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Ten Photo Fundamentals

Contents

It's very easy to get seduced by all the incredible things that you can do with cameras and computers. So many of the images you see on the Internet have had various effects applied, or have been shot in exotic locations - and then had special effects applied. Photography is more than just post processing effects, you do actually have to capture an image before you can polish it into a masterpiece.

Since the dawn of photography there have been certain aspects of camera operation that have remained much the same and this eGuide aims to look at Ten Basics of Photography, things that you need to fully understand before you can wield your camera with full confidence.

Two chapters are new to digital photography - JPEGs and Histograms. I still call these Basics because you need to know how they affect your shooting.

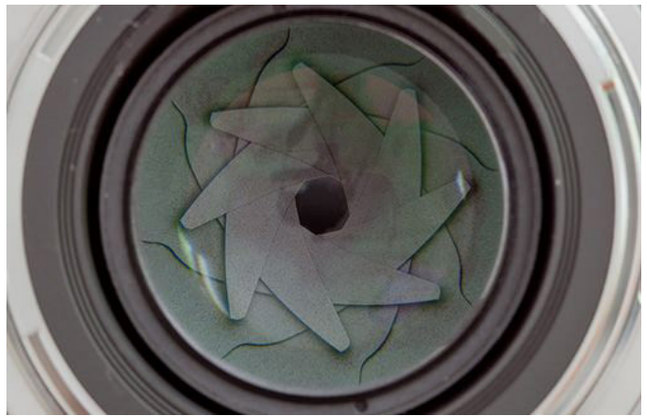
Mastering things like Shutter Speeds and Apertures might sound trivial but there are subtleties that escape beginners and advanced enthusiasts alike so read on and hopefully you'll pick up something that will help you out in the field.

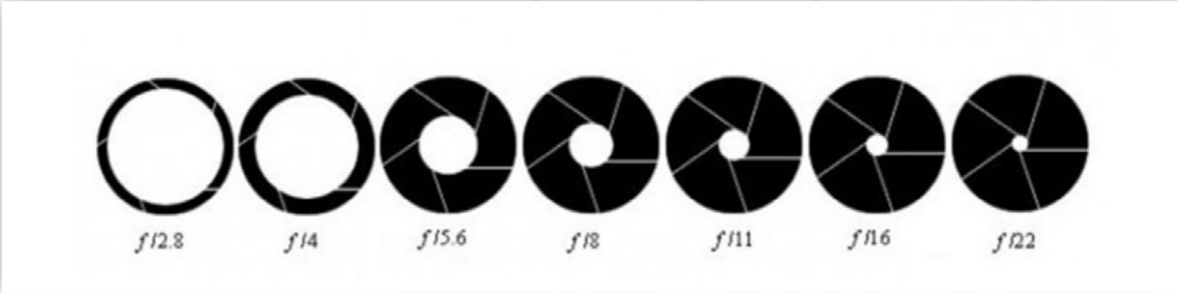
Apertures

The **aperture** is a crucial component of photographic lenses. Think about what the word means - an aperture is a gap or a hole in something.

Your eye has an iris, and if you look carefully at someone else's eye you'll see that the black disk in the centre is tiny on a bright day and quite wide when it's dark. This is exactly how a camera's aperture works – the size of the aperture controls the intensity of light entering the camera.

In a camera it's an adjustable iris made





Wide Aperture
More Light
Less Depth of Field

Small Aperture
Less Light
More Depth of Field

up of interleaved metal blades that can be closed to become a narrow hole or to be as wide as the inside of the lens allows. Why is it important? Well, if shutter speeds determine the length of **time** light shines on a camera's sensor then the aperture controls the **intensity** or brightness of that light. Think of it like a water pipe: a narrow pipe can only let so much water through in, say, 1 second, whilst a wider pipe can let through more in the same time.

This is very important for two reasons: Exposure and Depth of Field.

To achieve a correct exposure the aperture acts as a 'balance' to the shutter speed.

We'll look at shutter speeds, exposure and ISO sensitivity in more detail later but, briefly, the camera's sensor needs a specific amount of light to optimally capture all of the tones in a scene. A *short* exposure (high shutter speed) means a greater intensity of light is needed to achieve this result; conversely, during a *long* exposure (low shutter speed), less intensity is needed to get the same amount of light onto the sensor – this is known as the **exposure**.

Using the water pipe analogy, if a bucket is the sensor and a full bucket means an optimum exposure then a narrow pipe will need to run for longer to fill the bucket than a wide pipe.

Apertures

The ‘units’ of aperture are expressed as f-numbers; to be precise the f-number is the focal length (f) of the lens divided by the physical size of the iris opening. In other words it’s a ratio and so is independent of the lens itself when calculating exposure: f8 on one lens is (more or less) the same as f8 on any other lens.

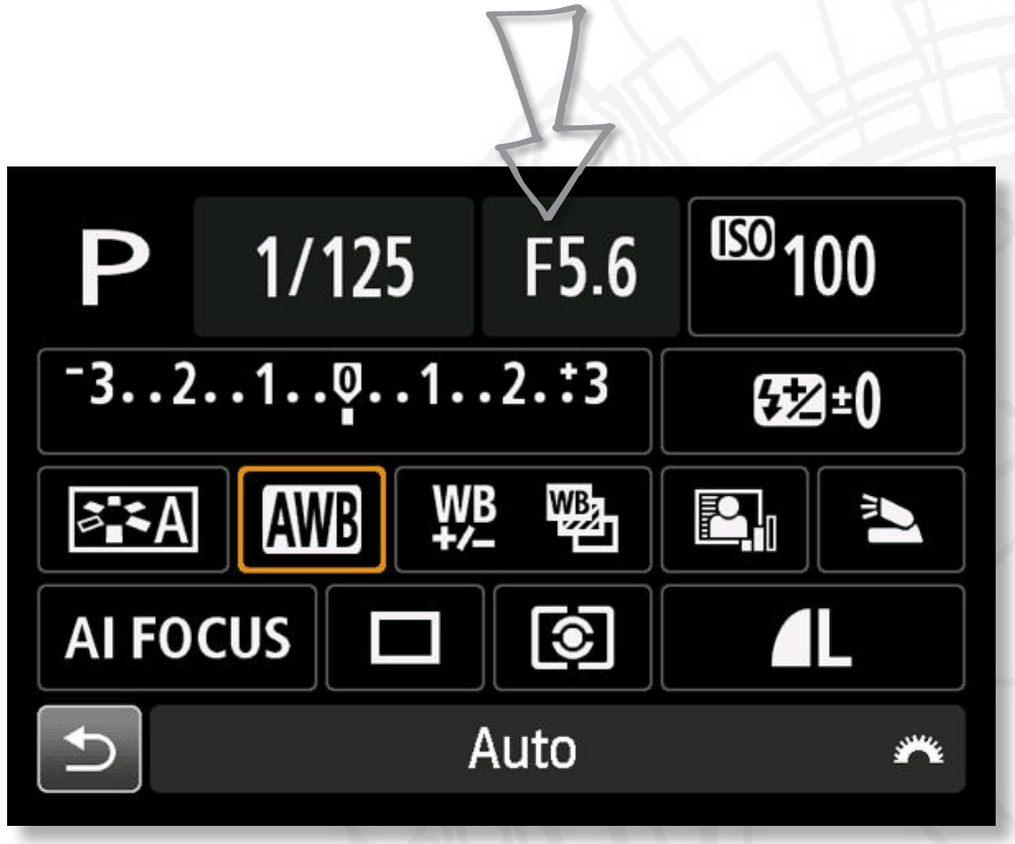
f4 on a 300mm lens means that the aperture is actually 75mm wide inside the lens. On a 24mm lens that same f4 aperture is physically 6mm across.

Apertures progress from small numbers to larger numbers - this is where some confusion arises. Small f number mean wide apertures and large f numbers mean small apertures.

The progression of numbers is standardised too. Starting at f1.0 each step is a multiple of 1.414 (the square root of 2). That’s why alternate apertures are full multiples of 2 as seen below:

1.0 1.4 2.0 2.8 4.0 5.6 8.0 11 16 22

On the back of the camera, in the Q - Quick Control Mode (on a typical DSLR) this is where you can see what aperture is being used, f5.6 in this case.



Apertures, Shutter Speeds and ISO form a kind of ‘trinity’ based around the concept of correct **exposure** - change one and at least one other must change to maintain the same overall exposure - but let’s not get ahead of ourselves here. I just want to establish the absolute basic principles before moving on to how they all work together.

I’ll be looking at Exposure in a later Chapter, in the meantime let’s move on to Shutter Speeds and then ISO so we can tie it all together in one neat package.

Apertures

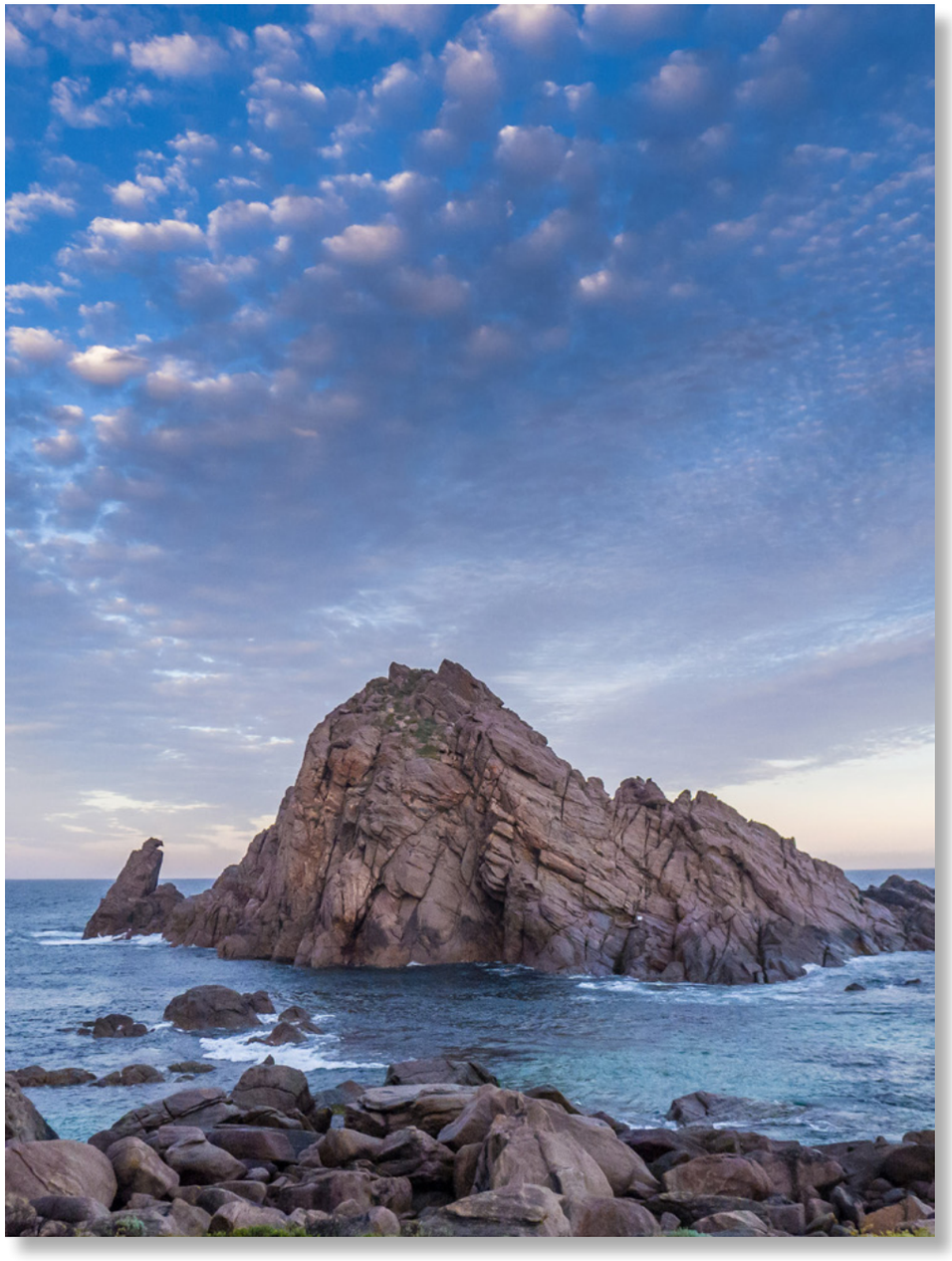
Controls the exposure by altering the amount of light entering the camera.
See Exposure Chapter.

