

# **A Basic Introduction to Photography**

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# Initial Words

Many introductory books have been written on photography, one better than another and some worse. At the same time, is there not a lot of information in the manual of your SLR camera for free? At least in Canon's manual there is enough to understand the basics. For those who desire to know more, countless online resources, free and paid for, from videos to text offer more advice and information.

So why another text?

Mainly because I like to talk about photography and it would be nice to have a script to go with it. On the other hand, I like to “play” when I shoot, and playing is possibly one of the best ways of discovering photography. As I believe I have read somewhere “first follow the rules, then break the rules” or similar. But it begs the question, why follow the rules in the first place? If you aspire to become a wedding photographer, a photojournalist, yes, learn the rules, master the techniques, but if you see yourself as an artist? Learn the technique and play. If you are happy with the result, it is a result worth keeping, no matter what others think. Accept criticism, but make sure you are happy, make sure your vision was captured and ideally, know why the image was captured how it was captured.

I must say, that I do not own a single book on photography. I have one year's worth of one photography magazine where some of the suggestions have been very valuable in getting into the basics of editing. At some point long in the past, I read the manual of my Canon SLR, but mainly, my knowledge is derived from the web and from playing. Of course talking with people was also valuable, both “offline” and online.

The limit of what I know is how far I could be bothered to venture out. Hence I know as much as I want to know, and aim to share my knowledge in this document.

I hope you will enjoy reading this script and find it useful.

*Detlev Conrad Mielczarek*

## **Author's Thanks**

Initially I wrote the text by myself - since however, I had the benefit of getting some input regarding corrections and improvements, in no particular order, the people who have contributed are listed below.

- My thanks go to Kim Patrick O'Leary, a fellow photographer and also former editor, who proof read my script and pointing out quite a few corrections in the text.

His work is available at <http://www.patrickoleary.photoshelter.com>.

# 1 The Basics of Using a DSLR

## 1.1 Explaining the Term DSLR

Single lens reflex (SLR) refers to a camera type in which the viewfinder is used to look through the same lens which will be used to record the image. Hence, what you see (scene, framing) is what the sensor will be exposed to. The term reflex specifically refers to the mirror that reflects the light into the viewfinder, or rather onto the focussing screen if one wants to be accurate. The D was added when SLR cameras went digital. Initially no match for film cameras in terms of quality, digital cameras have since beaten film in terms of ISO and are close in terms of resolution (though some claim digital today has beaten film in this respect too).

Estimates for the resolution of wet film vary wildly, with some people claiming around 10-15MP and some people claiming up 27MP on high quality low ISO/ASA film.

Of course, digital photographs were always more convenient. You can roughly evaluate your photograph “on location”, you can transport photographs a lot more easily and lastly you no longer need a costly darkroom which requires experience. The darkroom may seem like an unobvious aspect, but a photography laboratory would only expose film for you, and charge you too. If you had any creative aspirations, there was no alternative to getting your own darkroom. With digital photography this is no longer an issue, as most people will have a computer. Even weak machines suffice, though they will take significantly longer for the same task when compared to a more powerful computer.

Also, did I mention cost? Unless you are able to shoot very selectively, digital will be significantly cheaper than film which incurs a noticeable running cost. Digital storage is also reasonably cheap compared to a storing wet film, which requires a lot more space. SD/Compact Flash (CF) cards can be reused, while film may only be used once and then also comes with a “use by” date, a memory card does not “go bad” when stored. If I am to be picky, SD/CF cards have a limited lifetime in terms of write cycles, but the write cycles they will sustain are around several thousand per card (fully filled) and hence their cost becomes less important/insignificant in the grander scheme. I must say that none of my cards have so far gone bad from

write cycles or in any other way for that matter.

So there are plenty of reasons to go digital nowadays, more so if you are just starting out in photography. Of course film retains its charm and has its followers, as well as certain advantages - but these do not outweigh the advantages of digital photography, especially if you are just starting.

### **1.2 Some basic Rules to Follow**

A digital single lens reflex (DSLR) camera is a precision instrument, even if this is hard to believe considering how some professionals will treat their cameras. More amazingly though, they retain their precision in spite of the battering they receive. Still, it is recommended to follow a few guidelines set out by common sense and experience to extend life and hence joy you get out of your new camera.

- i Never touch the mirror in the camera. It is fragile. Maybe not as fragile as some people may make it seem, but you do not want to scratch it, let alone be forced to clean or replace it.
- ii Never store your SLR left open, as this will allow dust to get in. Aim to change lenses as seldom as possible, but as frequently as you need. Some people recommend changing lenses with the camera's mount facing down. If, for whatever reason you cannot store/transport your SLR with the lens attached, use the supplied cover.
- iii Never use any force - if something does not come off or move easily, you are doing something wrong and possibly overlooked a release button somewhere.
- iv A camera only does what you tell it to do. Unless you get an error code of some sort, when it does not do what you want it to do, you have overlooked some setting(s).

### **1.3 Some initial Suggestions**

In general you can start to shoot with your new camera right away, however it is often advantageous to prepare it for its future use immediately, as well as preparing your computer for the editing it will face.

- i Install the manufacturer supplied software on your computer. Use this to enter your name in the owner field on the camera. Some modern cameras allow you to input this information on the camera itself, still install the software as it has further benefits. For Canon, the supplied Digital Photo Professional (DPP) is an ideal software for learning general basic editing skills.
- ii Change the camera setting so it will not take photographs without a memory card (CF or SD). This will be a custom function so consult your manual to determine which one it is, as this varies from camera to camera. It might seem not that important to you, but shooting without a memory card has happened to various photographers and is at least extremely frustrating. Changing this setting will prevent the potential for any future grief caused by a lack of memory card.
- iii Just snap a few photographs on automatic using the viewfinder. Even if your SLR supports LiveView, get into the habit of using the viewfinder. Some exceptions exist where LiveView is the better choice, but these are mainly studio environments in which product or macro-photography is practised. Or alternatively, when using a tripod, LiveView also had some benefits. Your primary method of shooting photographs should be by looking through the viewfinder.
- iv If you wear glasses, it is highly recommended to get a correcting lens for the eyepiece. It is not an absolute requirement, but it makes looking through the viewfinder and obtaining an accurate perception of the scene easier.
- v Have a look at the settings used on the photographs you snapped. An automatic mode just automatically chooses the settings for you, hence manual with the same settings would give you the same result. The manufacturer supplied software, which you should have installed on your computer, will display this information for you, including camera manufacturer specific information.
- vi Once you start to play and shoot, it is important that you use RAW and not JPEG. In some cases you may have a requirement for quick JPEG images, for example if working as a photojournalist at a sports event, but at the start you should aim to shoot only RAW. Or, if you think that you have a requirement for a quick JPEG.

Before you continue to read, you should have a couple of images that may have turned out so-so or already looks quite well.

Something to be said at this point is that photographing with a DSLR is more work

than with a compact camera. You are expected to post process your images, even the best you shoot. Even more so, if you shoot RAW (which you generally should do).

## 1.4 Camera Modes

Every DSLR camera has a mode dial of some sort, an option to switch between automatic and manual modes. What I will be mentioning in this chapter will be building upon the naming scheme of Canon DSLRs, however every major manufacturer incorporates the same features, just with different naming schemes.

### 1.4.1 Automatic

This mode is also referred to as “green box mode” on Canon DSLRs. Generally frowned upon by photographers, it can give you decent to good results, but deprives you of understanding how an SLR works or even how photography as a whole works. Additionally, the algorithmic implementation of functions such as AF point selection might not agree with your expectations.

If you have just bought your new camera, automatic is quite possibly a good mode to get some initial use out of your camera, but you should aim to move away from it as quickly as possible.

Lastly, on older SLRs, you might not be able to save images in RAW when shooting in automatic mode, read section 1.5 to find out why shooting RAW is important.

### 1.4.2 P - Program

The Program mode on Canon SLRs is a first step up from automatic. For all intents and purposes, this is a fully automatic mode. However you are allowed to interfere with the camera’s functions and settings. While exposure, aperture and ISO are automatically, you are able to change these settings.

1. You can determine which focussing point the camera should use and do not have to leave it to chance/an algorithm that you do not know. Read section 3.1 if you are interested in further details about the autofocus on a modern SLR.
2. You can dial in exposure compensation, measured in stops, hence you can decide whether your image should be brighter or darker, over- or underexposed.



