are the ideal testing bed for learning about exposure. You can take as many shots as you like at no cost and they not only allow you to shoot in Auto mode and Manual mode – but also generally have semi-automatic modes like aperture priority and shutter priority modes which allow you to make decisions about one or two elements of the triangle and let the camera handle the other elements. Unlike rolls of film, you can change the sensitivity (ISO) of the sensor for each shot (with film you need to 'rate' and develop the whole roll of film to get a particular ISO).
- A lot more can be said about each of the three elements in the exposure triangle.....

ISO

- In traditional (film) photography ISO (or ASA, or DIN) was the indication of how sensitive a film was to light. It's measured in numbers - the lower the number, the lower the sensitivity of the film and the finer the grain in the shots you're taking.
- In Digital Photography, ISO measures the sensitivity of the image sensor. The same principles apply as in film photography – the lower the number the less sensitive your camera is to light - and the less 'digital noise'. Higher ISO settings are generally used in darker situations to get faster shutter speeds (for example an indoor sports event when you want to freeze the action in lower light) – however the cost is noisier shots. Noise is most visible in larger 'blank' areas of an image. See the two enlargements below – the one on the left was taken at 100 ISO and the one of the right at 3200 ISO.



ISO

- 100 ISO is generally accepted as 'normal' and will give you higher quality images (little noise/grain). However, any half-decent digital camera can work just as well at ISO200 and it will give a little more flexibility and a consistently higher shutter speed (which, as we'll see, is a GOOD thing.... usually).
- Some people keep their digital cameras in 'Auto Mode' where the camera selects the appropriate ISO setting depending upon the conditions you're shooting in (it will try to keep it as low as possible) but most cameras also give you the opportunity to select your own ISO.
- When you override your camera's Auto settings and choose a specific ISO you'll notice that it impacts the aperture and shutter speed needed for a well exposed shot. For example – if you bumped your ISO up from 100 to 400 you'll notice that you can shoot at higher shutter speeds and/or smaller apertures. How much higher and how much smaller will be discussed later.

ISO

When choosing the ISO setting we should ask ourselves the following four questions:

- ◆ 1. Light – Is the subject well lit?
- ◆ 2. Grain – Do I want a noise-free shot or can I accept some noise?
- ◆ 3. Tripod – Should I/Must I use a tripod?
- ◆ 4. Moving Subject – Is my subject moving or stationary?

If there is plenty of light, I want little grain, I'm using a tripod and my subject is stationary I will generally use a pretty low ISO rating.

However if it's dark, I can accept some noise, I don't have a tripod and/or my subject is moving I might consider increasing the ISO as it will enable me to shoot with a faster shutter speed and still expose the shot well.

The big trade-off of this increase in ISO will be noisier shots.

ISO

Situations where you might need to push ISO to higher settings include:

- * Indoor Sports Events – where your subject is moving fast yet you may have limited light available.
- * Concerts – also low in light and often ‘no-flash’ zones
- * Art Galleries, Churches etc- many galleries have rules against using a flash and of course being indoors are not well lit. (A tripod might help but they often have rules against them too!)
- * Birthday Parties – blowing out the candles in a dark room can give you a nice moody shot which would be ruined by a bright flash. Increasing the ISO can help capture the scene.

ISO is an important aspect of digital photography to have an understanding of if you want to gain more control of your digital camera. Experiment with different settings and how they impact your images today.

(The biggest contributing factor to digital noise is a high density of photo-receptors (pixels) on a sensor. Very expensive cameras have lower density – and have very little noise even at extremely high ISO – while cheaper cameras often cram too many receptors onto the sensor and they interfere with each other, electronically).

Shutter Speed

What is Shutter Speed?

'the amount of time that the shutter is open'.

- The length of time that the film or sensor is exposed to the scene you're photographing.
- The shutter itself is a small plastic or cloth sheet that opens and closes to allow light onto the sensor/film. When you press the shutter release button on your camera to take a picture, if using Auto Focus, the focusing will and then the shutter opens for a time determined by the user.
- In cameras with TTL (through the lens) viewfinders, the shutter release button also moves a mirror upwards and out of the way of the film and shutter curtain. It is this movement of the shutter curtain and the mirror that gives taking a picture its distinctive "click" sound, but note that it can also cause vibration. For this reason, some shooting modes on better cameras will lock the mirror up and pause before opening the shutter.
- Let's break down the topic into some bite sized pieces that should help digital camera owners trying to get their head around shutter speed.....