Affects the parts of the image which are seen as being “in focus”.
See Depth of Field Chapter.

Narrow apertures will require longer shutter speeds, running the risk of unsharp images, and/or higher ISO with added noise.

Apertures

This style of image relies on a wide aperture, f2.8 in this case, to throw the background out of focus and draw attention to the fern.
135mm, 1/60 f2.8 ISO100



Typical landscape images often demand lots of Depth of Field, in this case f11 has kept everything sharp.
17mm, 1/30 f11 ISO100

A simple image like this would use a mid range aperture such as f8 or f11 to optimise sharpness and depth of field.
17mm, 1/250 f11 ISO100

Shutter Speeds

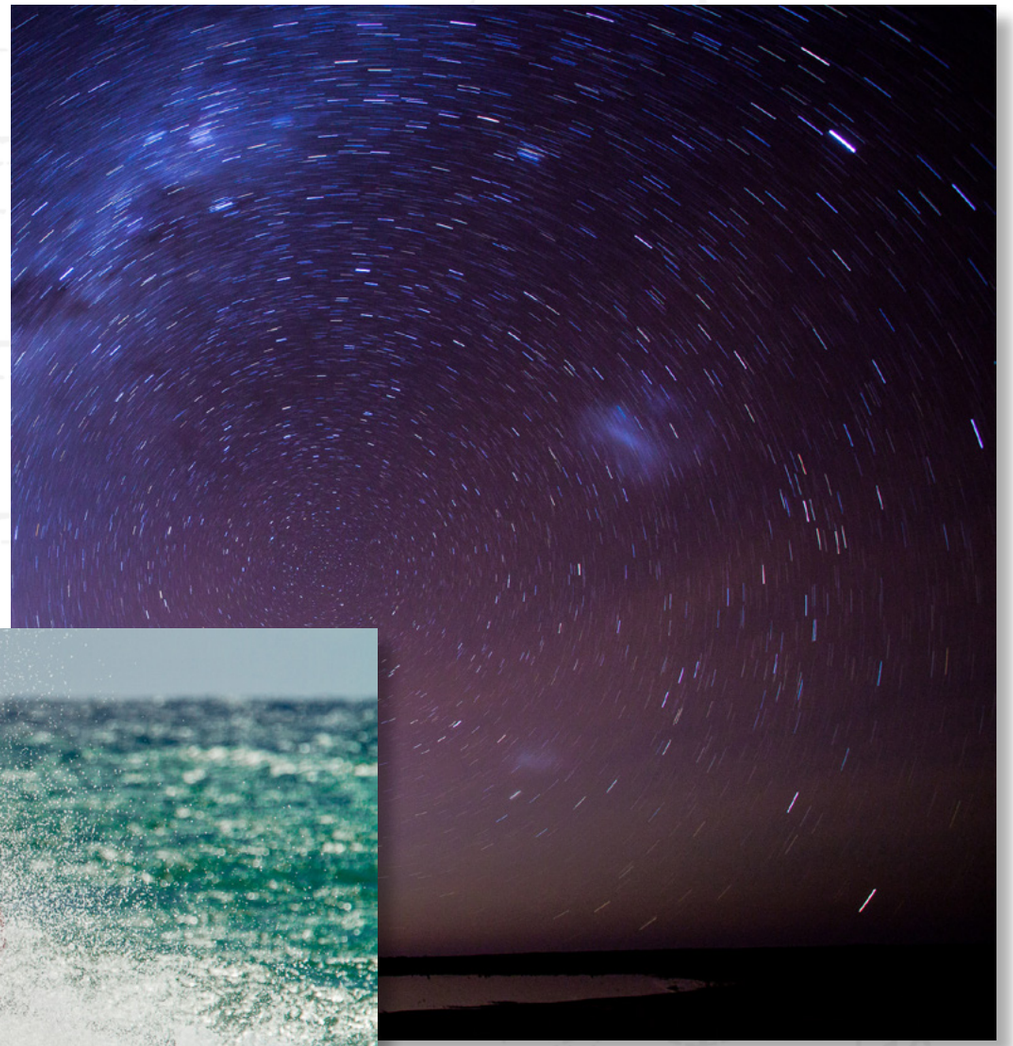
If the Aperture controls how much 'volume' of light comes into the camera then the Shutter Speed controls the length of time during which the light can enter the camera.

What is a Shutter Speed?

In order to record a photograph, the imaging sensor in a camera needs to be exposed to a controlled amount of light. This will vary depending on the brightness of the scene as well as the Aperture chosen (and the ISO sensitivity).

The shutter controls the length of time that light will be able to reach the sensor. In its resting position the featherweight leaves of the shutter blind sits in the path of light entering the camera and totally blocks light from the sensor. When a picture is taken the shutter moves out of the way very quickly allowing light to pass through to the sensor before returning once again to it's resting position, once again blocking the light. The time that the shutter is out of the way, or open, is measured in seconds or fractions of a second and is referred to as the Shutter Speed.

To cover as many lighting situations as possible modern cameras have a huge shutter speed range that can stretch from 30 seconds to an incredibly quick 1/8000th of a second.



Slow or Long Shutter Speed
600 seconds.

High or Fast Shutter Speed
1/4000 second.

Shutter Speeds

Why are Shutter Speeds important?

Shutter Speeds control the way the camera records movement, and there are two kinds of movement.

Camera Movement
As the name suggests, this is where the camera itself is moving. Usually, but not always, due to hand holding.

Subject Movement
Yes, that's when the subject is moving, no surprise there.

You can have both types of movement at the same time too - photographing birds from an inflatable zodiac out at sea would involve a *lot* of both.

The reason this is so important is because we normally want to be able to capture a sharp image and if the *image* has moved during the exposure it will be blurred. Note I said the 'image'. The image is projected by the lens onto the sensor and if this moves relative to the sensor then the subject will be blurred which is why both subject and camera movement can cause blur.

The length of time the shutter is open together with the amount of movement determine whether an image will be recorded as sharp or blurred. It's this aspect of shutter speeds that allows creative choices to be made - do you want the subject sharp or blurred? A certain amount of blur gives an impression of movement, even extreme blur can be used to creative effect.

Shutter Speed

Controls the exposure by altering the time during which light enters the camera. See Exposure Chapter.

Affects the way subject movement is recorded: this can be used to great creative effect.

Higher shutter speeds require wider apertures which reduces Depth of Field and/or higher ISO which might result in added noise.

Intermediate shutter speeds - in this case 1 second - blur the image just enough to show movement but not so much that it's unrecognisable. Leica S2, 30mm 1 second f16 ISO160

Shutter Speeds

A high shutter speed of 1/1000 second has frozen the breaking wave making it look like spun glass. 300f2.8L 1/1000 f4 ISO100

A 2 second shutter speed has allowed the water splashes to record as a series of white lines, giving a good impression of the water's movement.
Leica S2, 120mm 2 sec f16 ISO160

Aerial shots from helicopters or light planes require high shutter speeds to make sure there is no camera movement which might blur the shot.
Leica S2, 70mm 1/1000 f2.8 ISO320

ISO - Sensitivity

We have looked at both Shutter Speeds and Apertures, and considered how they can alter the overall exposure. There is a third factor - the sensitivity, or ISO, of the sensor - which also affects the exposure.

These three parameters form what I like to call the 'Trinity of Exposure', something we will be looking at in great detail in the Exposure Chapter. For now let's look at what ISO means.

ISO (pronounced EYE-soe) is the shortened name, but not an acronym, for the International Organisation for Standardization which sets all sorts of standards for many different things in many different industries. In this case it represents a standard scale for the sensitivity of a camera's sensor, or, back in the day, a *film's* sensitivity. It is also known as the film 'speed' and is simply a number which reflects the sensitivity to light of the capture device. Doubling of the number represents a doubling of the sensitivity. ISO400 is thus 4x the sensitivity of ISO100. Modern camera have ISOs up to well over 28,000.

For a photographer this is important because it affects the choice of which aperture and shutter speed to use to get a correct exposure. The three are firmly linked; if you change one you will have to change at least one of the others to get the same exposure.

Like shutter speeds and apertures, ISO also affects the way your images look. Apertures affect Depth of Field, shutter speeds affect motion capture and ISO affects actual image quality.

Once again referring back to film days, high speed films, those with high ISO ratings, were inherently grainy – this was the price you paid for sharp images in low light: grain. It's much the same now, not that there is any grain as such, but since the ISO setting is actually an amplification or gain: not only does it amplify the signal (light) but also any electronic noise.

All electronic devices have a certain amount of random noise in the system; think of the 'hiss' on a stereo if you turn the volume right up. If you think of increasing the ISO on a camera as turning up the volume then you will get the visual equivalent of hiss, known as noise. It looks like random granularity and purple 'splotches'. It's quite simple really – if you amplify the signal you also amplify the noise (engineers call this the S/N ratio or 'signal to noise' ratio).

Above : Dark clouds at ISO6400 with no post processing to control the obvious noise. Below : Dark clouds at ISO100. Both images are magnified to 100% on the screen.