3. You can change the aperture/shutter speed simultaneously, while the camera balances the exposure according to your exposure compensation. However the camera will not retain your modification, when you refocus, it will again decide according to its own algorithm which exposure and aperture to use.

Besides the three options mentioned above, you are further able to chose the metering mode, the colour temperature, the autofocus type and whether to shoot a single image or a series.

### 1.4.3 Tv - Shutter Priority

The Tv mode builds upon the P mode in section 1.4.2.

However, you are given full control over the shutter speed. The camera will change the aperture according to your exposure compensation. This is useful if you aim to capture for example action shots in difficult lighting where you require a certain shutter speed. Defining the shutter speed allows you to prevent motion blur, while staying focussed on shooting rather than changing your aperture to suit the lighting condition.

More information on the shutter speed, also referred to as exposure can be found in section 2.1

### 1.4.4 Av - Aperture Priority

The Av mode builds upon the P mode in section 1.4.2.

However, you are given full control over the aperture and the camera adapts the shutter speed according to your exposure compensation. This is useful for situations where you need to control the background blur, bokeh, but face varying lighting conditions. It also has its use when you are in a situation where you do not have the time to manually change settings, but know you will require a specific minimum aperture.

More information on the aperture can be found in section 2.2

### 1.4.5 M - Manual

The manual mode is what every photographer should aspire to be able to use competently.

Manual stands, as the name says, for full manual control. You are given control over every setting, from aperture over exposure to ISO as well as auto focus (AF), metering and colour temperature.

However, having said that, I have seen people comment that the manual mode is pointless if all you do is zero the needle in the viewfinder. This is true and you should choose the tools that suit your aims best. There is nothing wrong with using Av or Tv, provided you understand their workings and their limitations. To make full use of manual mode, you should read and understand chapter 2.

### 1.4.6 B - Bulb

The bulb mode is for long exposures beyond 30s or photographs where you need the option of starting and stopping the exposure manually. The shutter release is pressed to start the exposure and depressed to end it. However it would be very difficult to hold the camera steady if the button needs to be pressed for several seconds or even minutes. A tripod and remote control for your camera are thus highly recommended, which allow you to start the exposure and end it without touching (and hence shaking the) camera.



Figure 1.1: exposure of 106s

The image in figure 1.1 depicts one use for bulb mode, with an exposure time of 106s, timed with a stopwatch.

## 1.5 Shooting RAW

### 1.5.1 RAW vs. JPEG

I have told you to shoot RAW, so you must wonder what the difference between RAW and JPEG is, especially considering that I have told you to shoot RAW only. The easy way is to think of RAW as the most unprocessed and most complete retention of data collected by the sensor. Hence it is not an image in itself, but sensor data, a record of the information captured by the camera.

If you are curious about details, read on, otherwise, skip to the end of this section, however, I recommend that you do read on.

### 1.5.2 Camera Sensors versus the Human Eye - Dynamic Range

The human eye sees light intensity logarithmically, while the sensor sees it linearly. To put some random number to it as an example, assuming that human vision is represented by the logarithm of the brightness with base 10, we could have:

1. A brightness of say 0 for absolute black.
2. A brightness of say 100 in a dark shadow.
3. A brightness from 1000 to 10000 in a nice scene.
4. A brightness of 10000 to 100000 for lamps and the sun (light sources).

The human eye would read these as 2 for shadow, 3 to 4 for scenes, 5 to 6 for light sources. Hence we would have a range of about 6 arbitrary units for the human eye. In contrast, the camera would see this as 0 to 100000, a range of 1 million steps, which for technical reasons cannot be recorded.

Figure 1.2 shows the plot of  $y = x$  and  $y = \log(x)$  for  $x = 0$  to 100.

Canon's DPP which is supplied with every Canon SLR, has a "linear" checkbox, which allows you to reproduce the image the way it is seen by the sensor. This is shown in figure 1.3, while the same scene as experienced by a human viewer is shown in figure 1.4.

If you have ever photographed a scene that had a light source in it, it will show a halo around the light source. This halo is light (or specifically electric current) spilling "out" of the photodiodes affecting neighbouring diodes. The halo is an excess signal created by the light source, in a way similar to water that spills out of an overfilled

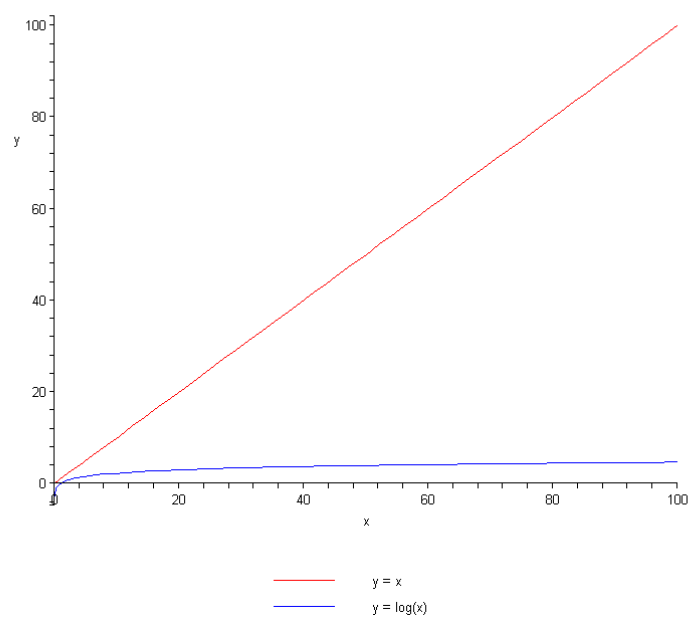


Figure 1.2: log compared to linear

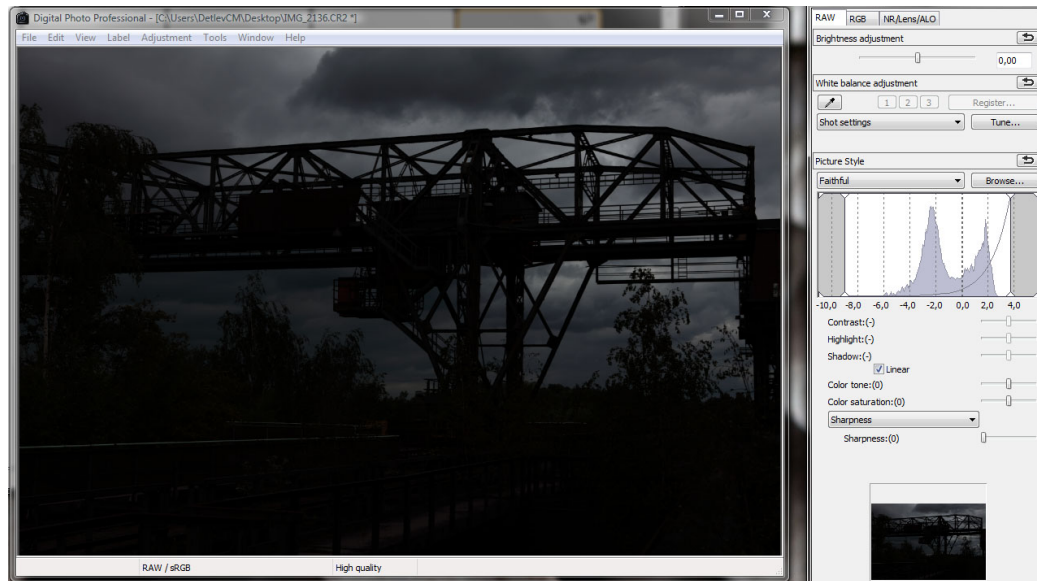


Figure 1.3: what a camera sensor sees

bucket and soaks the floor surrounding the bucket.

This is the main reason why it is difficult to replicate a scene the way we see it and why techniques have been developed to overcome this limitation of the recording medium, specifically high dynamic range (HDR). It must however also be said, that advances are made towards sensors that can capture the same dynamic range as human eyes.

A term that should be very important to the aspiring photographer is dynamic range. Dynamic range describes the spread of a scene in terms of “stops”. Stops are a way of describing the amount of light, or rather ratio of the amounts of light. A difference of 1 stop equals the difference between twice as much or half as much light.

