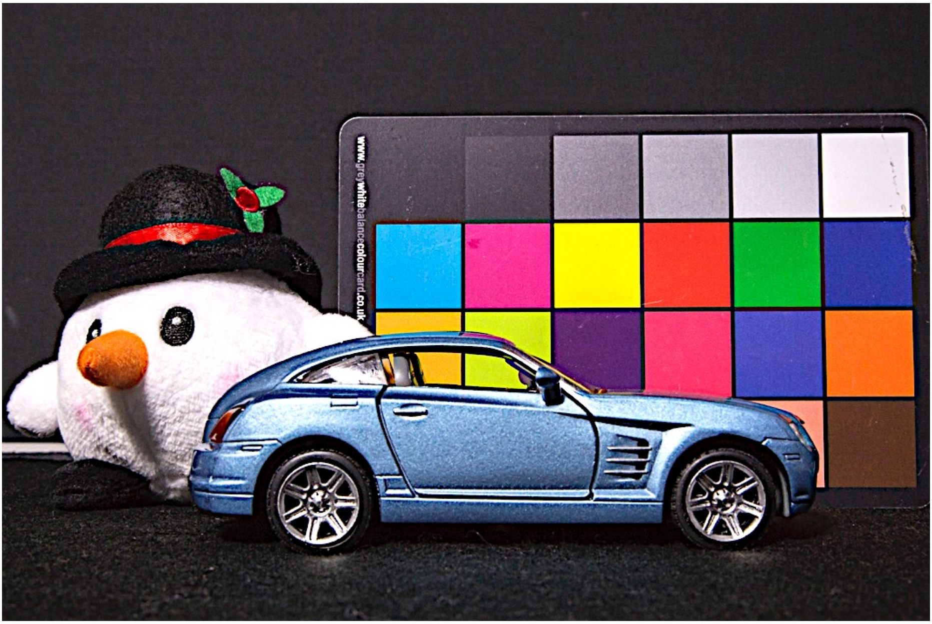
A free e-Booklet, with the compliments of Graham Houghton

UNDERSTANDING
EXPOSURE



All you need to know to take perfect images with your camera.

Graham Houghton

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Introduction:

If you a new convert to the world of digital photography using more than a simple smartphone to capture your images you could be forgiven for thinking that setting the exposure is complex.
One of the main reasons, I would argue, is that manufacturers have a vested interest in promoting this as a highly complex procedure that only their camera metering systems can help you with!
This would encompass even more sophisticated technologies such as different metering modes, auto exposure options, dynamic range optimisation and so on.
This is not the case at all and you will become to understand that these automated and supposedly "intelligent" options are really hindrances when it comes to understanding how to get the correct exposure!
The "problem" here is a very simple one.
There are exposures that are clearly wrong - for example those which are grossly over or underexposed - sometimes to the extreme that the subject is no longer recognisable.
I would argue that there is no "correct" exposure for any given subject/scene.

Consider the numerous combinations of Aperture, Shutter Speed and ISO there are which would produce vastly different looking images as well as producing lighter or darker images.
Consider this. Shooting by deliberately underexposing the image by 2 F-stops to create an intentional silhouette of your subject which is offset against a vibrant sunset is correct! So is over exposing your image by 2 F-stops if you are shooting a backlit subject to bring out the shadow detail!
Both of the resulting images are both entirely different and technically correct!
Correct being the extent by which your captured image matched your "mind's eye" when you conceived this image.
Our camera can't "see" the world that it is shooting - not at least in a meaningful way and it absolutely cannot make any creative decisions on its own as it just obeys a basic set of exposure algorithms programmed into the camera firmware. Let's face it, the camera is "best guessing" exposure!

I've probably been a little cruel here - for if you are a novice photographer the fully automated iA or semi-automated modes can make all the difference between getting an image versus no image at all. So where is this debate going?

Well it's back to the statements I've made repeatedly when using Panasonic Bridge/ Travel Zooms and CSC's and that is forget anything to do with digital enhancements in the camera set up.

So that means no I.Resolution, I.Dynamic and I.Zoom etc.

Forget iA and iA+ modes and make the basic choice from "A" aperture priority when depth of field is the primary choice for the image or "S" when its necessary to use fast (or slow) shutters speeds to stop or create subject motion blur in the image.
Set ISO to the native camera value which is usually 100 (200 in larger sensor cameras) and keep it there.

If you are shooting for the best possible image set the mode dial to "A", turn your control dial to set an aperture of F4 and go out and take some great pictures.
The only time you will need to over-ride the camera metering system is when there is a disproportionate ratio between the subject and background brightness's.
Such scenes would include snow and beach scenes which always result in the camera under exposing your image.
In time you will begin to "see" these scenes and automatically apply exposure compensation routinely.

What Is Exposure?

In a simplistic statement exposure is about making sure the right amount of light reaches the digital sensor to produce an image which looks correct!
There are numerous ways to achieve this so it is important to understand each of the elements which govern this exposure.

Let’s begin by looking at how an image is captured by the camera.
In some ways, the image captured by the camera sensor is like the image seen using our own vision system, our eyes and brain.
Just as the photons of light (these are the fundamental particles of light; they are both particles and waves and allows for their unique properties like refraction and diffusion) strike the retina in our eye and generate an electrical signal. The retina is a thin, delicate, photosensitive tissue that contains the special “photoreceptor” cells that convert light into electrical signals. These electrical signals are processed further, and then travel from the retina of the eye to the brain through the optic nerve, a bundle of about one million nerve fibres.
In the camera system, the retina is replaced by the photo sites, often referred to as “pixels” or picture elements. The photon striking the silicon atoms in the photo site release electrons which are converted

into an electric charge which can be amplified and measured in the camera processing pipeline.
Discounting the electronics used in the camera system the major difference between the two systems is in the fact that the eye can adapt to changing brightness levels, and more significantly, colour temperature changes in real time.
The camera sensor on the other hand has a fixed sensitivity at the time of the exposure and it is important that the camera sensor receives enough photons during the time that the shutter is open to produce an image which is neither too bright or too dark.
In many ways like our own eyes can be temporarily blinded by intense light, the photo sites in sensor have a finite storage capacity.