ISO - Sensitivity

Controlling Noise

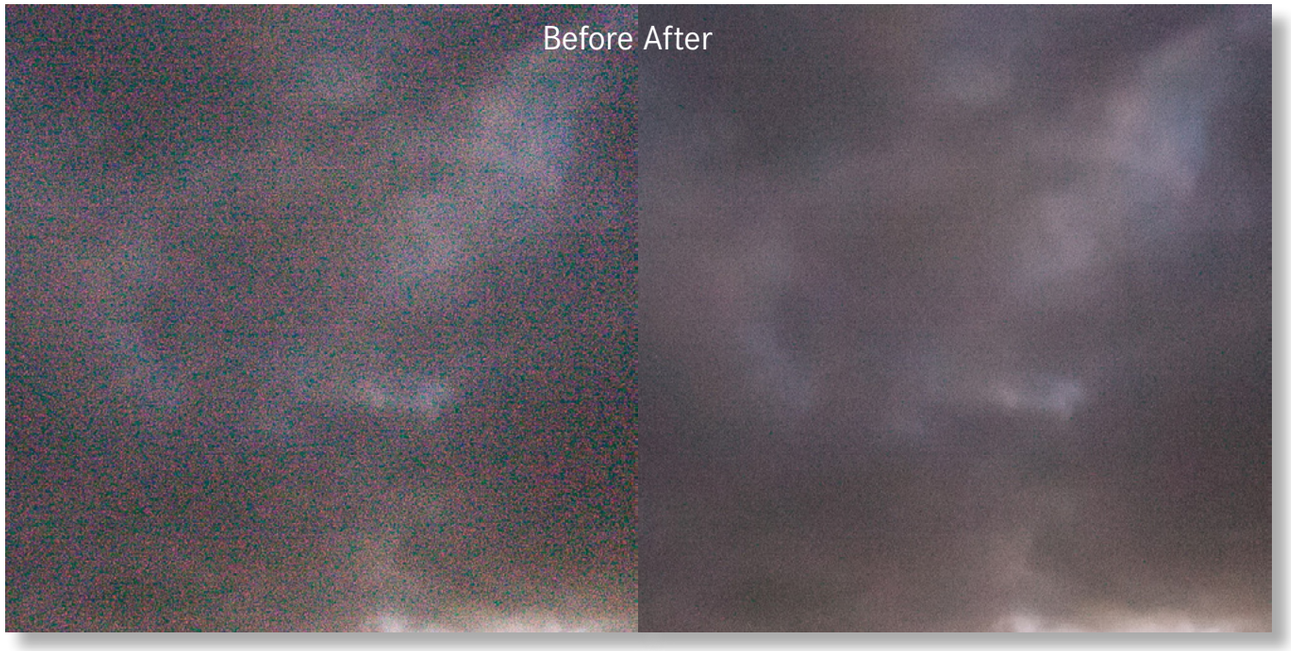
There are two main types of noise:

Luminance Noise which shows up as the granularity or 'grain' in the image. Luminance or brightness makes up all the details and textures within the image: trees, hills, faces etc.

Chroma Noise which shows as purple and green splotches. Chroma contains information about the colours within the image, not the detail.

Luckily Chroma noise, which is the most unsightly, is also the easiest to remove using post-production software because the colour information does not contain detail information and can be more heavily noise-reduced before the image starts to look softer.

Luminance noise, on the other hand, is where all the fine detail in the image resides so removing this type of noise can easily result in the image looking quite smudged, lacking in fine detail.



Smooth areas without any detail, such as clouds, can be massively noise-reduced in post- production (in this case using Lightroom) with very little degradation of the image.

ISO6400, 100% View

Areas with lots of detail can be made to look quite plasticky if you overdo any post-production noise reduction.

Lumix GH1, ISO1600
100% View

ISO - Sensitivity

ISO

Controls the sensitivity of the sensor. See Exposure Chapter.

Affects the quality of the image with high settings showing reduced dynamic range plus increasing Luminance and Chroma noise. Low ISO (usually ISO 100) has the least noise and thus captures the highest quality image.

High ISO will therefore allow higher shutter speeds to be used for sharper images and/or smaller apertures for more Depth of Field. The price you pay is increased noise.

Using long lenses in the low evening light often requires a high ISO to get a sharp image.
600mm, ISO1600

For fast moving subjects like children, a high ISO might be needed to keep the shutter speed high enough to freeze their movements.
Leica S2 70mm 1/500 f2.8 ISO320

Histograms

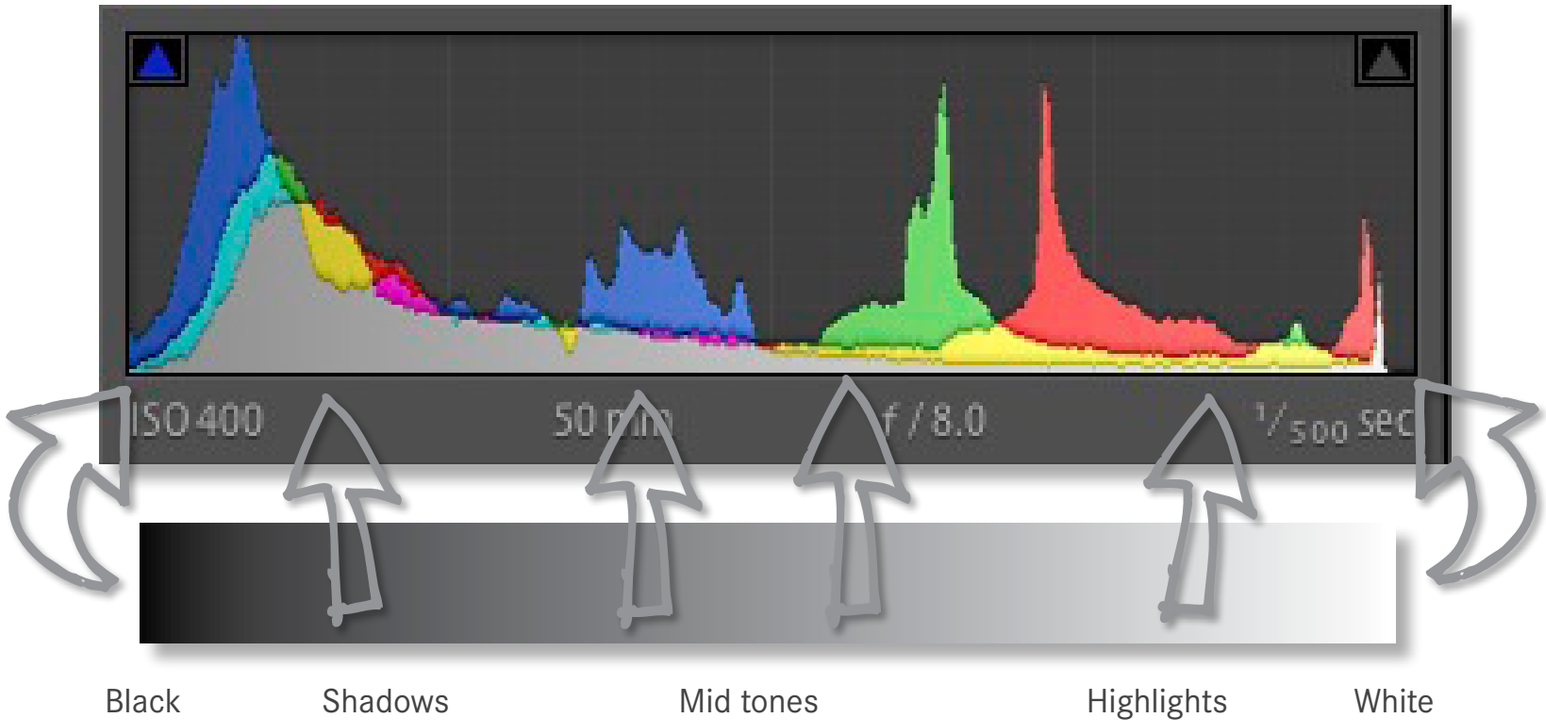
Before we get onto the concept of correct exposures there is one last tool we need to look at because whilst Apertures, Shutter Speeds and ISO control the level of exposure. It's the histogram on the back of the camera, and in almost all imaging software, that allows us to judge whether we have a good exposure or not.

A histogram is just a bar-chart showing how many pixels of any particular value are contained in the image.

The bottom axis runs from zero (dark) on the left to 255 (white) on the right. Some histograms show percentages from 0% to 100% but all show the same thing - the distribution of tones in the image.

By looking at a histogram you can see how the image is constructed - is it dark overall, or is it pale? How contrasty is it? Is there a predominant colour? Are the tones evenly distributed? Are they all bunched up at one end or the other?

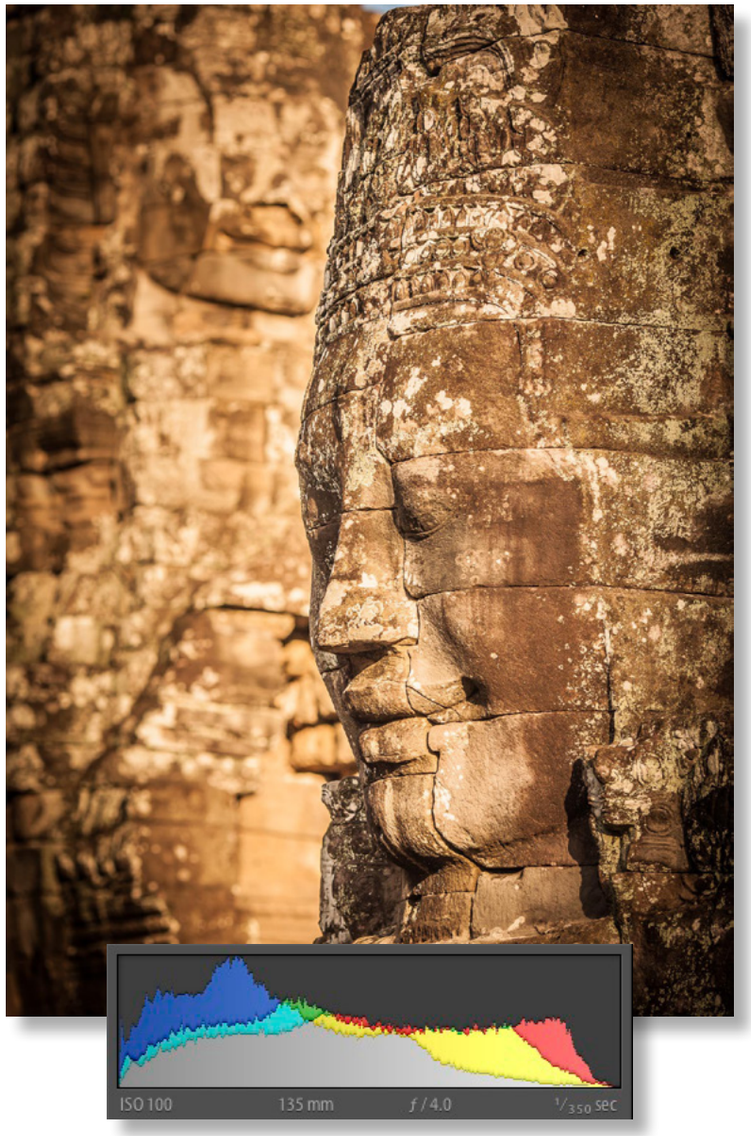
These shapes give you clues as to what tones the image is made up of.