The human eye covers about 18 stops of light, while sensors today will general cover around 6 to 8 stops at best. This means humans can see a scene where the brightest part of the scene contains  $2^{18}$  times as much light as the darkest scene, that is 262144 times as much light in “bright areas” over “dark areas”. In contrast, a modern camera sensor can resolve about 8 stops at best, which translates to 256

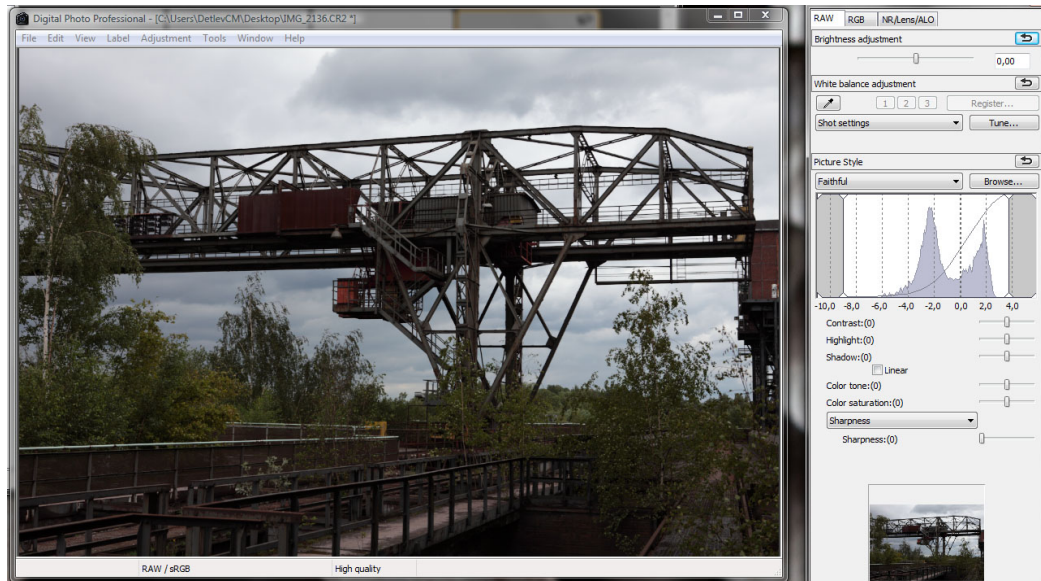


Figure 1.4: what we see

times as much light in the brightest part of the image when compared to the darkest scene in the image.

Anything that is darker than 8 stops will lose detail and become absolute black, while anything that is brighter than 8 stops will become absolute white or absolute red/green/blue if one colour dominates in this part of the scene.

Additionally, noise can reduce the amount of stops the sensor can resolve, as it adds a variation in the recorded data that can mask subtle changes.

### 1.5.3 Camera Sensors versus the Human Eye - Colours

Cameras record colours as a combination of red, green and blue light, the ratio between them is given in the white balance (also colour temperature) and colour tone. Colour depth of an image or a format is measured in bits per channel, for JPEG it is 8bits per channel, for RAW currently 14bits per channel on common DSLRs.

As long as the photodiodes on the sensor are not overloaded, a higher bit depth will always result in more details with respect to brightness and hence colours. If you overload the photodiodes, even the highest resolution will not save you any detail.

A section of the camera's sensor contains the pattern shown in figure 1.5.

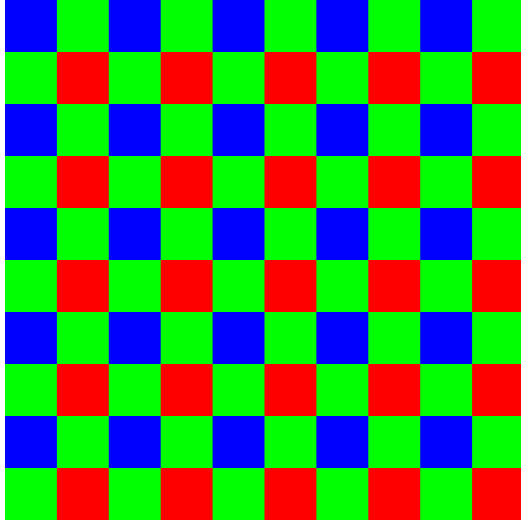


Figure 1.5: Section of a camera Sensor

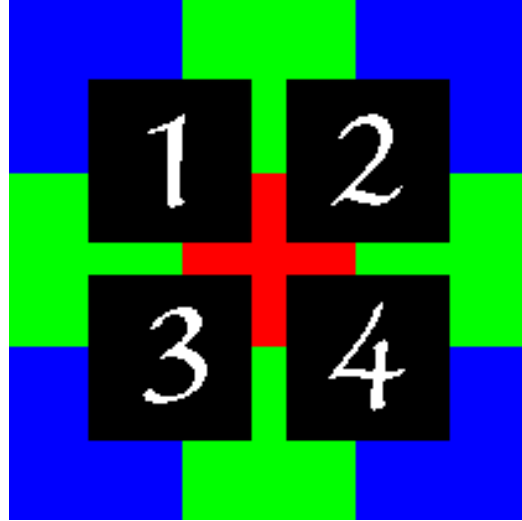


Figure 1.6: 4 Pixels you See

This type of sensor design is why manufacturers tend to specify two very different pixel counts for their sensor. For example, Canon specifies the following for two of their DSLRs, shown in table 1.1.

Camera Type	Effective Pixels	Total Pixels
7D	Approx 18.0M	Approx 19.0M
5D MK II	Approx 21.1M	Approx 22.0M

Table 1.1: Canon SLR pixel counts

The total pixel count states the number of photo diodes available on the sensor, which needs to be larger than the number of pixels in the final image, which are created from the readings of four photo diodes combined. See figure 1.6 for an illustration as to what information is used for a pixel, denoted by a black, numbered, box.

For the mathematically inclined, when the number of effective pixels is given by  $x \times y$ , where  $x$  and  $y$  are the horizontal and vertical resolution respectively, then the number of total pixels is given by  $(x + 1) \times (y + 1)$ . For a 5D MK II, this would mean at least around 9500 extra pixels are required.

While such sensor designs might seem prone to inaccurate results, algorithms have improved a lot since the first digital cameras. As a result, today's software is very good at reconstructing fine detail from the information collected by the sensor. How sharp an image is depends mainly on the anti-aliasing filter in front of the sensor and the post processing applied to the image, no matter whether the latter is done in the camera or on a computer.

Comparing the camera's sensor to our eyes, the receptors on a human retina will recognize either brightness alone, resulting in a grey image if they are the only input, or coloured brightness readings when enough light is present.

The receptors for brightness without colour are more numerous than the receptors for colour, hence humans perceive night scenes without a lot of light to be more grey than daylight scenes.

### **More Details on RAW**

A JPEG can only resolve  $2^8$  or 256 different levels of brightness for a colour, from 0 to 255. A RAW file in contrast can resolve  $2^{14}$  or 16384 levels of brightness per channel.

Additionally, four pixels from a JPEG require nine "pixels" from a RAW file, resulting in a more detailed recording of the same data.

Not only can one record light measurements over a greater range than in a JPEG, but also in finer steps. Hence, what is perfect white in a JPEG will still contain a colour tint in RAW. What is perfect black in a JPEG will contain detail in a RAW.

The RAW file format can allow you to save an image if you make minor mistakes, but please do not use this as an excuse for being sloppy when shooting photographs. While one can often save a slightly off image, shooting it the way one intended in the first place is generally the better choice as the final result will always look better. However, there are even more reasons to shoot in RAW instead of JPEG. A JPEG image is created using lossy compression, hence data is discarded (and lost forever) when compressing the raw sensor data and creating the image file. Any changes to the image, such as changes to sharpness, contrast, saturation are difficult or impossible to reverse.

A RAW file allows you, the photographer, to take full control over these settings.



You decide how much sharpening you want, how much you want to increase the saturation, how much you want to change the contrast. Of course if you feel lazy and like the result, you can apply some standard automatic settings and be done with it, but should you ever decide to re-interpret the image in the future, you will never regret shooting in RAW. Shooting in RAW is similar to buying the ingredients compared to buying a finished ready meal. Of course this requires you enjoy cooking to enjoy the meal, but you have full control over the result. Photography is similar, editing a photograph is very much a part of photography. Hence if you are serious about getting into photography, you should consider learning at least the basics of editing and accepting them as an essential ingredient in the final result.

#### **1.5.4 Sharpness and Saturation in RAW**

From compact cameras, many people are used to severely over sharpened and over-saturated images. When you see your first RAW file, it may seem flat (dull colours) and blurry because it has not been post-processed. Try not to resemble a compact camera when using a DSLR, because it is not a compact camera.