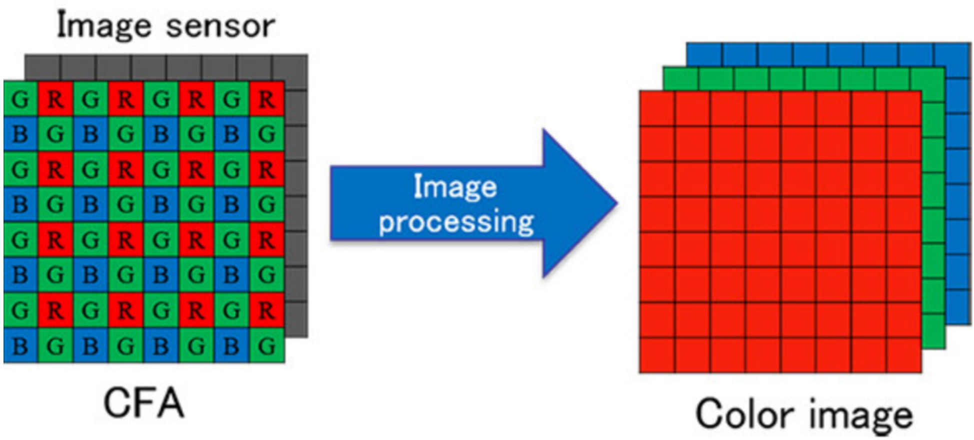
This capacity depends upon their physical size which in turn depends upon the overall sensor size and the pixel density.
The smaller the photo site the quicker that these are fully saturated by the photons arriving from the lens.

Once the photo site has been filled, by electrons released by the photons striking it, it becomes saturated and no matter how many more photons strike it they cannot release any more electrons.

We call this “blow out” and affects the brightest areas of the image.
As each photo site has an accompanying colour filter (physically covering it) these blow outs may occur in any, or all, colours that are fully saturated.

In the camera imaging system, the output from each photo site is an analogue dc voltage.
This voltage is extremely small and needs amplification to bring it to a sufficiently high enough value to be “digitised” in order that it can be processed mathematically by the image processing system.

The amount of amplification is tied into the sensitivity control of the camera which we refer to as ISO.
There is always some amplification needed to present the analogue to digital converter (ADC) with a voltage level that will deliver the full digital output that the ADC can provide. In our modern systems, these ADCs have 14 bit outputs capable of generating a digital value that can be one of 16384 values.
If there is no voltage present (black level) then the output from the ADC is 0.
If the sensor is outputting white value, at a saturation point, the ADC will output a value of 16384.
Thus, the image is made up from every photo site (pixel) analogue output digitised into a digital value in the range of 0 to 16384.
Because of the construction of the colour filter array (normally a Bayer matrix) the distribution of red to blue to green pixels is such that the green photo sites are more than the red and the blue ones.
This is to emulate our own eyes sensitivity which is predominantly in the green spectrum.



The Bayer Colour Filter Array and the de-mosaic colour image

In today's world of digital cameras, the most universal use image sensors pattern is the Bayer (Mosaic) sensor. The Bayer sensor is a U.S. patent registered in 1976 and the first digital camera invented back in 1975 by

Eastman Kodak and Steven Sasson to use this similar technology. This filter pattern alternates a row of red and green pixels with a row of blue and green pixels. Each pixel will either have a red, green or blue filter layer (See image above).

The Bayer sensor consist of 50% Green, 25% Red and 25% Blue pixels. Order to convert the raw input into a final image, the digital camera uses specialised de-mosaic algorithms to convert the sensor data into RGB pixel data.

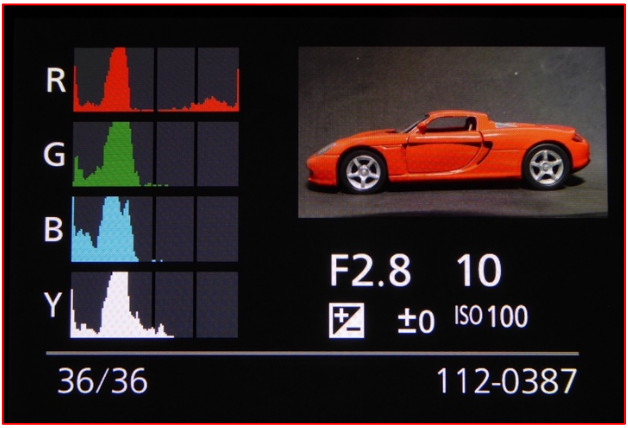
The camera computed the colour using several overlapping, example 2x2 arrays. This method sometimes can produce an unrealistic looking result.

The most common artefact is known as “moiré”.

Moiré patterns are often an undesired artefact in images produced by various digital cameras when shooting images with regular patterns like brick walls etc.

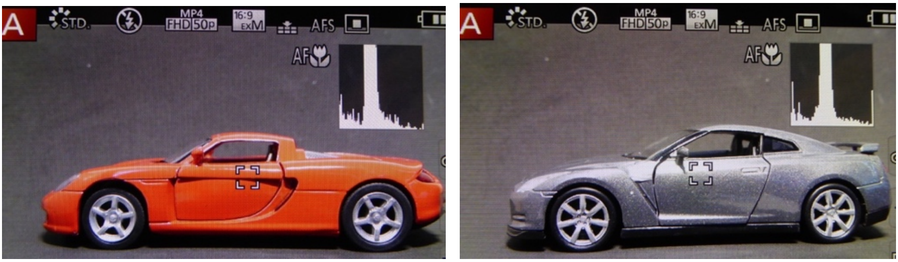
However, to overcome these artefacts depend on both of texture and software using to develop the digital camera RAW file.