This histogram is from Lightroom and shows a good distribution of tones between black (shadows) and very pale grey (highlights). The tonal range fits nicely inside the limits of the histogram which means all the tones are captured well.

The grey part of the histogram is the overall luminosity and the coloured sections represent each of the six primary and secondary colours.

Histograms



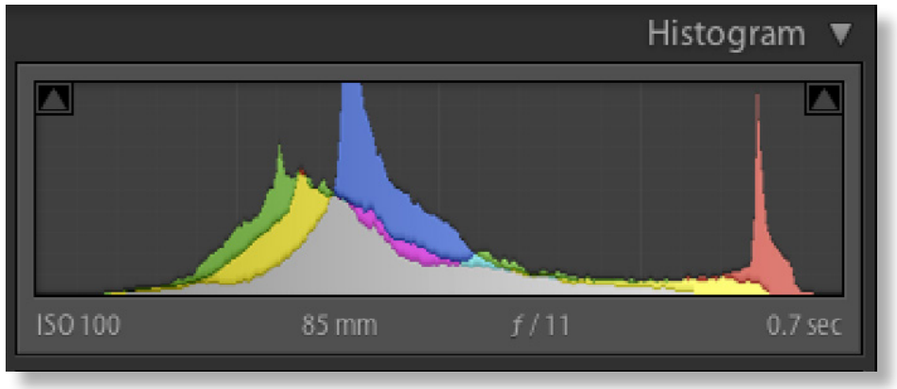
Normal - an even distribution of tones from bright highlights to deep shadows.

High Key - dominated by light tones with no significant shadows.

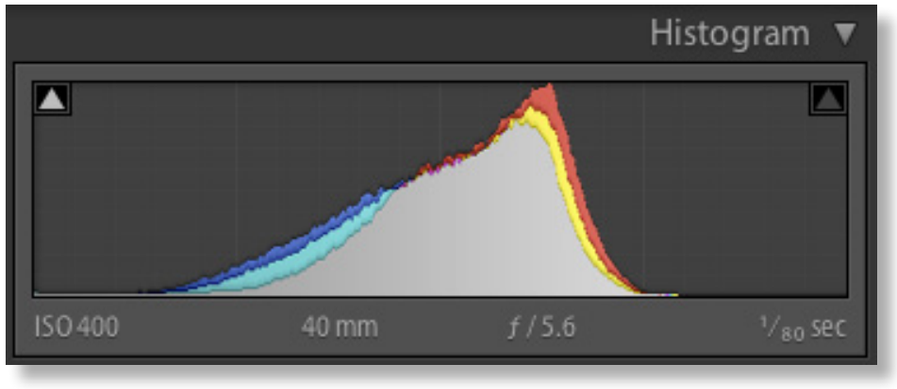
Low Key - dominated by darker tones but highlights are still very important.

Histograms

This histogram shows a wide range of tones with two distinct spikes, so the image will appear high contrast. There is a large area of mid-to-dark tones, dominated by blue plus a red spike in the highlights.

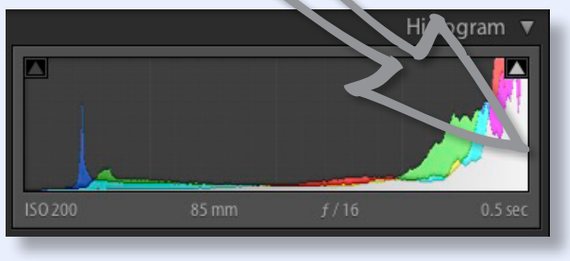


This histogram shows a very narrow range of tones with one peak, so the image will be very low contrast. There is no obvious dominating colour apart from a hint of red and yellow in the highlights.



The Histogram shows how the tones in an image fit within the sensor's sensitivity range based on the exposure. Changing the exposure in the camera will move the histogram either left for reduced exposure (darker) or right for extra exposure (lighter).

If the histogram is too far to the right, or overexposed, it is 'clipped' - see the section on Exposure.



Note that you cannot change the 'shape' of the histogram when you shoot the image - you can only slide it sideways by altering the exposure. The shape is completely determined by the subject's tonality. The height of the histogram tells you how many pixels of a particular tone are in the image, once again something you cannot control in camera - it's 'subject dependant'.

Correct exposure is critical when the subject is extremely high contrast like this one: the shadows need good exposure but, at the same time, the highlights need to remain unclipped.
50mm, 1/125 f4 ISO100

Exposure

We have looked at the three main controllers of exposure - Shutter Speed, Aperture and ISO. The first two are physical or mechanical devices and ISO is simply an amplification of the sensor's signal.

The camera's Histogram shows us what was (or is about to be) captured and can be considered a tool because it feeds back information about the tones in the image and how they relate to the sensor's own capture range. In many ways the Histogram can be thought of as the ultimate light meter because you can shoot more images until you have a perfect histogram.

The Perfect Exposure

I'm going to go out on a limb here and give you my own definition:

A perfect exposure is one which maximizes the quality of the image data.

This has nothing to do with aesthetics or subjective appearance (moody, light, dark, contrasty etc) it's just a simple technical definition and one which requires some explanation.

Data Quality

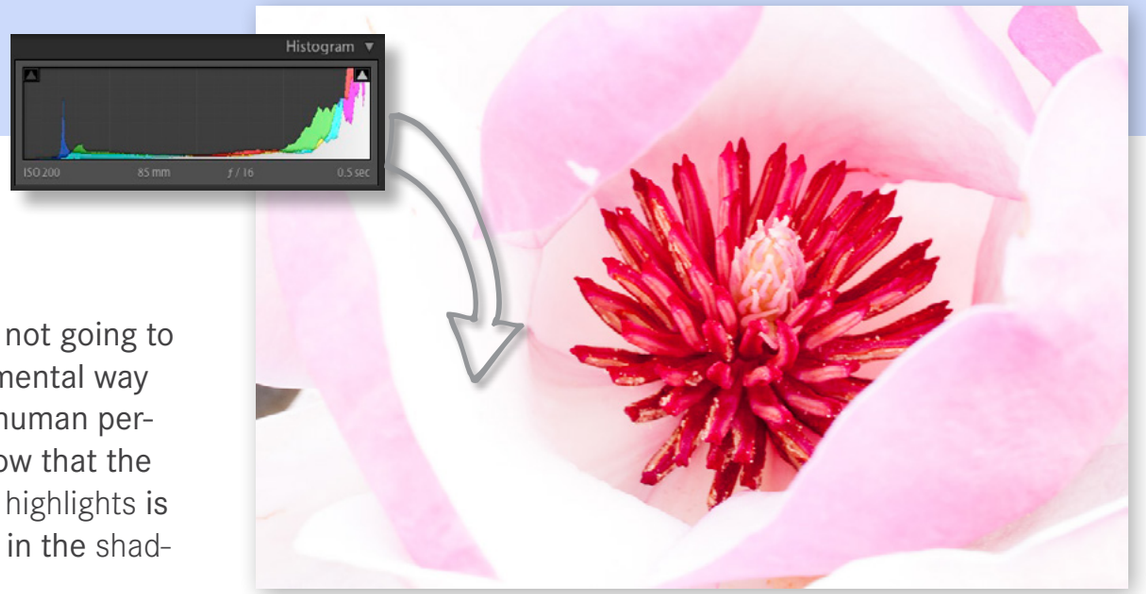
In the interests of simplicity I'm not going to delve too deeply into the fundamental way a camera's sensor differs from human perception but it's important to know that the subtlety of tone captured in the highlights is vastly better than that captured in the shadows.

The quality of capture is best in the brightest parts of the image for various reasons but one of the main ones is that the signal-to-noise ratio is highest in the brightest parts of the image. It's just like in a stereo - you only hear any slight hiss in the quietest parts of the music, in the loud bits the music drowns the hiss.

In an image, any 'noise' is swamped by the level of light at the highlight end of the range but in the shadows, where the light level (signal) is low, the 'noise' might be still visible.

The upshot of this is that the more exposure you can give the image the better.

But there is a catch!



This histogram shows clipped highlights

Overexposure

A sensor can only capture a certain amount of light, beyond that the sensor elements are simply 'full' and cannot record any more information. This will appear as a region of featureless white in the photo.

Clouds are a good example - correctly exposed white clouds should look bright white but will still have visible texture. If they are overexposed even by a small amount they will look more like cutouts - cloud shaped areas of pure white with no texture. This is what we call 'clipping' - all the tones over a certain brightness are clipped off and the result is a region of white with no details.