Shutter Speed

- Shutter speed is measured in seconds – in most cases, fractions of seconds (e.g. 1/1000th is much faster (shorter amount of time) than 1/30th).
- In most cases you'll probably be using shutter speeds of 1/60th of a second or faster. This is because anything slower than this is very difficult to use without getting camera shake. Camera shake is when your camera is moving while the shutter is open and results in blur in your photos.
- If you're using a slow shutter speed (anything slower than 1/60) you will need to either use a tripod or some some type of image stabilization (more and more cameras are coming with this built in).
- Shutter speeds available to you on your camera will usually double (approximately) with each setting. As a result you'll usually have the options for the following shutter speeds – 1/500, 1/250, 1/125, 1/60, 1/30, 1/15, 1/8 etc. This 'doubling' is handy to keep in mind as aperture settings also double the amount of light that is let in – as a result increasing shutter speed by one stop and decreasing aperture by one stop should give you similar exposure levels.

Shutter Speed

- Some cameras also give you the option for very slow shutter speeds that are not fractions of seconds but are measured in seconds. These are used in very low light situations, when you're going after special effects and/or when you're trying to capture a lot of movement in a shot). Some cameras also give you the option to shoot in 'B' (or 'Bulb') mode. Bulb mode lets you keep the shutter open for as long as you hold the button down. When considering what shutter speed to use in an image you should always ask yourself whether anything in your scene is moving and how you'd like to capture that movement. If there is movement in your scene you have the choice of either freezing the movement (so it looks still) or letting the moving object intentionally blur (giving it a sense of movement).
- To freeze movement in an image (like in the surfing shot above) you'll want to choose a faster shutter speed and to let the movement blur you'll want to choose a slower shutter speed. The actual speeds you should choose will vary depending upon the speed of the subject in your shot and how much you want it to be blurred.

Shutter Speed

- **Motion is not always bad** – there are times when motion is good. For example when you're taking a photo of a waterfall and want to show how fast the water is flowing, or when you're taking a shot of a racing car and want to give it a feeling of speed, or when you're taking a shot of a star scape and want to show how the stars move over a longer period of time etc. In all of these instances choosing a longer shutter speed will be the way to go. However in all of these cases you need to use a tripod or you'll run the risk of ruining the shots by adding camera movement (a different type of blur to motion blur).
- **Focal Length and Shutter Speed** - another thing to consider when choosing shutter speed is the focal length of the lens you're using. Longer focal lengths will accentuate the amount of camera shake you have and so you'll need to choose a faster shutter speed (unless you have image stabilization in your lens or camera – though that's not perfect). The 'rule of thumb' to use with focal length (in non image stabilized situations) is to choose a shutter speed with a denominator that is larger than the focal length of the lens. For example if you have a lens that is 50mm 1/60th is probably fine but if you have a 200mm lens you'll probably want to shoot at around 1/250. By the way, if you're using a tripod – turn off the image stabilization: the stabilization works against natural vibrations and movement by vibrating itself – so you would be introducing extra and unnecessary counter-vibration to nothing.

Aperture

What is Aperture?

- **Aperture** is 'the size of the opening in the lens when a picture is taken'.
- When you hit the shutter release button of your camera a hole opens up that allows your camera's image sensor to catch a glimpse of the scene. The aperture that you set impacts the size of that hole. The larger the hole the more light that gets in – the smaller the hole the less light.
- Aperture is measured in 'f-stops', or 'f numbers' – for example f/2.8, f/4, f/5.6, f/8, f/11, f/16, f/22 etc. They equate to fractions of the maximum lens aperture (a theoretical 'f/1'). Moving (a higher f number) from one f-stop to the next halves the size of the opening in your lens (and the amount of light getting through). Moving (lower in f number) doubles the amount. (The numbers above [f/2, f/2.8, f/4, f/5.6 etc] are whole 'stops', most lenses will have intermediate steps].
- Keep in mind that a change in shutter speed from one stop to the next will also double or halve the amount of light that gets in – this means if you increase one and decrease the other you let the same amount of light in – you will start to see the relationship..... a 'perfect' exposure might be, say, f/5.6 at 1/250th – the same exposure would be achieved with one stop more aperture (f/8) and one 'stop' slower shutter speed (1/125th) .