Once the image data has been “re-constructed” it can be reduced in noise, you controlling the amount of blur applied to mask either noise in the colour (chrominance) or brightness (luminance) channels.
This is where you make the most significant improvement over in camera JPEG processed files.
The analogue to digital conversion can be seen visually by looking at the camera “histogram” which shows the distribution of pixels from black (zero value on the X axis) to white (255 value on the X axis).
This is derived from the camera processing system RAW sensor data which is used to generate the JPEG file.
Yet camera manufacturers, have not incorporated a system which can show the real output values from the sensor.
As such any camera adjustments, which are attributed to the JPEG processing will reflect in the displayed histogram.
Things like the photo style (and any adjustments to its parameters) and white balance can skew the results.



The histogram is a pictorial representation of the number and distribution of pixels in the image.
On the left-hand side of the graph are the dark (shadow areas) and on the right the light (highlight areas).
The height of the bars represents the number of pixels of that value.
The shadows represent a digital value of 0 (zero) whilst the highlights have a digital value of 255.
Thus, each colour has a range of 256 discrete brightness values.

An image will have a maximum tonal range of 256 Red, 256 Green and 256 Blue values giving 16777216 colour values commonly referred to as "true colour".
The distribution pattern will give an indication on the exposure. A correct exposure will have bars in the highlight and shadow area and a peak or cluster of bars about halfway representing the mid-tones.
The playback histogram is more useful, in my opinion than the on-screen histogram available during shooting as this only shows the tonal range of the image, not how it was recorded.



brightness histogram displayed during shooting mode (if enabled in Custom Menu (4/9)

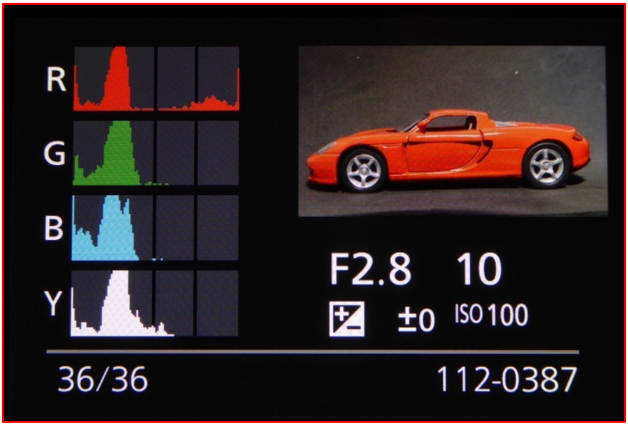
The brightness values can be seen in the two examples of images shown above.
There is a grouping of bars around the central area of the graph indicating the neutral grey background has many recordable pixels the blacks of the image (value 0) are visible as well as the highlight pixels with a value of 255.

If we look back a moment at the heart of this, the analogue to digital converter, depending upon the camera it may be constructed with 10, 12 or 14 bits of precision.
The precision will dictate how the final conversion will appear in the image.
Too low a conversion will result in banding or contouring especially in areas of close brightness such as in skies or areas of solid objects.

It is the purpose of the camera sensitivity system, the ISO control, to ensure that the fully saturated signals appear in the highest order bit of the ADC. This is where the maximum, individual tonal, values appear.
With a simple point and shoot camera the ADC may be 10 bits a DSLR on the other hand may have 14 bits of precision.

However, it’s worth remembering that during the conversion to JPEG this results in an image with just 8 bits or 256 discrete levels of brightness per colour.

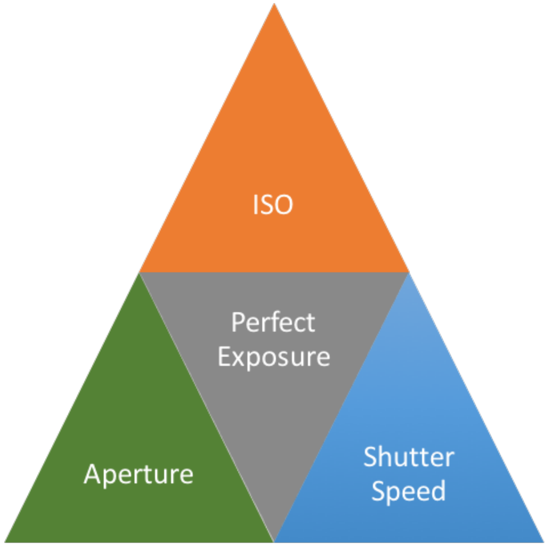
If we look at that in more detail it means that if we are to get the most possible tonal data in our image ranging from the shadows to the extreme highlights our ADC must be presented with the highlight voltage set so that it has the greatest effect on the image.
On the histogram, this means that the highlights should be as close to the right-hand side of the graph, without clipping important highlight detail.
If we capture an image where the highlights are mid-way across our histogram curve it means the image is probably underexposed and in subsequent post processing the whites must be increased by something like the "Levels" adjustment, or more crudely with the brightness and contrast control slider.



If you have an image with a highly saturated colour, like the one above, it is useful to look at the RGB & luminance histogram.
If we just looked at the black and white (luminance) curve it appears that we might be underexposing the image.
However, look at the red channel.
It has pixel brightness's hard against the right-hand edge indicating that some of the red pixels are likely to be saturated and contain no tonal information!
This technique of placing the highlights as close to the right-hand edge of the histogram is called "Exposing to the Right" or ETTR.
It's a process that is best suited to shooting in the RAW format as it allows the final contrast of the image to be set as you envision the scene as you shoot it.

If you were to use this with the in-camera JPEG processing option it is likely that the highlights will have been compressed and show no detail. This detail cannot be recovered in subsequent editing.