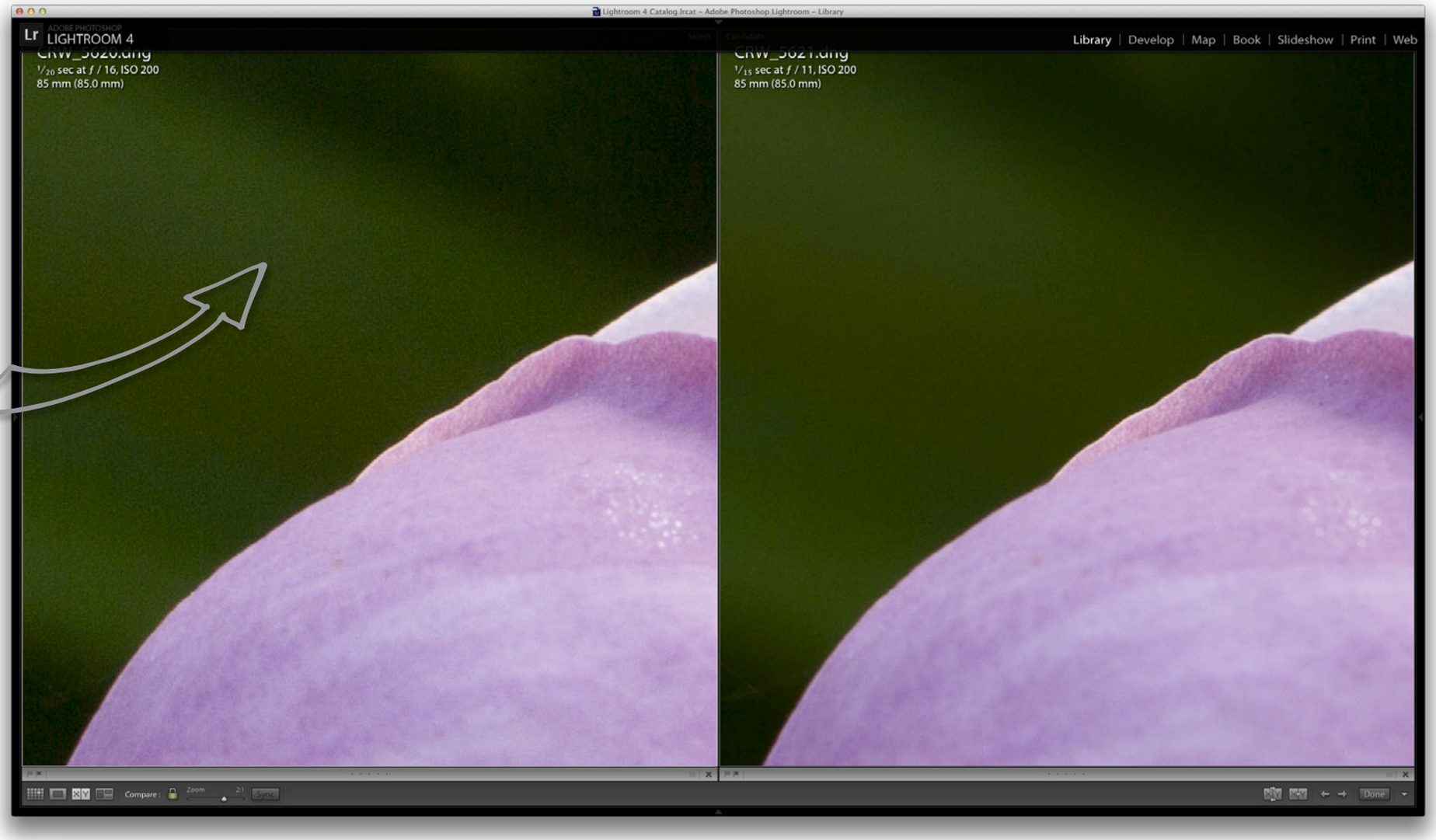
Exposure

This image shows how the quality of information is reduced in the darker regions.

These two shots are 1.3 stops different in exposure, a difference which has been adjusted in Lightroom by using the Exposure slider to make the darker shot look almost the same as the lighter shot.

It's pretty obvious that doing this has exaggerated the slight noise in the dark green areas but the brighter mauve areas look the same in both shots.

The darker shot was taken with the camera on auto, the lighter shot was taken with the exposure compensation set to +1.3 using the camera's own histogram to assess the exposure. By overriding the camera meter's recommendation we have ended up with higher quality image data.



The right image is 1.3 stops 'over-exposed' according to the camera's meter.

Exposure

Judging Correct Exposure

What does this all mean?

Firstly, the camera's meter is only giving you a best guess based on an assumption that all the tones in a scene average out to a mid grey - this is how meters have been working for decades.

Secondly, given this archaic averaging assumption, certain things can fool the meter into giving you an underexposed image.

- Snow scenes
- Backlighting
- Bright saturated single colours
- Bright sky
- Specular highlights like metallic reflections

Luckily we have the histogram to work with and this gives us a far better understanding of how the image tones fit within the sensor's recording range.

The meter gives you a good starting point if you are in a hurry, but the histogram allows you to get the best possible quality of capture.

High Quality Exposure

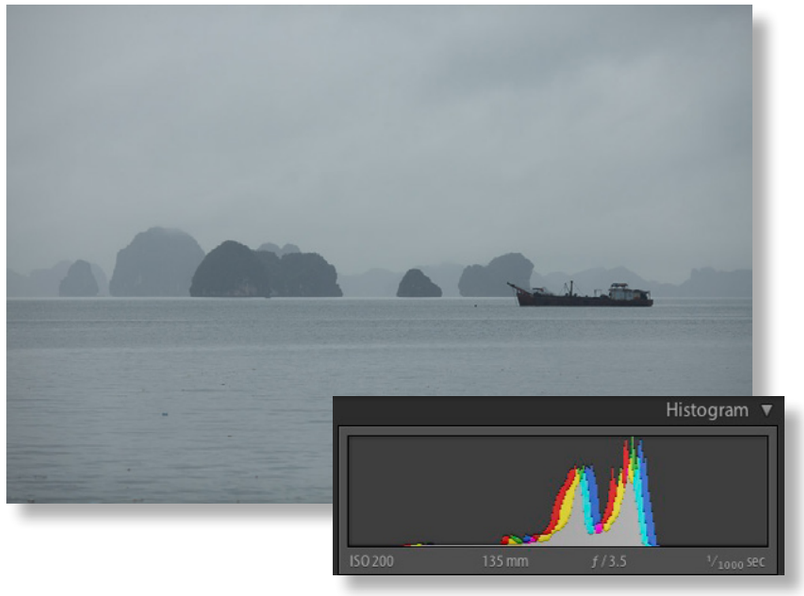
1. Give the image as much exposure as possible.

and at the same time

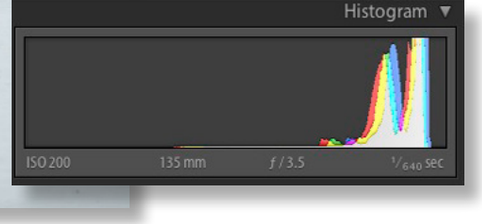
2. Do not allow the highlights to become clipped.

and remember...

3. Do not judge the exposure by the camera's rear LCD screen



This image is almost all pale greys and has 'fooled' the meter into recording the tones in the middle of the histogram. Setting the camera to 'overexpose' by 1.5 stops gives the histogram below which will record the ship's hull with much greater tonal detail. Note that the highlights are still well within the sensor's tonal range and even though it looks too pale, all the detail is still there.



Exposure

Controlling the Exposure

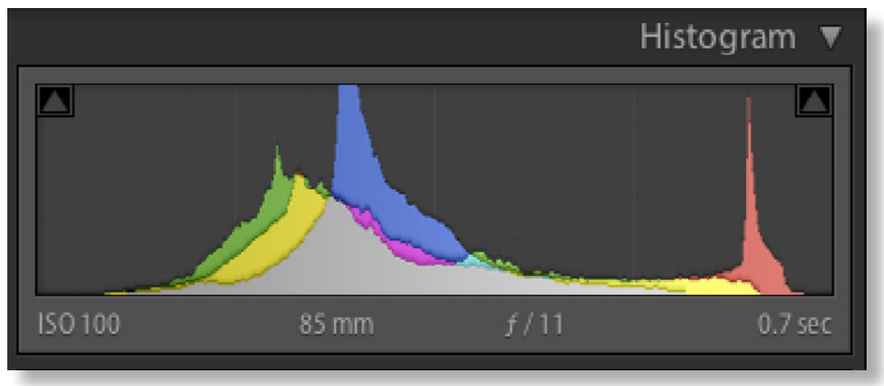
You adjust the Shutter Speed, Aperture and ISO to choose a combination of settings that results in a good histogram.

Each one can be changed in 'stops' that are equivalent in exposure value - in other words if you change the Aperture from f8 to f11 you can keep the same exposure by altering the Shutter Speed from 1/60 sec to 1/30 sec.

The same applies to ISO:

1/30 sec at f11 using ISO400 is the same as 1/30 sec at f5.6 using ISO100 or 1/15 sec at f11 using ISO200.

Remember, if you want to keep the same exposure, and thus keep the same histogram, then if you change one setting you must change another to compensate.

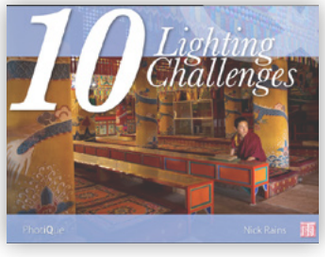


This well balanced histogram, results from an exposure of 0.7 seconds at f11 using ISO100.

The exact same histogram will result from many different combinations of shutter speed, aperture and ISO.

For example, these settings will all give you the same histogram:

Shutter Speed	Aperture f	ISO
1.5 sec	16	100
3.0 sec	22	100
1/20th	16	800
1/20th	5.6	100
1/60th	6.7	400



My other eBook, 10 Lighting Challenges, has lots more on the subject of Exposure.

Exposure

Choosing the Settings

This is where we need to make some decisions. If there are so many equivalent settings to give a good exposure which is a technical decision, how then do we choose which combination is best for how the subject should look.

Well, like so many things in photography, it depends.

Each of the three controls have their own consequences and it's this knowledge that will affect exactly which aperture, shutter speed and/or ISO you choose.

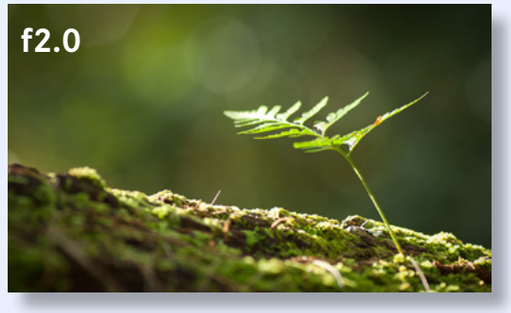
Which settings you prioritise will depend to a great extent on the subject and how it needs to be depicted. Sports is all about shutter speeds, landscape photography is often about depth of field and low ISO. Ask yourself what is the most important setting.

See the section on Camera Modes for more on this subject.

Exposure Trinity

Shutter Speed – controls blur, or lack of blur. Slow shutter speeds mean the subject (or camera) might have moved during the exposure and the image will record as a blur not a sharp image. Slow shutter speeds often require a tripod whilst fast shutter speeds are good at freezing motion. A good example is sports photography – a fast shutter speed will freeze movement.

Aperture – controls how much of the image is in focus. Small or narrow apertures (high numbers) means more of the scene is in focus, wide apertures (small numbers) mean less of the scene is in focus. A good example is portraiture where you might want the background out of focus and the eyes sharp - for this you'd use a wide aperture of f2.8 or f4.



ISO – using a high ISO will add noise to the image so it needs to be used with care. ISO100 will usually be noiseless, but ISO3200, depending on the camera, might show quite a bit of speckly grain. In low light you might be forced to use a high ISO to keep your shutter speed high enough to get a sharp image.

High contrast images need to be exposed very accurately to combine the best possible shadow detail with highlights that are not clipped. Shutter speed was not important in this shot (because I used a tripod) so I used low ISO and a mid range aperture.
50mm, 1/60 f8 ISO100

Depth of Field

To blur or not to blur

You may have noticed that some images are sharp from the nearest object in the frame right through to the most distant. Other images have only one thing sharp, with the background of the image appearing as a pleasingly blurred region, making the subject stand out.