The flat, desaturated look has been implemented by design, to ensure that more detail is retained. It might seem counterintuitive at first, but a “flat image”, hence one that has not been saturated severely will contain more colour information than a heavily saturated image, in which highlights can be lost and colour changes contains steep gradients.

With respect to sharpness, RAW sensor data, as shown in figure 1.6 needs to be interpreted to construct pixels, hence showing you the initial output will result in a slightly less sharp image. A bit of sharpening is easily applied with any post-processing software, with different algorithms implemented by different software.

Please do not make the mistake of thinking compact cameras capture the scene differently, they do not, they just post process the sensor data in camera. When shooting RAW images and post processing them yourself, you retain full control over how the image looks. As a result, able to obtain a natural look from your images and can avoid the artefacts created by excessive sharpening or the unnatural colours due to excess saturation.

However, that does not mean that oversaturated or over sharpened images such as often produced by compact cameras cannot have their place in photography as an art.

Please note though, should you aspire to become a photojournalist, you should edit your images as little as possible or might even be required not to edit them at all.

## 2 Exposure, Aperture, ISO - the Science behind Photography

Having already introduced stops as a way of describing the relationship between light intensity, it is now time to put this to good use. This chapter is a “must read” in the whole guide, as it will introduce you to the three most important concepts of digital or also analog photography, namely exposure, aperture and ISO.

This chapter will again require some mathematics, but only simple operations. To start off, a little bit of terminology. When stating “by a factor”, this refers to either a multiplication or division. Hence By a factor of two means divide by two or multiply by two.

### 2.1 Exposure

Exposure indicates how long the sensor is exposed (hence the name) to light.

A change in your exposure by a factor of two equals a change in light by one stop. Twice or half as much light will reach the sensor.

A rule of thumb for photography without image stabilization (IS) or a tripod, is that  $\frac{1}{\text{focal length of the lens}}$  is the longest exposure you should use. So for example, on a 50mm lens, the maximum recommended exposure when handholding is  $\frac{1}{50}$  seconds. This does not mean one cannot expose any longer, but it increases the risk of camera shake when not using IS.

As this rule dates back to the film era, and most SLRs (for Canon all models except the 5D and 1Ds series) have a sensor smaller than a slide of film, the maximum recommended exposure when handholding without IS is actually shorter. For so-called APS-C cameras from Canon, multiply by 1.6 for Nikon by 1.5. This means, a 50mm lens on an entry level Canon camera will have the field of view of an 80mm lens, and the maximum recommended exposure is  $\frac{1}{80}$  seconds. (Just to be accurate, the 1D from Canon has an APS-H sensor, which needs a factor of 1.3.)

### 2.1.1 Creating Motion Blur

Exposure is important in two ways.

On the one hand it describes how much light can reach the sensor, on the other hand, it also controls whether an image contains motion blur, such as soft, flowing water in streams and waterfalls or a spinning propeller on an aircraft or helicopter or spinning wheels on a car.

The longer the exposure, the more motion blur, the shorter the exposure, the less motion blur. A propeller aircraft tends to show nice propeller blur at around  $\frac{1}{250}s$  and anything faster than  $\frac{1}{1000}s$  should freeze pretty much any motion.

While not great images, the image in figure 2.1 and figure 2.2 illustrate the concept nicely. Notice how the propellers look different on the same King Air as it approaches the runway. On image 2.1 the propellers are frozen, while on image 2.2 the propellers show spin through motion blur resulting in a more pleasing image.



Figure 2.1:  $\frac{1}{1250}s$



Figure 2.2:  $\frac{1}{320}s$

### 2.1.2 Night Photography

If you have not got a good tripod, I would highly recommend you obtain one. In many cases you may end up disappointed without a tripod, however night photography can be done with and without a tripod, either handholding or using the support of a monopod.

The question you need to ask yourself is, “what is most important”. Is it getting the shot at all? Or is it getting a good/perfect result?

If you aspire to become a photojournalist, getting the shot can make your career,

in which case you would increase the ISO, open the aperture (See section 2.2 for more on the aperture) and do your best to use a shutter speed appropriate to your focal length. On the other hand, if your interest in photography is more artistic, you would aspire to obtain the best image quality possible, at a low ISO, appropriate aperture and hence slow shutter. However, this does not mean you must use a tripod at all times.

For example, have a look at the following photographs, first figure 2.3 and figure 2.4.

The Humber Bridge might not look like a long exposure, but it was a 30s exposure. Even though I increased the ISO a bit (see section sec:ISO for more details), because I used f13.0 I needed a long exposure. As a result, the full image retains detail that would otherwise be lost in noise or by being out of focus. As the image file presented is a small sample, you will not be able to appreciate this fact that well. Further, the water has a silky smooth appearance because any waves or ripples are smoothed out by motion blur.

The next image I would like to draw your attention to is presented in figure 2.4. A refinery at night, well lit. All the lighting allowed for a reduced exposure, but again detail was key. The ISO was lower when compared to the Humber Bridge, and the aperture opened a bit more, still the exposure time for the image was 5s. You should be able to discern the smooth plumes of steam in the image. This is due to the long exposure, which allowed the steam to travel, and smooth out details in it. A shorter exposure would have just captured a point in time, including detail in the steam.

Hence remember:

Exposing an image for a long amount of time leads to a smooth texture/blur on moving objects.

After the long exposure, the short exposure night photography. Again two sample images that I would like to draw your attention to, this time one image from Leeds in figure 2.5 and one image from Sheffield in figure 2.6.

In Leeds City Centre, I did not have a tripod with me, but I really liked the reflections on the wet town square. I had walked past them without a camera, and there I was, with time, with a camera.

I increased the ISO as much as I was willing to do without getting too much noise,



Figure 2.3: Humber Bridge



Figure 2.4: Refinery

widened the aperture and used an exposure of  $\frac{1}{40}s$  to capture this image. Could I have done better with a tripod? Of course. The question is, when will I be able to shoot such a scene again? I do not carry a camera with me every day, nor do I carry a tripod every time I carry a camera. Capturing an acceptable photograph in this moment was more important to me than getting the absolute best possible, which would be possible with a tripod.

The next image I would like to draw your attention to is from the fountain at Sheffield Station, in figure 2.6. In this situation, setting up a tripod would be difficult, but not impossible. Additionally, I wanted to capture the water as frozen in time and not in motion. The image was shot at an elevated ISO, with f4.0 at  $\frac{1}{20}s$ , handheld. A slow shutter to allow enough light to reach the sensor, but also at the outer edges of what can be handheld steadily, especially in winter. The choice of shutter speed also allows for the water's flow to be frozen in time.

Whatever you chose in the end, it needs to gain you a result that you are happy with. I hope I have presented to you, that either approach, handholding or using a tripod can get you the desired photograph, but that using a tripod is beneficial if absolute image quality is your key concern.

### 2.1.3 Conclusion - Exposure

The best advice I can give you, is to go out and try it for yourself, as only experience will allow you to quickly judge the most appropriate shutter speed.

One suggestion needs to be made though. If you plan on doing any night pho-



Figure 2.5: Leeds City Centre



Figure 2.6: Sheffield, Fountain

tography, get a good tripod, as even the best image stabilization generally does not help against camera shake at the shutter speeds frequently employed in night photography.

The best IS will gain you about 4 stops of light, while older lenses might just gain you about 2 stops with IS.

## 2.2 Aperture

### 2.2.1 A Quick general Explanation

Aperture is important because it again has two functions, just like exposure. It controls how much light can enter the camera, but also how much depth of field you get. Hence how much of the background/foreground is visible, and how much blurred.

The following illustration in figure 2.7 hopefully helps you to understand the concept of the depth of field.

The yellow triangle in figure 2.7 illustrates the angle of view through the lens, the camera being denoted by a black box. The red arrows refer to the distance to the subject, in this case a violet X.