The Elements of Exposure



Looking at the traditional "exposure triangle" the three elements that make up an exposure are the Aperture, the Shutter Speed and the ISO. Each of these elements affects the way in which the image is created.

Aperture affects the amount of light reaching the sensor. A large aperture allows more light to enter the lens resulting in a brighter image. However, it is primarily used to determine the amount of depth of field in the image.
A small aperture (large F number like F8) creates more depth of field than a larger one (small F number like F2.8).

Shutter Speed affects the duration which light from the lens falls on the sensor but is primarily used to determine the amount of subject

motion blur in the image either intentionally or otherwise. A short shutter speed arrests any subject motion whereas a longer shutter speed creates some motion blur in a moving subject.
The final element **ISO** doesn't vary the amount of light reaching the sensor however its action is to brighten the image by increasing the gain of the amplification of the photo sites before being applied to the analogue to digital converter.

The three elements work in conjunction to provide the correct exposure.
The exposure can be created by any combination of the three elements so in a sense there is no correct exposure, it is just the way that each of the settings will influence the final appearance of the resulting image.

If you make a change to one of the three elements to keep the exposure consistent you must make an opposite and equal adjustment to one of the others (or a combination of changes in the other two).

For example, if the existing exposure reads 1/125sec, F5.6 and ISO 100 if you wanted more depth of field you could go for an aperture setting of F8.
To keep the exposure the same you would need to allow the camera to expose the light on the sensor for a longer period as the aperture opening of F8 is smaller than F5.6 thus reducing the light intensity.

If you wanted to keep the shutter speed the same because of subject motion possibilities, then you would need to make a compensating change to the ISO to make the camera more sensitive.
A change from ISO 100 to ISO 200 would do this.
The choice of which element to change is obviously dictated by the subject being captured and the needs of that image when processed.

Controlling Exposure: Aperture

As we know the aperture is the hole inside the lens which limits the intensity of light allowed to reach the sensor.
Thus, a larger aperture allows more light to reach the sensor and a smaller one obviously reduces it.

As you can see the aperture size is denoted by a “F” number and this is a mathematical ratio of the diameter of the aperture and the focal length of the lens.
For example, if a lens had a focal length of 50mm and the aperture diameter was 25mm the F-stop would be 50/25 = F2.

That is why F4 is always the same amount of light irrespective of how large or small a lens is or how long or short its focal length is.

It is this fact that allows us to use lenses from one camera mount to be used on others – if an adaptor is available to get the focus point at infinity to be in focus at the sensor plain.

The reference to the “F” numbers is based upon a series of numbers on a log(2) scale normally beginning with F1.0, then 1.1, 1.4, 2.0, 2.8, 4.0, 5.6, 8, 11, 16 and F22.

Each step doubles or halves the amount of light passed through the lens.

The principal reason for using an aperture is one of being able to control the depth of field recorded in the image.

In a landscape shot, for example, you normally want everything from the foreground to infinity in sharp focus so we select a wide-angle lens setting and a small aperture.
It is worth remembering that with a small sensor camera the crop factor will give extensive depth of field so even an aperture of F4 gives the equivalent of F22 on a full frame camera.
Choosing a smaller aperture like F8 doesn't improve on the depth of field and starts to soften the image through diffraction occurring because of the small aperture diameter.
Focussing at a distance of 1/3 of the way into the scene usually sets the focus point at the hyperfocal focus distance which ensures the lens captures the maximum depth of field at that aperture and focal length.

The other feature of a large aperture is to be able to isolate a subject against the background as with flower photography.

By using a longer focal length and a large aperture the depth of field is significantly reduced allowing the subject to be isolated against its background.
This is a useful technique if the background has a lot of clutter and would distract from the subject.

Controlling Exposure: Shutter Speed

The purpose of the shutter is the same as the aperture in the lens, it is used to regulate the amount of light reaching the sensor.
It does so by setting the time that the light from the lens falls upon the sensor surface.
In compact and bridge cameras, the shutter is within the lens itself. Unlike a DSLR camera in which is positioned just before the sensor itself.

This has a significant advantage that it can be used to synchronise flash at any of the available mechanical shutter speeds.
The primary reason photographers will choose to shoot with shutter priority is to enable them to dictate the amount of subject motion blur in the recorded image.
Choosing a short shutter speed (like 1/500 sec) allows the camera to capture fast moving subjects i.e. it freezes the subject motion.
Using a longer shutter speed (like 1/4sec) allows any subject which has motion to be captured with subject motion blur.
This is the technique used to capture silky flowing water or clouds.

Shutter speed allows for more exposure correction than aperture as it has a far bigger control range from seconds to 1/8000 second giving as much as 18 stops of control!
When selecting a shutter speed to freeze subject motion it is important to consider both the distance and the angle at which the subject is moving relative to the camera.
A subject moving across the frame at a short distance from the camera needs an exposure which is faster than the same subject moving at the same speed further away from the camera.

Controlling Exposure: ISO

Although this method controls exposure it is unlike the aperture or shutter speed controls which directly adjust the amount of light reaching the sensor.

As I previously mentioned the ISO control directly adjusts the amplifier gain of the analogue output from the sensor pixels.

However, there is a dire consequence of using this control to set the exposure.

As with all forms of amplification not only is the active signal amplified but also any noise that is in the system is amplified as well.

That is the reason that I keep stating that it is always best to use the Base or Native ISO that the camera has, in order to minimise the noise introduced into the system.

In most daylight lighting this is usually not a problem, in fact in some countries bright sunshine is a positive disadvantage necessitating the use of ND filters if you want to shoot with larger apertures.

Noise in the Digital Camera:

In our digital camera processing system, we can identify three distinct sources of noise.

This noise affects image sharpness and contrast and we must take appropriate steps to ensure that the noise introduced is as little as possible.

Firstly, light is an electromagnetic wave and as such has noise, not unlike the noise that you hear on a radio transmission. This noise is usually in proportion to the amplitude of the signal itself.