Depth of Field (DOF) is the optical phenomenon, or illusion, that causes this effect – large DOF equates to most things being sharp and shallow DOF renders the background out of focus for creative effect. Control of this factor is essential to a successful photograph. DOF is mostly controlled by the aperture settings but like with most things photographic, it's not quite as simple as it would appear.

Aperture

Put quite simply, a large f-number like f16 gives deep DOF and a small f-number like f2.0 will give you a narrow DOF and tend to throw the background out of focus.

Confusingly, a large f-number is actually a small aperture physically, i.e. a narrow hole in the lens iris if you look into the front of the lens. Conversely, a small f-number is a large iris settings and lets more light in (see my previous article about the relationship between aperture, shutter speed and ISO). The easiest way to remember is that small f-numbers give you least DOF and the larger numbers the most. As a broad rule of thumb small details and portraits can look fantastic shot at wide apertures for minimal DOF whilst scenes, interiors and vistas look best when everything is sharp.

How it works

As the aperture is closed down to a smaller and smaller hole the angle at which the light converges onto the sensor narrows too. This has the illusion of increasing the region of sharpness both in front of and behind the subject. I say 'illusion' because in reality the only thing truly sharp is whatever you are actually focussed on: DOF is actually nothing more than a region of 'acceptable' focus.

What this means is that if something is only just out of focus either in front of or behind the subject, and this slight degree of 'blur' is less than the eye can clearly resolve, then the image still looks sharp. It's only when the degree of blur is strong enough for the eye to resolve it that something actually looks blurred. This degree of blur decreases both in front and behind the subject as the aperture is closed down and this gives the illusion of a widening band of focus even though it's actually a rather vaguely defined area.

This also has consequences with respect to the size at which you print your images – yes, print size affects apparent DOF. Small prints will have more apparent DOF than large prints, which is somewhat counterintuitive but nevertheless true.

Lenses

Without overcomplicating matters, long telephoto lenses give the impression of having less DOF than wide angle lenses and so a lens like a 135mm (on a DSLR) works well as a portrait lens if you want the background nicely out of focus. Landscapes are generally shot with wide lenses because you can fit more of the scene in the frame and more of the subject will be sharp from the foreground to the distant horizon.

We'll look at some examples in the next few pages...

Depth of Field

400mm 1/500 f4 ISO400

Telephoto lenses give the illusion of having shallow depth of field - it's actually more complex than that, but using a long lens at a wide aperture will certainly make a close subject stand out from its background.

Wide angle lenses can make a shot look sharp from front to back, particularly if you use a small aperture.

17mm, L1/15 f11 ISO100

Telephoto lenses do not always give you shallow depth of field - for more distant subjects they can still get everything sharp even at f5.6.
Leica S2, 120mm 1/60 f5.6 ISO160

Focus

Regardless of what aperture and shutter speed you use, you still need to be able to capture a sharp image, or at least capture an image that is as sharp as you want it to be.

What we need is an image that's 'in focus'.

In focus simply means that the sharpest part of the image is where the photographer intended it to be. An image can be out of focus but sharp, or it can be in focus but unsharp. What you want is for your image to be **in focus** and **sharp** at the same time.

If this sounds a bit confusing imagine a portrait where the subject's ears are sharp but their eyes are not. It's a sharp image because there is no apparent camera shake and the subject has not moved - the only problem is that the point of sharpest focus is not where it should be, on the eyes.

Conversely, the same shot could be focused bang on the eyes but due to a low shutter speed the whole image is slightly blurred. It's correctly focused but not sharp.

You need to focus in the right place AND capture a sharp image.

Correct focus on the eyes combined with an out of focus background makes it very obvious where the photographer wants you to look - if you dare.
85mm, f2.8

Focus

The left image is very sharp but the sharp bits are in the wrong place. The focus is not on the eyes therefore it's considered a reject. The subject leant forward slightly just as the image was captured and so the focus point is too far back.

The right image is very sharp and the focus is correctly on the eyes. This is a keeper.

85mm, 1/180 f4 ISO100

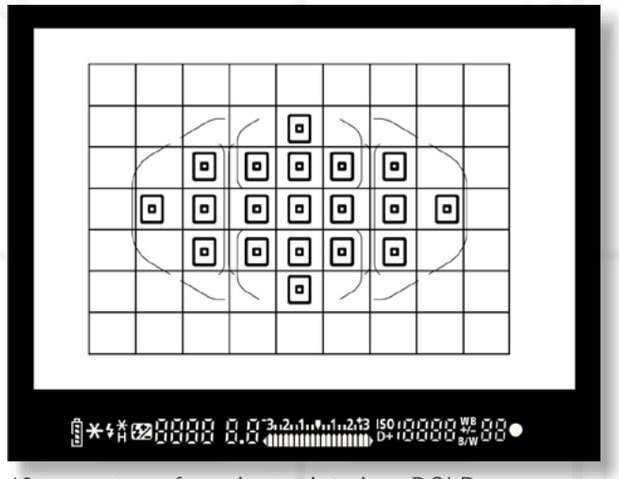
Focus

Placing your point of focus exactly where you want it to be is critical. In portraiture for example, the subject's eye must be sharp, preferably the nearest one, so developing skills to get consistently good focus is a really good idea.

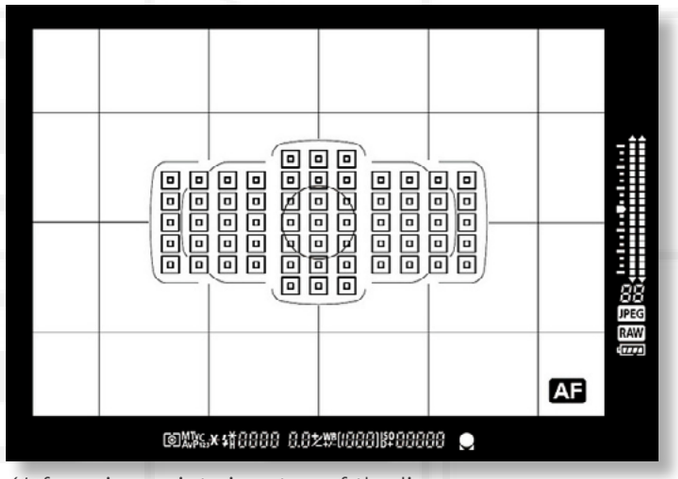
Most people use auto focus (AF). This is a good thing because, by and large, AF is excellent and will do a better job than your eye. However, it's far from foolproof and you do need to be aware of its limitations and strengths.

The following suggestions and advice are the way I do things - I'm not saying this is the only way, just my way. I'm quite sure that others will do things a little bit different but in the main my methods work - for me.

The first thing to take note of is that not all focusing points are created equal. In all cameras, the centre point is the most accurate and will work accurately in the lowest light. Depending on the camera, there may be others of equal sensitivity but this is related to the price you pay for the camera.



19 cross-type focusing points in a DSLR



61 focusing points in a top of the line DSLR, of these 41 are cross-type.

Camera manufacturers have also spent a lot of time working out how best to use this mass of focusing points and you can set the camera to choose them by analyzing the scene and picking the most appropriate points. With all due respect to the engineers, they are not photographers and given that placing the point of best focus is intrinsic to the process of composing and capturing an image, ***I*** am the one who should choose.

This is why I tend to use just the central, most accurate, focus point and 90% of the time ignore the rest. I also re-jig the camera's controls so that the shutter button does not trigger AF, just the AF-On button on the rear, under your thumb. How you customise the controls will depend on the camera brand.

Focus

Leica S2, 35mm 1/60 f8 ISO160

In a controlled environment like a studio I will use only the central focus point because it works best in low light. I'll focus on the eye, hold the focus locked and then recompose the shot before releasing the shutter

600mm 1/1000 f5.6 ISO200

For tracking AF I'll use the central group of focus points because the tracking system works best if you use multiple points. This is the only time I use multiple points, where possible I use the focus/recompose technique with the centre AF point.

An image can be in focus but not sharp. I deliberately *blurred* this shot by using a 1/4 second shutter speed, but it's still *focussed* on the monks.
50mm 1/4 f8 ISO400

Shooting Modes

Very broadly speaking there is one correct or optimal exposure for any given subject. What I mean by that is that there will be a certain amount of light being reflected off your subject and to get a good healthy histogram, with the full tonal range of the sensor fully utilised, the camera will need a certain amount of light to fall on the sensor. This amount can be termed the **Exposure Value or EV**.

Leaving out ISO for the moment, for any given Exposure Value (EV) there are a number of different combinations of aperture and shutter speeds that you can use; but to maintain any particular exposure you must increase one and decrease the other at the same time. In other words 1/60 second at f8 is the same 'exposure' as 1/15 second at f16 – both will allow the same amount of light to hit the sensor.

Shooting modes give you options to control these combinations of apertures and shutter speeds, but they all rely on whatever EV the camera meter has measured. The camera calculates a recommended EV and the *camera modes merely present you with this information in different ways*, and , if you accept the camera's recommended EV, they will all give you the same results.

Manual

Many people are put off by the idea of using Manual exposure, it's seen as somehow more 'advanced' than the other three. Well, let me tell you, it's actually no more advanced than the other modes and will lead you to the exact same combinations of aperture and shutter speeds as the other three Auto Modes.

Manual Mode involves the photographer manually setting both aperture value (Av) and shutter speed (Tv) combinations so that a pointer or needle in the viewfinder is centred in the exposure scale. This simply means that the chosen Aperture and Shutter Speed combination will provide an exposure that matches the EV as recommended by the camera's meter. It's also clear that if you change the Aperture by one 'stop', say from f8 to f11, the needle will shift by one 'step' on the scale, and if you then change the Shutter Speed from 1/60 second to 1/30 second the needle will come back to the centred position.

Manual Exposure shows very clearly if the exposure that you have set yourself matches that recommended by the camera. If the needle is not centred, the scale shows you whether your settings will lead to overexposure or under exposure *relative to the camera meter's recommendation*. It's critical to understand that this recommendation is not necessarily correct – the histogram will show the truth in the file and you may need to adjust your exposure accordingly.

Shooting Modes

Av - Aperture Priority

This mode prioritises the Aperture by letting you choose, and fix, the aperture; then the camera will pick a shutter speed which gives an exposure value that matches the recommendation of the camera's meter. If you choose f8 and the camera sets the shutter speed to 1/60 second then this is exactly the same as using manual mode and manually choosing the exact same settings (which would mean the manual mode meter needle would be centred).

This mode is best used where the choice of Aperture is more important that the Shutter Speed, such as when you are using a tripod and the subject is still.

Tv - Shutter Priority

This mode prioritises the Shutter Speed by letting you choose, and fix, the shutter speed; then the camera will pick an aperture which gives an exposure value that matches the recommendation of the camera's meter. If you choose 1/60 second and the camera sets the aperture to f8 second then this is exactly the same as using manual mode and manually choosing the exact same settings (which would mean the manual mode meter needle would be centred).