The blue area in figure 2.7 is the depth of field. If we for example assume the “X” is 2 metres away, the depth of field can be  $\pm 5cm$ , or  $\pm 10cm$ . The depth of field depends on the aperture and distance to the object, provided the aperture and focal length is constant. For a constant aperture, the further the object, the greater the depth of field, the closer the object, the smaller the depth of field. As a result, you

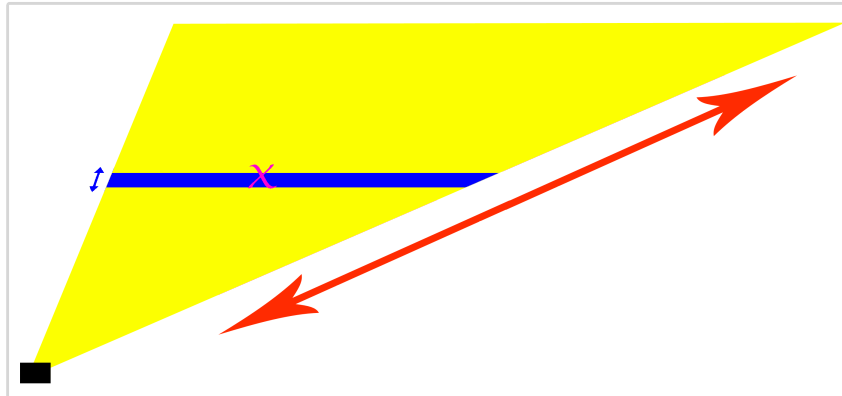


Figure 2.7: Depth of Field - Illustration

will find that macro photography often takes place at apertures such as f11 to ensure the object of interest is in focus.

The effect of increasing depth of field with distance partially relates to infinity focus, which especially on wider lenses tends to begin as close as 3m or 10 feet. As a result using a wide angle to standard lens, an object 5m away would require nearly identical focussing compared to an object 6m away.

For more detail on lenses, see chapter 4

### 2.2.2 Mathematics of Stops with Aperture

First the mathematics once again. A factor of the square root of two ( $\sqrt{2}$ ), which is approximately 1.41 equates to a difference of one stop.

Hence stopping a lens down from f2.0 to f2.8 would equate to a difference of one stop. Stopping down from f2.8 to f4.0 would be another stop. Stopping down from f2.8 to f3.2 would be a third of a stop, while f2.8 to f3.5 would be two-thirds of a stop.

### 2.2.3 Lenses and their Aperture

A lens is described generally by its maximum aperture besides its focal length. For a “kit lens” this would typically be 18-55mm f3.5-5.6. This means, that at 18mm it has an aperture of 3.5 and at 55mm an aperture of 5.6, which translates to the lens letting in 1.3 stops less light at 55mm compared to 18mm. Such lenses are also called variable aperture lenses.



Lenses with a constant aperture would be labelled for example 17-50mm f2.8, which denotes that the aperture does not change with the focal length. A downside of these lenses is, that they are more difficult to build, requiring more glass, making them heavier and more expensive. Often however, they are also optically superior, especially when stopped down to match the aperture of variable aperture lens. Most lenses perform at their worst when “wide open”, hence at their maximum aperture, and benefit significantly from being stopped down one or two stops. The “sweet spot” of maximum sharpness is reached at f8 for many lenses, but this varies between different lenses.

The largest aperture commonly available on the market is f1.2 on professional Canon lenses, with Nikon possibly selling comparable products.

Leica produces a very expensive f0.9 lens and Canon made a 50mm f1.0 in the past, where one copy I am aware of sold for \$5400 or more on EBay. Even an f1.2 lens will cost more than 1000€ from Canon. The cheapest wide aperture lens must be the Canon 50mm f1.8 lens at around 100€. This should give you an estimate of lens pricing and as you can possibly gather, wide aperture lenses are expensive.

On the other end, most lenses will generally stop down to f22 and some tele lenses go as far down as f32. If you have a medium format camera, you will be able to find your lens stopping down even further.

By now you possibly wonder why f32 is lower than f22 - well, technically the aperture is a fraction and  $\frac{1}{32}$  is smaller than  $\frac{1}{22}$ . This is confusing at the start, but just accepting the terminology is pretty much the only thing you can do. With time, one gets used to it. The bigger the “f-number”, the smaller the aperture.

### 2.2.4 Background Blur - Bokeh

What I have mentioned, but have not elaborated on, was background blur. The technical term for it is “bokeh” and comes from the Japanese. It has no direct translation and is used, as spelled, to describe a pleasant background blur. Some people view the bokeh created by the 50mm f1.8 lens mentioned above as harsh, while the 85mm f1.2 bokeh is generally admired as one of the best. Bokeh, or pleasing background blur, is a result of the shape of the aperture blades (pentagon shaped on the 50mm f1.8 or near perfectly circular or more expensive wide aperture lenses such as the 85mm f1.2) as well as the size of the aperture.

Generally, the background blur of lenses with circular aperture blades is viewed as

more pleasing and hence described as the more pleasing bokeh, but the quality of the glass used also has an effect.

However, there is another element to background blur, namely the focal length. A longer focal length on a lens will result in a shorter depth of field at the same aperture, compared to a lens with a shorter focal length.

Let me illustrate this with some examples. The distance rating is taken from the exif data in the photographs in figures 2.8 and 2.9 and estimated for the image in figure 2.10.



Figure 2.8: f2.8, 70mm, 0.7m



Figure 2.9: 34mm, f2.8, 0.7m



Figure 2.10: 300mm on 1.6 crop, f5.6, app. 4m

While the aperture for the photograph in figure 2.10 was stopped down two stops over the aperture settings for the photographs in figures 2.8 and 2.9, the background blur is similarly pronounced, because a longer focal length was used.

Between the photographs in figures 2.8 and 2.9, you should be able to determine less “background blur” in figure 2.9 due to the reduced focal length.

### 2.2.5 Conclusion on Aperture

The basic rule for beginners with respect to aperture breaks down into the following two statements.

- 1 The wider the aperture (the lower the f-number), the shallower the depth of field, hence the greater the background blur.

2 Conversely, the smaller the aperture (the bigger the f-number), the greater the depth of field and the background blur disappears/reduces.

If you desire an image with the foreground as sharp as distant objects, take a wide angle or standard zoom lens and set it to f22, manually focussing at 3 feet or 1m.

## 2.3 ISO previously also ASA

ISO, or also ASA in the past, is used to denote how sensitive the film is to light. On a digital camera, it has an identical effect, but slightly different meaning. It does not so much describe sensitivity to light, but rather sensor gain, which results in the same effect.

A factor of two equates to a difference of one stop with respect to ISO.

As with the previous two settings, ISO has a second side to it, mainly noise, or signal errors. The higher the ISO, the greater the noise. It is often advisable to keep the ISO setting low, but modern SLRs should be very "clean" up to ISO800 across all manufacturers. Noise reduction can also help with noise, but increased ISO also compresses the dynamic range. It is up to you to decide what ISO settings you are happy to use on your camera, as every camera is different. Additionally, different situations as well as expectations to quality will be a part of your decision. For example, a noisy image is better than no image or a blurred image.

## 2.4 Conclusion - Exposure, Aperture, ISO

Having finished this chapter, you have completed the basic introduction to the key settings of a digital SLR camera. You can now head out and experiment a bit, or alternatively, read on.



## 3 Autofocus and Metering

### 3.1 Autofocus

Whether you use AF or manual focus (MF) is really your choice, however nowadays, on digital SLRs, autofocus is often more accurate. Exceptions again exist, and include product macro shots in a studio where manual focus tends to be preferable. Creative photography can also benefit from manual focus at times, especially when you have difficulty to find a suitable focussing target. In very dark environments, manual focus may also be beneficial, as the AF sensors require light to function properly.

If you do use autofocus, learn how to control the focussing points (marked in the viewfinder) or focussing point groups to your advantage. Do not let the camera decide what is important, but tell the camera where to focus automatically. While it is a great help to most photographers, it is a tool very easily abused, especially if misunderstood. The camera does not know what you want to focus on and thus how you want your image to look. Nevertheless, it is good at focussing on a spot, so use the autofocus to your advantage.

For this, you should know how the autofocus works.

A camera has “normal” AF sensors or “cross type” AF sensors. (Double cross type exists, but is not commonly found on consumer grade equipment.) An AF sensor measures the brightness change where it is pointed at. The greater the step in brightness, the less gradual the change, the sharper the image. An unfocussed image would result in a blurry, smooth change in brightness. This is why patterns are generally great for focussing and plain coloured flat areas are useless.

The following three images in figures 3.1, 3.2 and 3.3 give you a simplified example as to how an AF sensor sees a “target” and what it aims to achieve.

The difference between “normal” AF sensors and a “cross type” AF sensor is, that a normal AF sensor measures either horizontally or vertically while a cross type sensor measures horizontally and vertically. Pretty much every SLR has at least one cross type AF point at the centre. As a result, this is the most accurate indi-



Figure 3.1: unfocussed



Figure 3.2: badly focussed



Figure 3.3: focussed

vidual focussing point on any SLR. However, this does not mean in any way that the external points are bad. Again, it is a matter of choosing the right tools for the job and personal experience is most valuable in selecting the right AF point or group.