If you have lots of signal amplitude, then noise isn't usually a problem. This is called "shot noise". If you are shooting with good ambient light, then the signal to noise ratio is very high and noise is mainly insignificant. However, shoot in lower light levels and increase the ISO then the signal to noise ratio decreases and noise becomes a significant part of the image. Shot noise is the most significant of the three noise sources.

The second noise source is called “read out” noise and it relates to the variations in the voltage read out from the sensor pixels.

This doesn’t vary with changes to ISO however any noise which is introduced at this stage will be amplified by the changes in ISO.

Ironically as cameras are now being made to shoot at faster frame rates and required to output 4K video at 60fps the “read out” noise is increasing!

The third source of system noise is “dark current”.
Dark current noise is created by electrons that emerge through thermal processes in the pixel.
The number of electrons increases with increased exposure time and temperature.
Dark noise can be reduced by cooling the sensor, which removes inherent energy from the sensor, thus reducing the number of rogue electrons.
In consumer cameras, this process of cooling the sensor it not normally employed.
It is possible for the sensor to heat up quite significantly when using the video modes and it is common to see increases in noise captured in still images if they are shot immediately after shooting video with the camera.
So, in summary, noise is inevitable in the process of converting light energy into a digital image. However, there are two other factors which also relate to this.
Size of the actual pixel and the sensor technology.
Large photo sites (pixels) are less prone to the issues of shot noise so even if you have a large format camera if the pixel density requires that the pixel size is reduced then although resolution may be improved, noise performance may be degraded.
Secondly read out noise is more of an issue with the latest generation CMOS sensors as each pixel now has its own amplifier.

CCD devices suffered less read out noise but manufacturing costs were significantly more and the ability to read out the data at fast enough speeds for even 1080p video sadly preclude them from modern cameras.

So, in summary changing aperture or shutter speed are the only ways to affect an exposure change unless the optimum exposure is either impossible or undesirable where changing ISO is the only alternative.

White Balance:

Whilst white balance does not technically play any part in exposure determination, especially shooting in the RAW file format it does have a very significant impact on the way JPEG images are produced.
The reason for this is that the temperature of light can vary due to the time of day or the light source.

It can range from "warm" to "cold" – a sunrise or sunset being "warm" and images shot in strong shadow can appear "cold".
Our perception of colour remains consistent no matter what the light source is.
A white object will look white when illuminated by the rays of sunset or in deep shade.

The camera, on the other hand, will show predominance of red/yellow in the sunset and blue/cyan in the shadow image.
With your camera, there are a few options available to you to try and ensure the camera records white as white irrespective of the illumination colour temperature.
The first one is to trust the camera's Auto White Balance. The accuracy of modern white balance systems has vastly improved in recent years and now AWB is a viable solution for JPEG only shooters.

Secondly you could rely on the nearest camera pre-set options to record the scene with perfect colours. This could be daylight, cloudy, flash etc.,

Thirdly you can dial in the correct Degrees Kelvin of the light source in the “K” setting mode.

My final alternative for you is to use a neutral grey reference card and shoot the first image including this reference in the image and shoot in the RAW file mode.

Use this to set the correct white balance in RAW processing, by using the WB picker tool, and if the light does not change during the rest of the exposures you can use Photoshop's or Lightroom's batch processing method to set the white balance of all the associated files.

Setting white balance can often be essential – for example in product advertising photography however for general photography it might not always be desirable.
As an example, if you are shooting a landscape at dawn or dusk the light will appear to be much warmer than at any other time of the day.

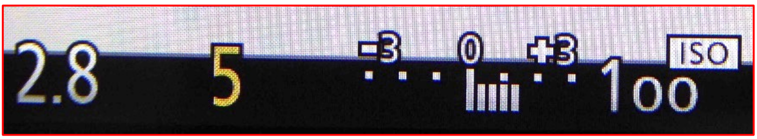
If you were to use a method which recorded the actual white balance of the scene the image will appear much cooler than what you experience.
The best solution here is to set the accurate white balance point but in post processing apply a warming filter or, if you shoot JPEG only, you could use the sunset filter in the creative filter mode.

Exposure and Metering:

We've seen how aperture, shutter speed and ISO directly affect exposure but how do we know what combination of these settings will give the correct exposure for any given scene.

As an example, take a landscape illuminated by a full moon on a clear night.
Metered with a hand-held exposure meter it might have an exposure value of -2 with an exposure of 8 seconds at F4 with an ISO of 100.
Shoot the same scene by overcast daylight and the meter may show an EV of 13.
If you used the same aperture and ISO the shutter speed would be around 1/100 second to obtain the correct exposure.
What this shows is the fact that we need to measure scene brightness to determine exposure.

Conveniently all digital cameras have a very accurate (1/3EV) exposure meter built in that can measure the scene brightness.
Additionally, these meters also provide a direct illustration of the combination of aperture, shutter speed and ISO needed to create the correct exposure.



As you may have discovered the meter gets you perfect exposures in most scene situation.
There are a number though of instances where you may feel that the exposure was quite as good as it ought to have been.
Let's look at why this might be the case.
All in built camera metering systems suffer from two problems.

The first is that they measure the scene using reflected light from the scene rather than the ambient light falling upon it.
This is often referred to as TTL or through the lens metering.
The second problem is that they are calibrated based upon the assumption that all photographed scenes integrate out to a neutral grey.
I think historically Kodak analysed thousands of customer negatives and arrived at the conclusion that the "average" scene reflectance gave a 18% reflectance and that became the standard for the photographic industry and many test targets called "Shirleys" were produced for professional photofinishers to correctly set up their film processing, printer calibration and paper processing. I have fond memories of seeing these Shirleys being displayed on colour negative analysers and workstations.