This mode is best used where the choice of Shutter Speed is more important than the Aperture, such as when you need to keep a high enough shutter speed to freeze a subject in motion or to counter camera shake if you are hand-holding.

P- Program

This mode (P) is often dismissed as a beginner's mode but nothing could be further from the truth. Firstly, this mode automatically chooses both Shutter Speed and Aperture for you, again to match the camera's metering recommendation. However, it does not do this randomly. Program mode picks settings based on the lens you are using so if you have a telephoto lens fitted the camera will try to set a shutter speed high enough to get a sharp picture. If you have a zoom fitted try using Program mode and then zooming in and out. You should see the shutter speed changing at different focal lengths and the aperture changing to keep the recommended exposure value the same.

Shooting Modes

The camera is set to Manual, the Tv is set to 1.5 seconds and the Av is set to f8. The needle under the scale is centred so the camera's meter is telling you that it thinks this is a correct exposure.

The camera is set to Manual, the Tv is now set to 3 seconds and the Av is still f8. The needle under the scale is not centred, it's on the Plus side of the scale and thus indicates that the currently set exposure is higher than the camera's meter is recommending by one stop.

Tv is now set back to 1.5 seconds and the Av is now set to f5.6. The needle under the scale is not centred, it's on the Plus side of the scale and thus still indicates that the currently set exposure is higher than the camera's meter is recommending by one stop.

Shooting Modes

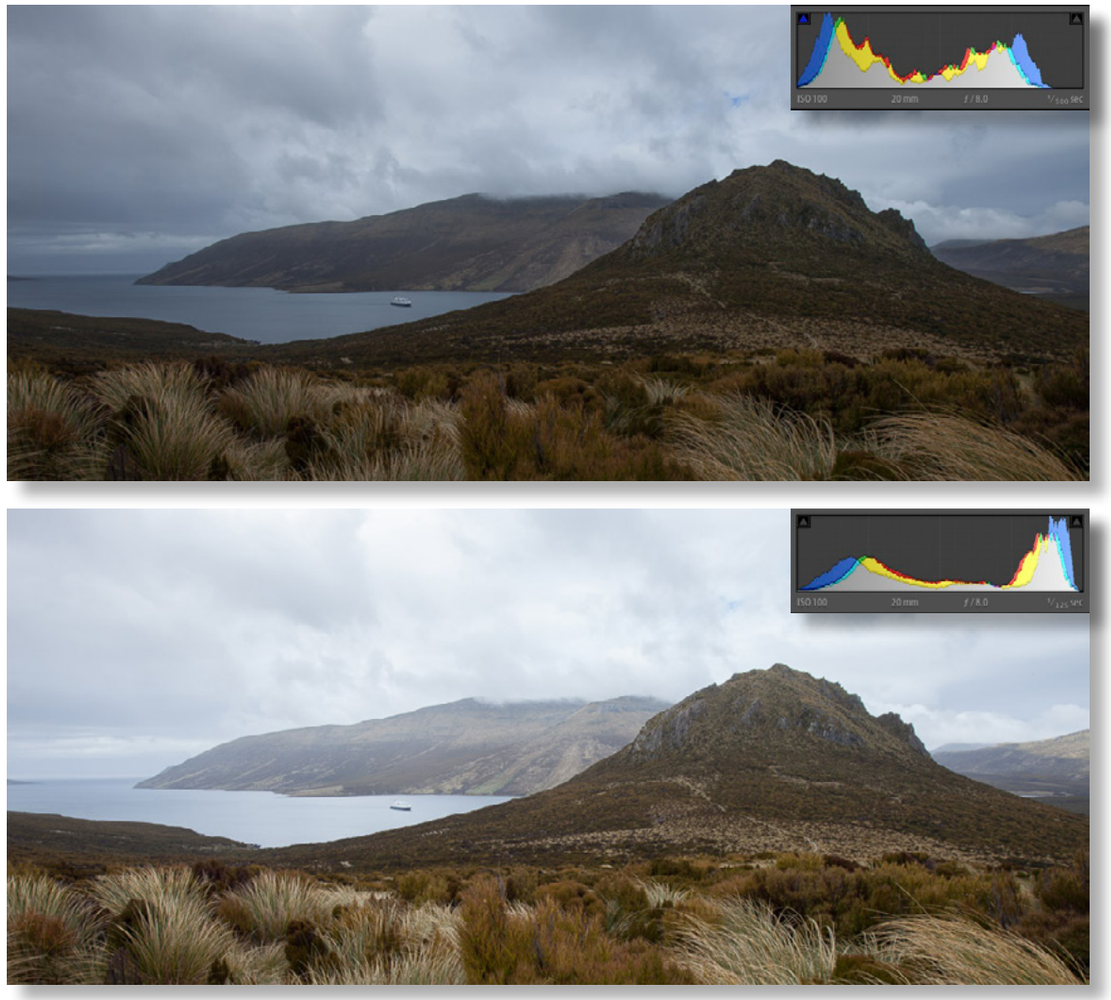
Exposure Compensation in Auto Modes

I have been stressing the fact that the camera's meter offers a recommendation that may, or may not, be the precise best exposure according to the histograms – it should be pretty close but you might need to override it to get an even better exposure.

It's worth mentioning that underexposing is very unusual if you are trying to get a good histogram, broadly speaking you will be trying to push the histogram to the right (over exposing).

Exposure Compensation forces the auto modes (Av, Tv, P) to give you a shutter/aperture combination that will override what the meter suggests is 'correct'. In any of the auto modes (not manual) the meter needle indicates the amount of this exposure override by showing the needle off centre one way or the other.

The meter 'needle' shows Plus 1 exposure compensation is set.



17mm 1/125 f8 ISO100

In **Aperture Priority** mode and with the Aperture set to f8 the meter gave me a recommended shutter speed of 1/250 second. On looking at the histogram I saw there was room for the highlights to move to the right and dialed in Plus 1 exposure compensation.

This altered the shutter speed to 1/125 second and gave me a much better histogram.

By pushing the histogram to the right I have kept all the highlight information intact but have given the shadows one stop more exposure. This seemingly small difference has actually doubled the information captured in the shadows.

When working quickly in difficult lighting, getting the shot is more important than worrying about which camera mode to use - if in doubt, start with Program and then refine the exposure if you have time.
85mm 1/125 f2.8 ISO100

JPEG and Raw

Most decent dSLR cameras can record images in two totally different file formats - JPEG and Raw - and I'm always banging on about shooting in Raw so it counts as a Photo Basic to look at what JPEGs really are, why they can indeed be useful and how to get the most out of them.

JPEG is an acronym for the Joint Photographic Experts Group, the name of the committee that created the JPEG standard. The first JPEG standard was issued in 1992 and confirmed under ISO/IEC 10918-1 in 1994. The format is intended for use on images with continuous, smoothly varying tones such as photographs and paintings and is not suited for line art and diagrams.

Because the JPEG format includes what's known as 'lossy compression' it is best used as a 'once only' format either direct out of a digital camera or as a delivery medium for finished images. It should never be used as an editing format with re-saving because repeated compression will quickly destroy the image's fidelity.

Variable File Sizes

There is also a direct correlation between the compressed file size and the image quality – since the JPEG format does throw away information it follows that the more it is compressed the more information is lost and at some point this will be visible in the image. It is quite remarkable just how much an image can be compressed with no visible loss of quality, it's quite feasible to compress a file to 1/10th of it's uncompressed size with very little visible loss.

One other aspect of compression that sometimes confuses people is that the resulting file size as saved to the memory card is very different from one shot to another. Compression works best on large smooth areas of minimal detail, like skies. An image of a forest with fine organic details will be much harder to compress and might only be ¼the size of the original whilst a silhouette against a sunset might compress to 1/20 the size, still on Quality 8 in Photoshop. When you save a batch of images for the web it is quite usual to see great variations of file size, even through all the images are, say, 800x500px. This is entirely due to differing subject matter.

204KB
Large areas of smooth tone compress easily.

688KB
Busy, complex images will not compress as much without losing important detail.

JPEG and Raw

How much Compression?

JPEG compression uses RGB as a colour-space on maximum quality but if you go below this the data is converted to a working space called YCC – Y is brightness and the two Cs are Chroma channels. The reason for this change is that the human eye is very good at detecting subtle changes in brightness but relatively poor at seeing small changes in hue and saturation.

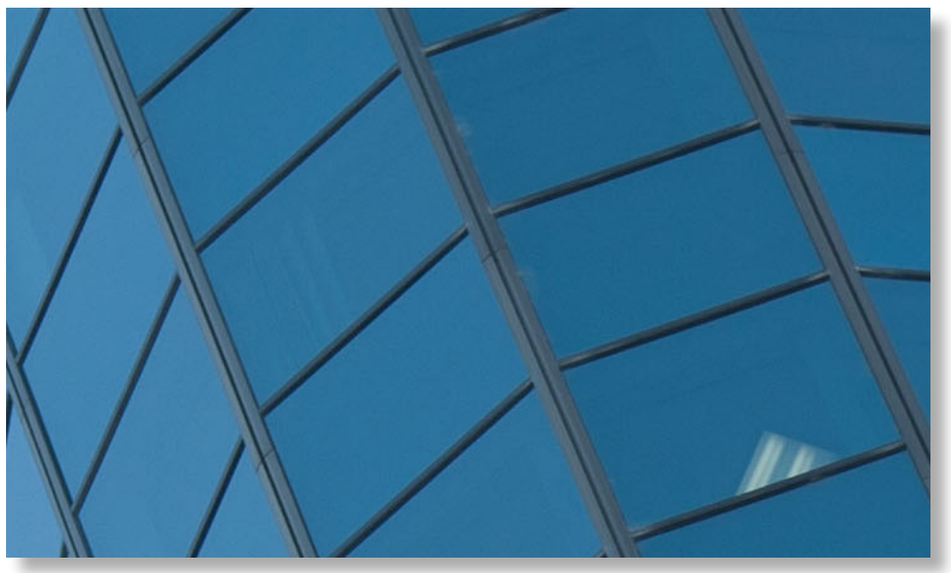
The resolution of these two colour channels can be halved with virtually no visual loss of image quality. This is called Chroma Subsampling and can be 4:4:4 (no down sampling, 4:2:2 (halved in the horizontal direction only) or 4:2:0 (halved in both directions). The eye is actually more sensitive to vertical details so halving the horizontal resolution can pass undetected.

Images are also broken down into blocks of 8x8 pixels – known as block splitting. This bit is quite technical and beyond the scope of this article, it involves cosine transformations, frequency domains and quantisation matrixes. I don't pretend to understand any of this so I'll trust the clever folks in the JPEG committee to work all this out.

I did some tests and found that you can use quality settings down to about 50% before objectionable artifacts start appearing. These usually show up worst around hard boundaries of different strong colours and where thin lines change direction sharply – ie text. Diagonal lines can become jagged and smooth sky tones will start to show a slight patchiness.