Just for completion, should you have a double cross-type AF sensor, it will measure vertically, horizontally and diagonally.

## 3.2 Metering

Metering is another important, or one could say vital, aspect of photography. You measure the light in a scene either with the “needle” in the viewfinder, which tends to typically be able to display  $\pm 2$  or  $\pm 3$  stops, or alternatively by using an external light meter.

The two key metering modes are spot metering or average metering. Spot metering measures the light at the active AF point, average metering takes the whole scene into account. Generally the camera will try to make whatever it meters (the spot or average brightness) an 18% grey. This works on most scenes, but fails in snowy scenes (grey snow instead of white) or with black targets such as dark suits (which leads to overexposed images with grey suits). Again, experience is the best mentor in this case.

On most landscape shots you will tend to want to be around  $\pm 0$  stops on the meter, but if you ever shoot in difficult and demanding conditions such as parties, concerts or night scenes, experience will tell you how to meter most effectively. Alternatively you can also just add or subtract from the displayed value using exposure compensation as appropriate and then again meter for  $\pm 0$ .

## 3.3 Histograms

### 3.3.1 Introduction

One of the most valuable features on a camera is the histogram. While there is no perfect histogram, its look can give you an idea whether an image is over or under-exposed.

The height of the histogram, or rather the area under the peak represents the relative proportion of the pixels with the brightness denoted by the x-axis, going from black at the left ( $x = 0$ ) to white at the right. If the histogram touches either side, you have either lost shadow detail (touches the left side) or highlight detail (touches the right side).

You should also notice that the histogram on your (Canon) camera and in some editors is divided into 5 areas; these are the five stops of dynamic range that you will get in a typical JPEG image. Mind you, a RAW file, as mentioned earlier, can contain more than five stops of dynamic range and can be compressed into five stops in post processing.

### 3.3.2 Examples

So let us look at some examples. First, images as photographed, unprocessed to give you an idea as to how varied the histogram can be, then a look at some images and what histogram they present after they were edited.

When the unedited RAW file is displayed, Canon's DPP displays the light intensity in stops, when an edited image is shown, the colour channels are shown individually and without markings for stops of light.

Take for example the histogram for the image in figure 3.4, a fountain in the MüGa in Germany. You should see a nice, not quite symmetrical, but "right heavy" overall dumbbell shape. The histogram touches neither the right hand side nor the left hand side at  $-7.5$  or  $4.0$ . Hence neither shadow detail nor highlight detail has been lost.

Overall, when shooting general scenes, a distribution such as this is what you should aim for, as it retains the largest amount of detail possible. However, one could argue that the image could be about 1 stop brighter.

The next daylight image is presented in figure 3.5. You should again see that neither side of the histogram is touched, so no shadow or highlight detail has been lost. What you should further notice is, that the histogram touches the "ceiling" on the right hand side. This is of no concern, it just means that the count has gone "through

### 3 Autofocus and Metering

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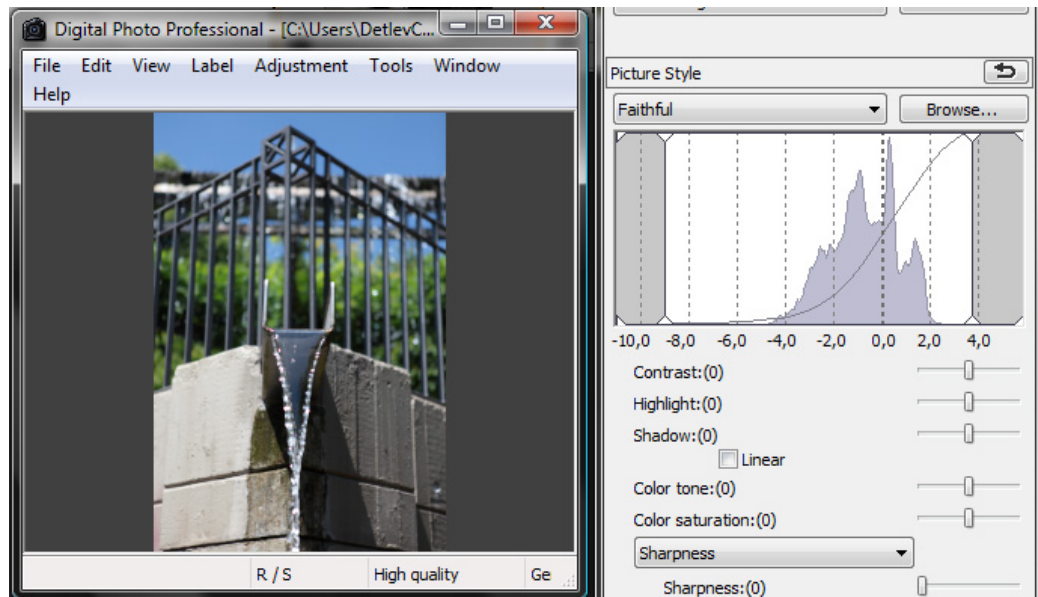


Figure 3.4: day, balanced

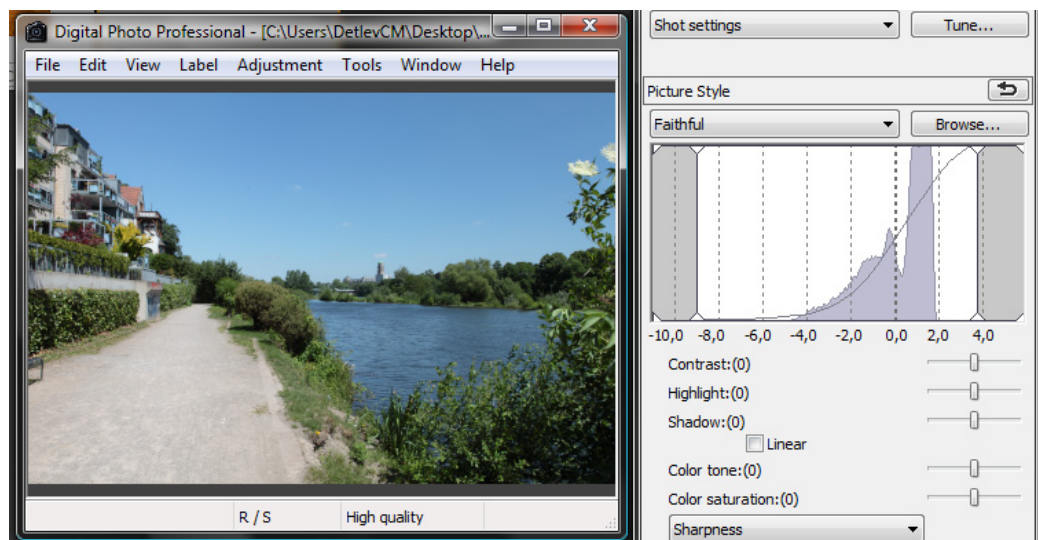


Figure 3.5: day, light image



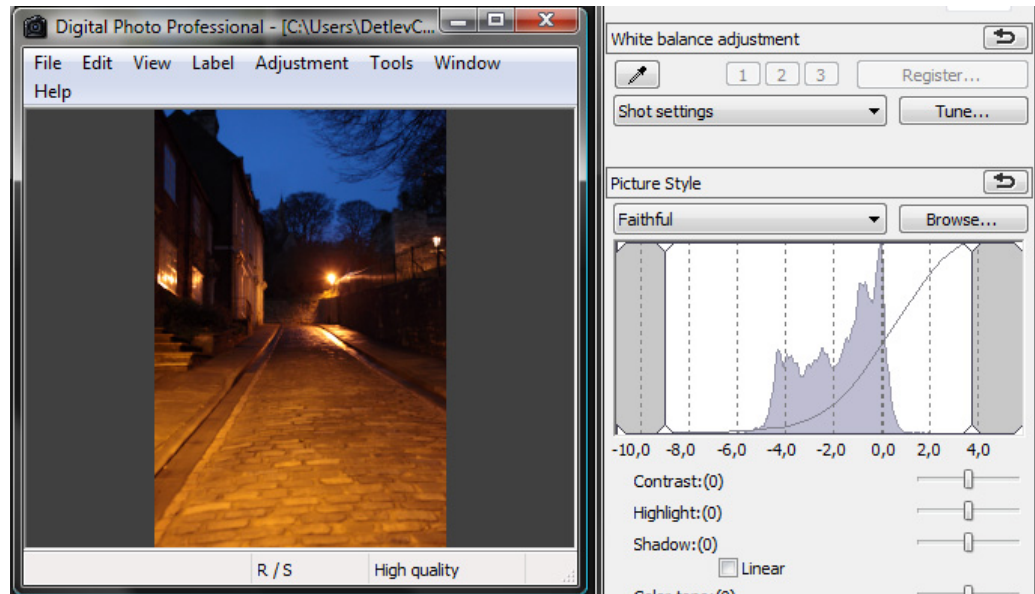


Figure 3.6: night, balanced image

the roof”, hence a significant proportion of the image is very light or bright, but no detail has been lost. This can happen in bright scenes and as a result the overall histogram is a bit right heavy when compared to the histogram in figure 3.4.