A typical Kodak "Shirley" with the densitometer measurement patch

Metering Modes:

All our digital cameras offer a range of metering options which the user can select depending upon the scene type complexity to get the correct exposure.
These are:
Full screen evaluative/matrix mode. This mode doesn't rely on just scene brightness; they take a range of measurements from different areas of the image and then compare these readings to a set of parameters stored within the camera firmware to recognise how the scene should be metered.
For example, if the camera is used to photograph a backlit portrait and the metering based the exposure on the average scene it would probably result in an underexposed image.
If the camera was set to evaluative/matrix mode, then the system would recognise this fact and adjust the exposure using positive EV compensation to brighten the image.
These systems are getting more sophisticated and can also base exposure on not only brightness but colour information as well.

Centre weighted mode. This mode rather than metering the scene it takes a reading from the centre portion of the image. In our backlit portrait example this would produce a much better result. This is because any background brightness is largely ignored in the exposure determination.

Spot metering mode. This mode and the Panasonic precise mode is one which is becoming more common in use.
The reading is restricted to just a few degrees of view allowing you to select specific areas to measure the exposure.
You can even target the highlight areas then the shadow areas to determine the total contrast within the image.
This mode is extremely useful when you are photographing a subject which is either brighter or darker than its background.

By using this precise measurement spot it is easier to get the correct exposure for that area.

Tricky Exposure Situations:

Quite often no matter what metering mode you use the camera will still get the exposure incorrect.
This is because the fundamental calibration is designed to make every reading result in the 18% reflected value being achieved.
This may result in dark subjects being recorded too light and light scenes being recorded too dark.
One solution in situations like these is to use a target specifically designed for this purpose – an 18% grey card.
As its name suggests it is nothing more than a spectrally neutral grey card designed to reflect an “average” amount of light from the incident/ambient light that is falling on the subject.
So, if you place this card in the light that you are photographing the scene with and use the camera spot meter to measure the exposure from this card.
Record the value suggested by the meter on the LCD and then set these values into the manual exposure mode of the camera.
Returning to our backlit portrait, if you were to ask your subject to hold this target card in front of them and you point the spot meter at this card you will get an exposure reading that you can then set in the manual mode and get a perfect exposure.
This highlights the fundamental flaw in relying upon the TTL metering mode of the camera under subject conditions.
To get the most accurate exposure reading it is better to use this reflected light from the grey card method or use a special hand held meter in its incident light meter mode to gather the exposure reading.
If you are using Aperture or Shutter priority modes to capture images you may, over a period, develop a “feel” for those specific scenes which consistently fool the camera exposure system.

Such is the case with snow or beach scenes in bright sunlight which inherently have a bright background.
In a typical snow scene, it may be necessary to use something of the order of 2 -3 F-stops of exposure compensation to get an exposure which doesn't look grey or underexposed.

If you were to use the camera histogram feature it would need to have the highlights set against the right-hand side of the graph however, it should not result in the highlight detail being lost due to blow outs.

Dynamic Range:

One of the skills that you will develop as you progress with your photography is the envisioning how the actual scenes before you are rendered as a digital image by the camera.
We have seen that in shooting a backlit portrait this can quickly result in a silhouette being produced and a bright snow scene being underexposed.
In other words, what our eye "sees" is not how the camera records the scene for us.

We have seen techniques to compensate for these metering failures to obtain an exposure that more accurately matches our expectations of our image.
The problem is that the camera has a much-reduced range of tones that it can capture within the one exposure compared to our own vision system.
The very best of consumer cameras may be able to capture about 12 F-stops of difference between highlight and shadow. It has been estimated that our eyes can see with a range of about 24 F-stops!

Smaller sensor cameras such as compact point and shoot types or bridge cameras may only be able to record a total range of 8 to 9 F-stops.
This range is called the "dynamic range" and is one of the most problematic areas in image capture.
Dynamic range is related to pixel size and ISO amplification.
Larger sensors with larger pixels have a wider range than smaller sensors with smaller pixels.

As ISO is increased to get our exposures correct so noise is introduced into the system. Noise reduces contrast which directly reduces dynamic range.
It is a fact but if our scene that we want to capture faithfully has a tonal range which exceeds that by which the camera can capture we will end up with a compromise as to where we will sacrifice some image detail. This will be either the highlight areas or the shadow areas.
Which one you choose will depend upon the scene content.
If you imagine shooting a wedding scene it is desirable to capture highlight details in the brides wedding dress than texture in the groom's dark suit. Again, the histogram will be your friend here to set the highlight areas against the right-hand side of the graph and you would ideally shoot in the RAW mode so that you can extract as much highlight detail as possible.

JPEG images may compress so much of the highlight detail.

So, what can be done to improve our chances of capturing the scene correctly?

Well the best advice I can give you here is to stop shooting scenes that you know are well beyond the dynamic range of the camera.

Wait until the light falling upon your subject has a much-reduced contrast range.

Shooting flowers in bright sunshine, for example, causes too many highlights that if you were to set the exposure to capture detail in these areas the shadows and mid-tones would be very much under exposed. It would be better to wait for overcast lighting or create your own diffused lighting by placing a white nylon diffuser between the sun and the flower.

Well this advice doesn’t appear to be offering much practical advice in shooting in these situations but honestly the best advice would be to learn how the camera “sees” the image rather than believe your eyes.

A technique that I learned was to “squint” my eyes. This has the effect of reducing the natural dynamic range of our eyes thus bringing them nearer to how the camera will record the image.

Some Thoughts on Controlling Dynamic Range:

We have seen previously how to control exposure by adjusting aperture, shutter speed, ISO or any combination of them.
In some situations, particularly low light ones, we can often be forced to raise the camera ISO because we want to have a specific depth of field, or we are at maximum aperture, and have a shutter speed which is already on the limit of capturing some amount of blur through subject motion. In this situation, our only option is to increase the camera ISO.
As I have previously mentioned increasing ISO not only increases image noise it also reduces the dynamic range that the camera can record.
In this situation, the only viable option is to add some additional light into the scene.
This might be by using some additional lights, the use of a reflector to bounce light back into the subject or to use some form of flash.