Aperture



Depth of Field and Aperture.... There are a number of results of changing the aperture of your shots that you'll want to keep in mind as you consider your setting but the most noticeable one will be the depth of field that your shot will have.

- Depth of Field (DOF) is that amount of your shot that will be in best focus. Large depth of field means that most of your image will be in focus whether it's close to your camera or far away (like the picture to the top left where both the foreground and background are largely in focus – taken with an aperture of **f/22**).
- Small (or shallow) depth of field means that only part of the image will be in focus and the rest will be blurred (like in the bottom left). You'll see in it that the tip of the yellow stems are in focus but even though they are only 1cm or so behind them that the petals are out of focus. This is a very shallow depth of field and was taken with an aperture of **f/4**.



Aperture

- Small numbers mean small DOF and large numbers mean large DOF. While the camera can actually only focus on one tiny point in space, the depth of field determines how much of the image is in "acceptable focus" to the human eye.
- Do some experimenting. Go outside and find a spot where you've got items close to you as well as far away (fence posts, perhaps) and take a series of shots with different aperture settings from the smallest setting to the largest. You'll quickly see the impact that it can have and the usefulness of being able to control aperture.
- Some styles of photography require large DOF. For example in most landscape photography you'll see small aperture settings (large numbers) selected by photographers. This ensures that almost everything from the foreground to the horizon is relatively in focus. A wider angle lens (around the 20-28mm equivalent) has a huge DOF at almost all apertures used.
- On the other hand, in portrait photography it can be very handy to have your subject perfectly in focus but to have a nice blurry background in order to ensure that your subject is the main focal point and that other elements in the shot are not distracting. In this case you'd choose a large aperture (small number) to ensure a shallow depth of field. A longer than 'normal' lens is used very often because the longer lens (like the equivalent of 90mm) has a narrower *relative* DOF at wide apertures.
- Macro photographers tend mainly to use large apertures to ensure that their subject totally captures the attention of the viewer while the rest of the image is completely thrown out of focus. DOF also depends on distance to subject and the focal length of the lens – in Macro shots the DOF is incredibly small, while in longer distance shots, with a telephoto lens, the DOF is relatively small, compared to a wider angle lens.

Depth of Field - 1

- Depth of field is the range of distance within the subject that is acceptably sharp. The depth of field varies depending on camera type, aperture and focusing distance, although print size and viewing distance can influence our perception of it.
- The depth of field does not abruptly change from sharp to unsharp, but instead occurs as a gradual transition. In fact, everything immediately in front of or behind the focusing distance begins to lose sharpness - even if this is not perceived by our eyes or by the resolution of the camera.

Three shots taken with the same lens, from the same spot, using different apertures..... (left to right – f/2.8, f/5.6, f/8.)



Depth of Field - 2

- Aperture and focal distance are the two main factors that determine how big the DOF will be on your camera's sensor. Larger apertures (smaller F-stop number) and closer focal distances produce a shallower depth of field.
- Why not just use the smallest aperture (largest number) to achieve the best possible depth of field? Other than the fact that this may require prohibitively long shutter speeds without a camera tripod, a very small aperture softens the image by creating a larger circle of confusion (or "Airy disk") due to an effect called diffraction - even within the plane of focus. Diffraction quickly becomes more of a limiting factor than depth of field as the aperture gets smaller. (Despite their extreme depth of field, this is also why "pinhole cameras" have limited resolution). Your camera may go to f/32..... don't bother to use it, or indeed anything above f/22.

The Exposure Triangle



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The Exposure Triangle

Bringing It All Together

So, we've seen that the three main elements in photography have to combine together so that we can get the best effects. It's quite possible that you'll happily switch your camera's operation control to P (for professional, eh?) or Auto and don't bother with what's going on inside. Well that's fair enough – it could be said that you're concentrating on the composition of the subject and not getting hung up on the technicalities. But successful photographers – I mean those that exhibit, get published, make a living out of it – need to know the nuts and bolts intimately. At an enthusiasts level, we will become better by knowing those elements.

Each element of the triangle is important and must be selected in harmony – and each element also has 'side effects' that we should use to our advantage.

Oh, did I mention the fourth Element? It may be more like an Exposure Square rather than a Triangle? Oh well.... another day perhaps.