The next histogram is from a night scene and shown in figure 3.6. You should notice that it gives an overall balanced appearance. In fact, it is even slightly “right heavy” rather than “left heavy” as you would possibly have expected.

This is not standard for night images, as figure 3.7 shows.

Figure 3.7 shows the histogram of a more dynamic night scene. A well lit building, water that reflects light and the dark sky. The photographer will, unless it is a HDR approach is planned, have to make a compromise between capturing the details in darkness and the details well lit. If the darker scenes are correctly exposed, the light will be blown out white without detail, conversely, if the lamps are well exposed, the shadows will be absolute black.

Overall however, the image is still reasonably well balanced, but more “left heavy”, with more of the scene in darkness, but no obvious detail loss showing in the histogram. (Although I can tell you that the lamps and the wall behind them do not contain any detail.)

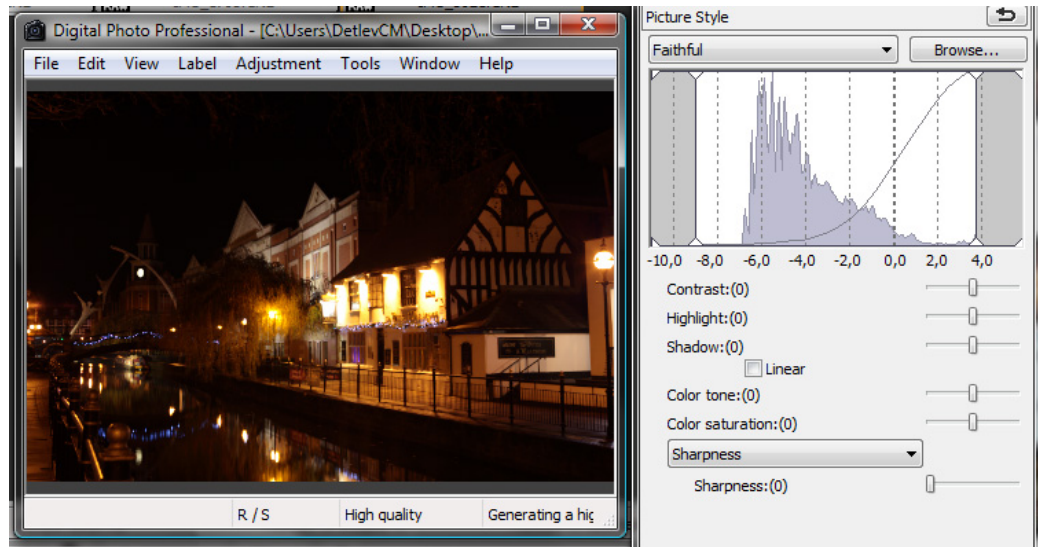


Figure 3.7: night, dark image

So what about images where shadow detail is lost? Take for example the following image from Leeds, shown in figure 3.8

The image is very “left heavy” with shadow detail lost. But does this make it a bad or wrong image? No, because the scene it depicts contains very dark areas. The underexposure was chosen to convey the mood of the scene and to maintain details in the light and reflections of light.

#### 3.3.3 Conclusion and Recommendation

To conclude, there is no perfect histogram. No histogram is more right or wrong than another. However it is a useful tool to assess the exposure of an image quickly and to determine whether the resulting image has any problems due to the dynamic range of the scene captured.

Thus it is highly recommended that you check your histogram after capturing a scene. It is always accurate, no matter what lighting conditions and always more representative than the image visible on the LCD display.

If you want to be extremely cautious, Canon cameras offer you the ability to display a histogram for every colour channel, as exposure can vary by a fair amount between different channels.

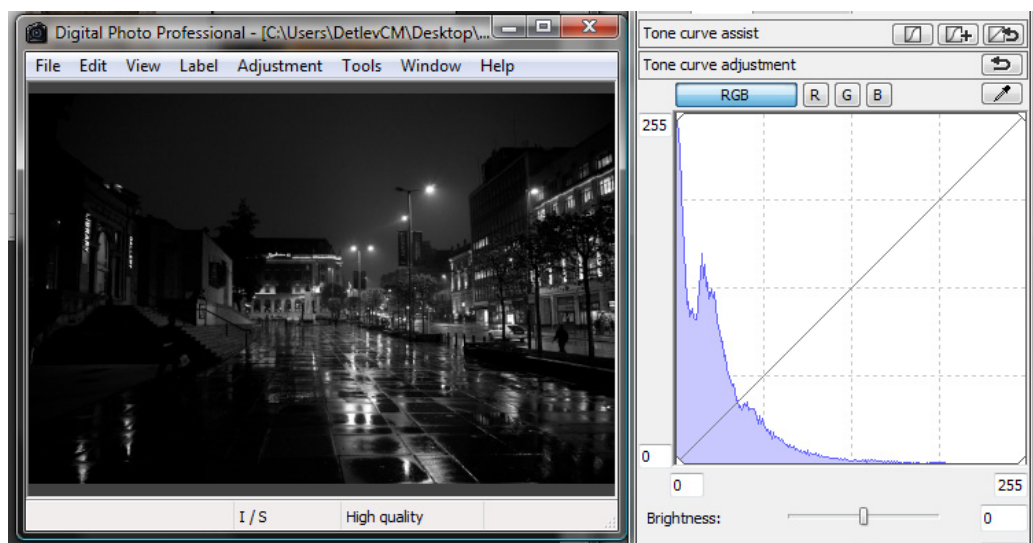


Figure 3.8: night image



## 4 Lenses

### 4.1 General Introduction to Lenses

The ability to change lenses is one of the most defining features of an SLR camera. Besides rangefinder cameras, this feature is further found only in micro four-thirds cameras.

When you begin, buying the right lens for your photography can seem like a daunting task. Similarly, selecting the right lens or lenses to take along can seem like a tricky problem, because we cannot carry more than a few easily. Every time we go out to photograph something we need to compromise and decide which lens forms the ideal tool for what we aim to photograph. A starting point is to understand the types of lenses available to photographers today, what their uses are and how they affect the resulting image.

#### 4.1.1 Focal Length instead of Zoom Factor

First let me introduce you to the appropriate terminology with respect to lenses. On compact cameras, we got used to reading statements such as 10x zoom, which are meaningless, on compacts as well as SLRs.

18-55mm is about 3x zoom, as is 70-200mm.

However, 18-200mm would be an 11x zoom.

Can you spot the problem?

SLR lenses are described using their focal lengths only, which is a property of the lens and may hence be used to identify it uniquely when including its aperture.

#### 4.1.2 Focal Length, Field of View and Sensor Size

The conventions of grouping lenses into categories only applies to a full frame sensor, or rather a sensor with the same physical size as a slide of film. As most SLRs have smaller sensors, the viewing angle changes to that equivalent to a different

focal length on full frame while the focal length of the lens stays the same, as it is a property of the lens.

Take a look at the drawing in figure 4.1, which is not quite to scale, but close in terms of relative sensor sizes.

The dimensions of a full frame sensor are  $36mm \times 24mm$ , while it is  $\approx 27.9mm \times 18.6mm$  for APS-H and  $\approx 22.3mm \times 14.9mm$  for APS-C for Canon. While the size of full frame sensors is defined by old wet film, crop formats are specified by the manufacturer.

The size of the sensor defines how much of the image circle thrown by the lens is actually visible and recorded, hence a smaller sensor crops out a part of the whole image.