In this picture of my daughter’s wedding I had to use fill flash to compensate for the fact that they were in a backlit situation and I wanted to retain the ambient background which would have been blown out if I had used exposure compensation.

In the studio, we can control our lighting precisely.
We can meter the highlights and the shadows and ensure that they fall within the cameras dynamic range. If they exceed it, we can add fill light to reduce the contrast.
If we are shooting landscapes quite often the skies are much brighter than the foreground and again result in a situation where we cannot get a suitable exposure to show detail in both areas.
In some circumstances, it is possible to reduce the contrast by using graduated neutral density filters where the upper portion of the filter "holds" back some of the light reaching the sensor.
Whilst this works well however, if the landscape has objects such as trees or mountain peaks which rise into this area these too will be darkened and look artificial.
There is also a technique where you can capture multiple images at different exposures (exposure bracketing) and then merge them in your editing program using layer masking techniques.
This is not without problems. If there is any subject motion this will be evident in the merged images.
On way around this is to shoot in the RAW mode and then make separate JPEG images from the one image. One for highlights, one for mid-tones and finally one for the shadows.
Again, the three images can be combined to give the best compromise.
Some cameras have the facility to produce an in-camera image with increased dynamic range.
Again, the camera can take several images and then combine these into one image in a process usually known as HDR or High Dynamic Range.
These images can be quite unpredictable in their outcome and I find tem hard to envision before I take the shot. I am not a fan of the highly processed HDR images which have extreme distortions of the subject's original contrast.

Conclusions:

Well I hope in this short guide to exposure it has given you some answers to problems that you might be seeking an answer to.

If you need more information on shooting with flash to reduce dynamic range, then I do have the User's Guide to Flash again available as a free download on my Photoblog Downloads page.
https://www.grahamhoughton.com/download-section/

If you want to provide any feedback on this guide, please do so by emailing me at support@grahamhoughton.com

Glossary of Photographic Terms:

Aperture - the variable opening in the lens through which light passes to the film or digital sensor. Measured in f-stops. I like to compare it to your pupil which opens and closes to allow light to enter your eye depending on the brightness level of the room.

Bracketing - taking a series of images at different exposures or EV. You may see a setting on your camera that says AEB (auto exposure bracketing). This is often used when creating HDR images or in difficult lighting situations where you may want to have a range of exposures from light to dark.

Bulb - the "B" setting on your camera where the shutter remains opened for as long as the button or cable release (remote trigger) is pressed.

EV - Exposure Value is a number that represents the various combinations of aperture and shutter speed that can create the same exposure effect.

Exposure compensation - modifying the shutter speed or aperture from the camera's recommended exposure to create a certain effect (over or under exposing) – usually used in the Shutter Priority or Aperture Priority modes. Represented by a little +/- button on your camera. Your camera reads light bouncing off your subject and is designed to expose for medium grey. So, when photographing a subject that is lighter or darker than 18% grey, you can use this setting to tell the camera the proper exposure.

Exposure - the total amount of light reaching the camera sensor. It is controlled by the setting of the aperture, shutter speed and ISO. See my Exposure Triangle for more details.

F-stop - is a measure of the aperture opening in the lens defined by dividing the focal length of the lens by the aperture diameter. Sequence of f-stops that are multiples of the square root of 2 (1.4): giving a range of 1, 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 22, etc. Remember that each step is double the amount of light.

ISO - stands for International Standards Organization and represents the sensitivity of your camera's digital sensor to light and subsequent signal amplification. The lower the number (ISO 100), the less sensitive, the higher the number (ISO 3200) the more sensitive. A higher ISO allows you to shoot in low light conditions

Shutter speed - the amount of time the shutter is opened during an exposure. The shutter speed controls subject motion blur. Use a fast speed (like 1/2000th of a second) to freeze motion, or a slow one (1/4 of a second or longer) to blur moving objects.

Zoom lens - any lens that has variable focal lengths such as a 24-70mm or 18-55mm. You zoom in or out by rotating the barrel of the lens.

Remote trigger or digital cable release – a device that allows the camera to be fired without pressing the button or touching the camera. Helps eliminate movement of the camera during long exposures.

Macro lens - one that focuses very close to the subject allowing for 1:1 reproduction size of the object or larger.

Camera resolution - expressed in megapixels is the dimensions your camera's sensor is capable of capturing. This is not the only factor in image quality, but generally the large the number, the larger prints you can produce from it without loss of quality.

File format JPEG versus RAW - The FZ300/330 has the ability to shoot both formats. If you choose JPG, the camera will shoot a RAW file, process it using the Photo style you've selected in your menu, save it as a JPG and discard the RAW version. If shot in RAW the resulting file will be larger, carry more information (but the same pixel resolution, see above) and require software to process. It gives you the photographer more control over the final look of your image.

Lighting and Portrait Photography Terms

Ambient light - also referred to as available light, is the light that is occurring in the scene without adding any flash or light modifiers. This could be daylight, or artificial light such as tungsten or LED Lights.

Main light or key light - is the main light source for a photograph. It could be the sun, a studio strobe, a flash, a reflector or something else. But it is the source of light that is producing the pattern of light on the subject with the most intensity.

Fill light - is the light source that is secondary to the mail light. It is used to "fill" in the shadows to a desired degree. It can be produced by using a flash, a reflector, or a studio strobe.

Lighting pattern - this is the way the light falls on the subject's face. A pattern of light and shadow that is created.

Lighting ratio - is a comparison between the intensity (brightness) of the main light and the fill light and thus the difference of the lit and shadow sides of the subject's face.