See my eGuide - "Inkjet Printing" - for more on colour spaces.

This image (top) is 15MB but compresses to 150k at Quality 1 in Photoshop - that's 1% of its full size. The artifacts are obvious in this magnified view above. Compare to Quality 8 (below), which is compressed to 750k, still a massive saving at 5% of the total.



JPEG and Raw

JPEGs in Use

JPEGs have a valuable role to play in digital photography as they are easy to work with, small in size, quick to deliver and fast to shoot.

For sports and news shooters JPEGs are extremely useful because they are immediately available, small in size and capable of top quality reproduction.

Conclusion.

If you have fully considered both sides of the situation, and have concluded that you need to shoot JPEGs then this is the right way to go.

If you do not have a pressing need to shoot JPEGs then consider setting the camera to RAW+JPEG mode to have the best of both worlds, or just ditch the JPEGs and shoot raw.

I call raw shooting ‘data capture’ – collect as much data as you can in the field and massage this data later on to make the image look as good as is possible. If you want finished images out of the camera, this is fine too but just be aware of the limitations.

Pros:

Small file size. Leica M - Large Fine JPEG approx. 6MB: Raw file size approx. 30MB. This means a card will hold five times as many images.

Higher burst capacity. Many more JPEGs than Raws can be shot before the buffer fills up

Fast delivery. If you need to get the shots out to a client real fast you may not have time to process raws.

Compatibility. Most software applications recognise JPEGs. Try dropping a raw file into MS Word!

Cons:

Limited bit depth. Jpegs are 8 bit only and can record only 256 distinct tones in each channel. Raw files can record at least 4096 per channel. If you do even modest post-processing, raw files will give you more room to move.

Control. Data is processed by far less sophisticated software in-camera, four or five crude sliders cannot compare with the vast number of adjustments available in a decent raw processor.

Output. Out of camera JPEGs are 'baked', for example sharpening cannot be reversed.

White balance. It's critical to set the correct white balance in-camera. Photoshop cannot fully correct a wrongly set white balance after the fact.

All the images in this eGuide are JPEGs. I hope you will agree, they look pretty good. But they all started life as Raw files, they were only saved as JPEGs once they were finished and ready for viewing on this iPad.
17mm, 1/15 f5.6 ISO400

White Balance

I think it would be fair to say that most people would have heard of the term 'White Balance' (WB) – it's the setting you change when you go from indoors to outdoors, or on a cloudy day. The intention of this setting is to make sure that a white object still looks white in the final image. If you are not sure which setting to use then you might use 'Auto' and the camera will make a best guess at an appropriate setting, which is usually good enough - but not always.

So, what is this 'white balance' What does 'Daylight' or 'Cloudy' mean and why is it important?

Light is not always neutral in colour. It can be very 'warm' in the case of sunsets and indoor incandescent light bulbs, or very 'cool' in open shade.

The measure of this colour cast is called the Colour Temperature: imagine a theoretical 'black body' heated progressively until it glows hot. As it gets hot it will glow “red hot” and as the temperature increases further it will tend towards more of a blue/ white, what we might call “white hot”. The temperature directly relates to the colour of the light given off and is thus called the 'Colour Temperature” and is expressed in degrees Kelvin or 'K' for short.

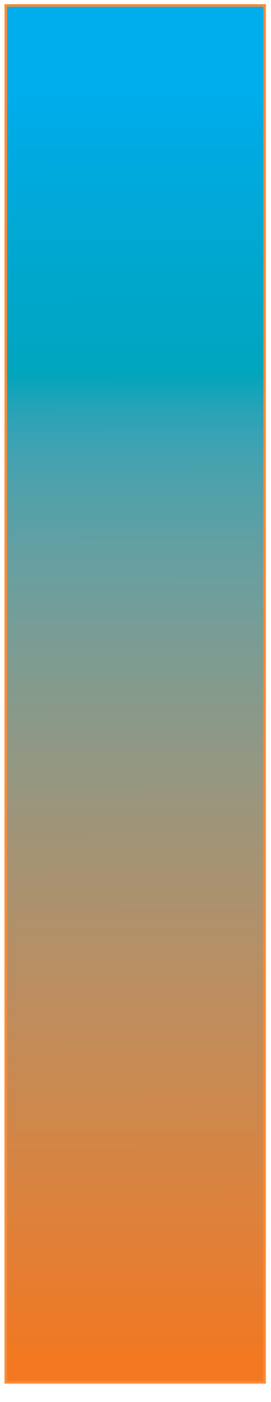
A low number is 'warm', ie a low voltage desk lamp is maybe 3000ºK, and open shade will be very 'cool' at maybe 10000ºK.

It follows that if the colour sensitivity setting (WB) of a digital camera does not match the colour temperature of the actual available light then there will be a colour cast and grey or neutral coloured objects will obviously no longer appear neutral. If you take a shot outdoors but have the camera set to 'Indoors' then the resulting image will be quite strongly blue in tone. Conversely using a Daylight setting indoors will produce very amber results.

Digital Sensors

In practice Raw files allow the camera to be set to any white balance because it can be chosen later in the Raw converter. For JPEGs it’s critical to set the correct WB on the camera because it cannot be fully corrected later since there is no genuine WB adjustment in Photoshop.

But remember, the preview on the rear screen **is** affected by the white balance setting, even in Raw mode, so if your colours look a bit ‘off’, check your white balance and I’ll bet it’s on Auto White Balance.



10000K - Deep Shade or bright overcast.

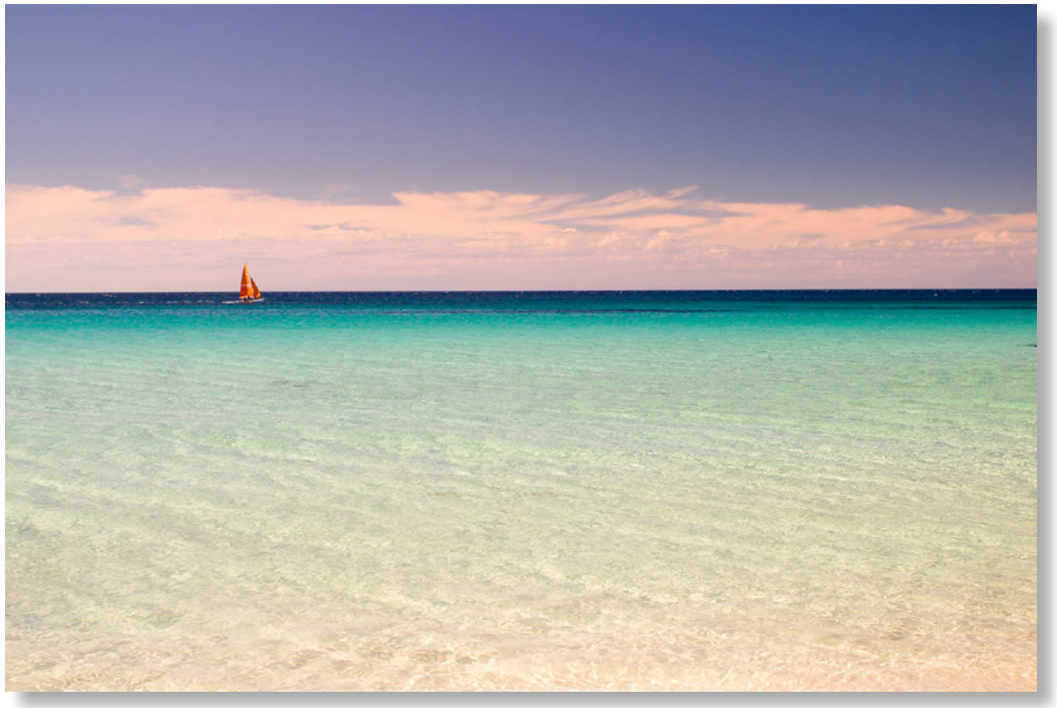
7000K - Open Shade

5500K - Standard Daylight

4500K - Evening sunlight

3000K - Indoor incandescent

White Balance



50mm 1/250 f8 ISO50

Failure of Auto White Balance (AWB).

AWB works fine if there is a full range of colours in a scene - blue sky and green fields will be OK for example. Where AWB fails badly is when there is one dominating colour that you actually want to capture because any strong overall colour is seen as a 'mistake' and AWB tries to remove it. This image of Eagle Bay in WA was taken to capture the intense blue of the water. Setting the WB to **Auto** has given me this hideous version on the left whilst using the correct **Daylight** setting gives me what I expected. Glorious red sunsets are defeated by AWB too.

Remember, this only applies to JPEG captures, Raws can be adjusted later, but it does affect the image display on the back of the camera and can cause you to doubt the success of the capture when the colours look all dulled down.

I leave my camera on Cloudy and shoot Raw; that means I can change my mind later but the image on the back of the camera looks pretty decent under most circumstances.

White Balance




135mm, 1/250 f2.8 ISO400

White Balance can also be a creative decision - which of these four images on the left do you prefer? They are shot using Auto, Daylight, Tungsten and Cloudy but can you tell which is which?

Personally I don't like any of them and would almost certainly adjust the Temp and Tint sliders in Lightroom until I was happy, like the final shot below.

There's no need to get too concerned about some sort of white balance 'accuracy' by measuring it or shooting a grey card for refence - personally I take the position that if it looks good it is good. It's too easy to kill a 'mood' by slavishly trying to neutralise colour casts when it might be that precise colour cast that is the mood.

The intense red of the Simpson Desert would be totally neutralised by using Auto White Balance. Using the Daylight white balance setting keeps the colours as intense as in real life.
135mm, 1/500 f5.6 ISO100

Nick Rains

I have been a full time professional photographer since 1985 when I left the United Kingdom in search of adventure and ended up in Australia shooting the Americas Cup yachting extravaganza in 1986/7.

Returning to the UK I mostly shot sport and travel around Europe before returning to Australia for good in 1990 where, being based in Sydney, I became more involved with both landscape photography and commercial photography.

During my eight years in Sydney I worked for a variety of publishers including Reader's Digest Books, Random House, New Holland, Penguin and Viking. I also did commercial work for the likes of Shell, Australian Tourism Commission and NSW Tourism but it was my landscape and travel images that gave me the most satisfaction. Over the years I have clocked up over half a million kms around Australia, looking for new places to photograph or even going back to the same places to get better images.

I moved to Queensland in 1998, and opened a gallery in Brisbane in 2001 and I have written and photographed six books, of which the currently in print title, **Australia - A Photographer's Eye** - is now in a second edition.

Since 2006 I have been shooting more travel work outside Australia, and doing a lot more writing about all things photographic. This lead to me becoming Principal Instructor for **Leica Akademie Australia** as well as leading tours overseas for keen photographers.

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