Incident light meter - is a handheld device separate from your camera that measures the amount of light falling on a subject (as opposed to the reflective reading your camera takes which is light bouncing off the subject back to the camera). It is not fooled by the brightness range of the subject, whereas in camera reflective meters can be fooled.

Reflector - a device that is used to reflect light, generally back towards the subject. It can be a specialized factory made reflector or as simple as a piece of white cardboard.

Light meter - a device that measures the amount of light in a scene. Your FZ300/330 has one built in, it uses reflective readings (light bouncing off the subject coming back through the lens [TTL])

Remote flash trigger - a device used to fire remote flash units off camera.

Subtractive lighting - as the name implies it is the taking away of light to create a desired effect. Commonly it involves holding a reflector or opaque panel over the subject's head to block light from above and open deep eye shadows cause by overhead lighting. It can also mean holding a black reflector opposite your main light to create a deeper shadow, reflecting black onto the subject instead of light.

Hard light - harsh light such as produced by bright sunlight, a small flashgun, or an on-camera flash. It produces harsh shadows with well-defined edges, contrast, and texture (if used at an angle to the subject). Emphasizes texture, lines and wrinkles, and used to create a more dramatic type of portrait.

Soft light - diffused light such as from an overcast sky, north facing window with no direct light, or a large studio softbox. This type of light produces soft shadows with soft edges, lower contrast, and less texture. Generally preferred by most wedding and portrait photographers as it flatter the subject more.

Flash sync - simply put is the synchronization of the firing of an electronic flash and the shutter speed. You need to know what shutter speed your camera syncs at, otherwise if you shoot too fast a shutter speed you may get a partially illuminated image. For the FZ300/330 because of the in-lens shutter flash can be synched at any of the available shutter speeds.

Some Slang Photographic Jargon

Become familiar with them so you can walk among the pros with confidence!

Fast glass - refers to a lens with a very large maximum aperture such as f1.8 or f1.2. "Fast" as in, it allows you to shoot at a fast shutter speed due to the large aperture.

Chimping - slang term meaning looking at the back of the camera after every image. Spending too much time reviewing images on camera, not enough time shooting.

Bokeh - often mispronounced "bow-kay" or "bow-kuh" it is correctly pronounced as "bo-ke" like the ke in kettle. It is used to described the out of focus blurred bits in the background when "fast glass" is used. Most often bokeh occurs where small light sources are in the background, far in the distance.

Depth of Field - (DOF or DoF)- the distance between the nearest and farthest objects in your scene that appear in focus. It is controlled by many factors including the aperture, lens focal length, distance to subject.

Circles of confusion - closely related to the above bokeh, the textbook definition is: the largest blur spot that is indistinguishable from the point source that is being rendered. Objects outside the depth of field of an image that the human eye can determine as “out of focus”.

Hyperfocal distance - often used by landscape photographers, it is the focus distance providing the maximum amount of depth of field.

Gobo - something used to block unwanted or stray light from falling onto the subject. Often a reflector (using the black side) can serve a dual purpose and act as a gobo as well.

Scrim - a translucent device used to diffuse and soften the light, could be a reflector with a translucent panel or option. Also, used on movie sets scrims can be made extremely large, several feet across, and clamped in place to create shade where these is direct sun without it.

Shutter lag - the slight delay from the time you press the shutter button to the time it fires and opens.

Chromatic aberration - in terms of lens optics it is the failure of the lens to focus all colours (RGB) at the same point. It shows up as colour fringes in areas of the image where dark meet light (think edge of a building against the sky). It is more common in wide angle lenses, and those of inferior optics. It is correctable, to some degree, using Photoshop, Lightroom - or software of your choice.

Rear shutter curtain sync - by default most cameras are set to front curtain sync which means that if the flash fires, it does so at the beginning of the exposure time. By setting to rear shutter curtain sync it fires the flash at the end of the exposure time. The difference in some cases me be negligible, but in shooting a moving subject front sync will put any motion blur in front of the subject, whereas rear sync will place the blur behind the subject. Neither is wrong, just preference.

Camera shake - this is a blurry image which has resulted from an insufficiently fast enough shutter speed, while hand holding the camera. So how slow is too slow? Many will say that 1/60th of a second is the rule of thumb. I tend to recommend 1 over the focal lens of your lens instead, as the longer the lens the more amplified any shake will become.

Lens flare - occurs when the light source hits the lens directly, it can manifest as a hazy looking image or artefacts such as circles of light. Some photographers desire lens flare and position their camera to create it and use it as a compositional element.

Kelvin - is the absolute measurement of colour temperature. On your camera under the White Balance settings you make see a “K” setting. This allows you to adjust the colour manually by degrees Kelvin. The lower numbers represent warmer colours like orange (tungsten light) and the higher numbers are cooler (blues).

ND filter - stands for neutral density filter which is a filter designed to go in front of the lens to block out some of the light entering the camera. Often used by landscape photographers to be able to get slow shutter speeds when photographing waterfalls and streams in full daylight.

Panning - the act of using a slow shutter speed, and moving the camera in the same direction as a moving subject, during the exposure to create a blurred background.

Stopping down - the act of closing the aperture to a smaller opening say f2.8 to f4.

TTL and ETTL - stands for Through the Lens, refers to the metering system in regards to flash exposure. The flash emits light until it is turned off by the camera sensor. ETTL is evaluative through the lens metering and fires a “pre-flash” to evaluate and calculate for lost light then compensates and fires the main flash. It happens so fast you do not see two flashes.

Golden hour - also called “magic hour” is the hour right before sunset or right after sunrise. The sun is low on the horizon and it is an optimal time for photography.

Blown out - having highlights that are off the chart on the right side of the histogram, having no detail in the white areas.

Clipped - similar to blown out being off the histogram, but it can also apply to shadow or black areas of the image.

Selfie - a self portrait

SOOC - straight out of camera, no post processing or editing done.

Wide open - using your lens with the aperture at the widest setting (f2.8 for example)