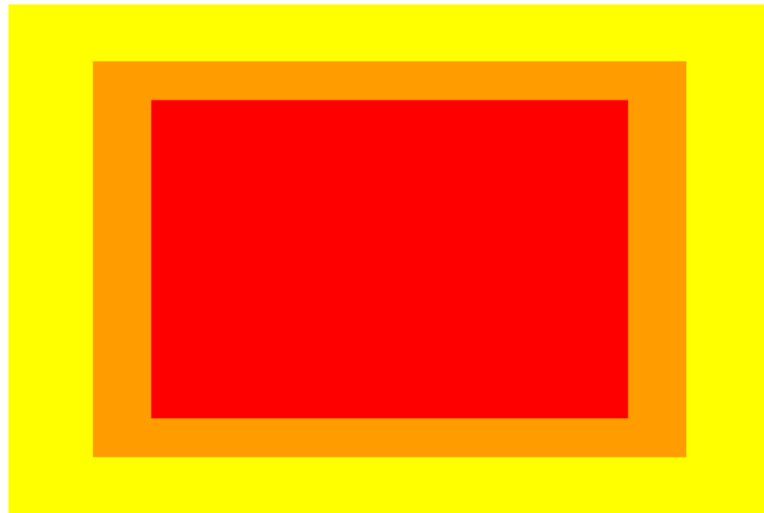


Figure 4.1: Comparison of sensor sizes, yellow = FF, orange = APS-H, red = APS-C

Confused? I shall try a simple example.

A 50mm lens is a 50mm lens. But on a Canon APS-C sensor, which is a 1.6 crop, it will have the same viewing angle as an 80mm lens on a full frame camera. It remains a 50mm lens, but you only see a part of the image it throws.

Have a look at the image in figure 4.2. It was shot with a 24mm zoom lens on

full frame. The image in figure 4.3 shows the sensor sizes overlaid and the resulting field of view for a 24mm lens on different sensors.



Figure 4.2: Beverly Minster



Figure 4.3: sensor overlay

Comparison of sensor sizes, yellow = FF, orange = APS-H, red = APS-C

The main reason for the use of smaller sensors is cost. A full frame sensor is several hundred Euros more expensive to make than a smaller APS-C sensor.

Broadly, lenses fall into four categories, which can be commonly grouped as follows:

Type of Lens	On a Full Frame Sensor	On a 1.6 Crop Sensor
Wide Angle	$< 35mm$	$< 24mm$
Standard	$50mm$	$\approx 30mm$
Tele	$> 70mm$	$> 50mm$
Super-Tele	$> 200/300mm$	$> 200mm$

Table 4.1: Lens Classifications

A standard zoom lens covers the standard focal length, plus “some extra” on either side. For example, a 24-70mm lens is considered a standard zoom on full frame. For a camera with a smaller sensor, one needs to work out the focal length required, by dividing through the “crop factor” of the smaller sensor to obtain equivalents with respect to the viewing angle.

In the case of a Canon SLR, with a crop of 1.6, a standard zoom would be either 17-50mm or 18-55mm, where the kit supplied kit lens generally covers 18-55mm.

Three other “speciality lenses” also exist, namely fisheye, tilt-shift and macro, where the latter is generally a tele lens with the ability to focus on close objects, hence a lens design with a small minimum focussing distance.

### 4.1.3 Sensor Sizes and Lens Mounts

Something to pay attention to, is what the lenses are designed for. Canon has an EF-S (crop sensor) line-up, which is cheaper, and an EF line-up that works on a full frame sensors. The key difference between both designs is the image circle thrown by the lens. An EF lens will work on a crop camera and full frame camera, but an EF-S lens will not fit onto a full frame, EF mount. While an EF-S lens can be made to fit onto a full frame camera, please do NOT do this, as it will also protrude further into the camera at some focal lengths, which risks a collision between the mirror and lens, which would lead to expensive damage.

Additionally, with third party manufacturers, lenses will generally be an EF mount, but some only throw an image circle appropriate for APS-C.

### 4.1.4 Field of View

Before I go into details as to what you can expect of a certain lens type in section 4.2, please consider the sketch under figure 4.4 as a rough description of the field of view covered by different lenses. The black box symbolizes the camera and the pink “x” denotes a potential subject in the photograph.

### 4.1.5 Lens Hoods and Lens Flare

Two aspects of lenses you should be aware of, are lens hoods and lens flare.

Lens flare is caused by internal reflections in the lens. Whenever you have a light source inside the picture, there is a chance of lens flare occurring in the image. This



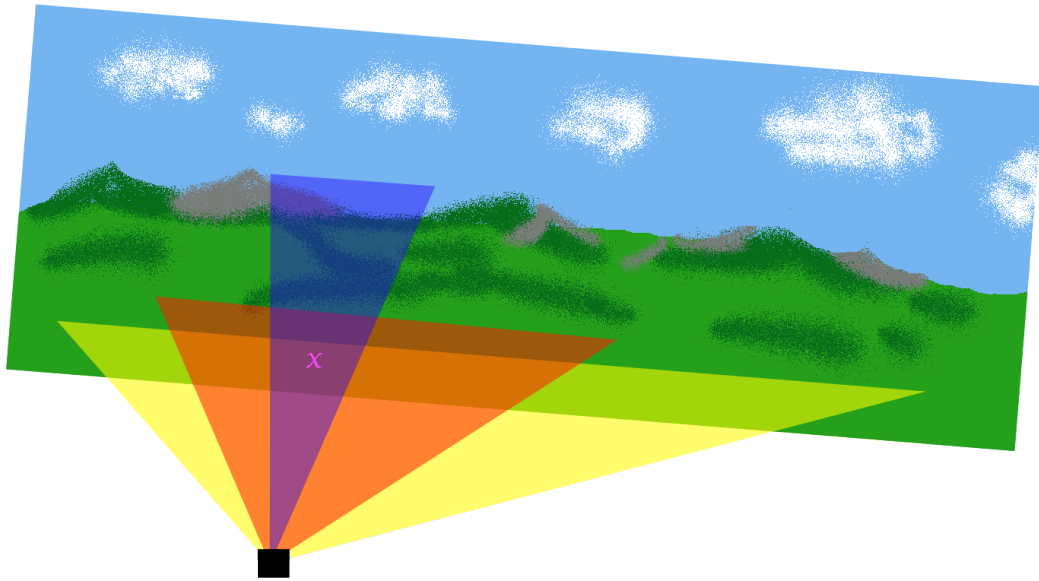


Figure 4.4: yellow = wide angle, red = standard, blue = tele

can be used artistically, so it is not always undesirable, however in the majority of photographs is undesirable.

It is a good recommendation to check your images for lens flare, whenever you shoot images with (direct) light sources in them, or just outside of the image frame.

Filters often make lens flare worse, so they are not a solution. Lens flare is often worse on wide angle lenses than on tele lenses, however both can be equally susceptible depending on the quality of the lens.

A solution to minimizing lens flare, is to use a lens hood. Due to the nature of the field of view, explained in Section 4.1.4, lens hoods are more effective on tele lenses than on wide-angle lenses.

Third party manufacturers will often supply a lens hood with most of their lenses, while Canon only supplies it “included in the price” with their L-lenses lineup. Whether buying a lens hood for other Canon lenses is worth it, is entirely your decision, especially as the prices charged for the them are rather high.

Because a lens hood reduces stray light, it can also help with contrast. Additionally, a lens hood offers some protection should you bump into things by accident.

## 4.2 Short Introduction to Different Types of Lenses

### 4.2.1 Prime versus Zoom

Before I mention what types of lenses exist, I would like to introduce some more terminology. You are most likely familiar with a zoom lens, which is a lens that can change its focal length, or rather a lens that can cover multiple focal lengths.

In contrast, a prime lens is a lens that only covers one focal length, which cannot be changed.

If you ask, which is better, the answer is neither. A prime lens will in general provide superior optical performance and offer wider apertures than a comparable focal length zoom lens. In contrast, a zoom lens will offer a lot more versatility, covering a range of focal lengths.

Some people use only primes, while others have a preference for zooms. You need to take your own decision on this topic. If you are not sure what to do, it may be an idea to buy a cheap 50mm prime lens to go along with your kit lens and see which of the two lenses you prefer.

### 4.2.2 Wide Angle

Wide-angle lenses have a short focal length and thus cover a wide angle of view. Classic uses for wide-angle lenses include landscape photography, architectural photography and interiors where space is at a premium. Portraits are generally not shot with a wide-angle lens as this results in a “noisy”, distracting background and sometimes rather odd distortion. An exception to this is the photograph of a large group of people, especially if space is at a premium.

### 4.2.3 Standard lenses

Standard lenses cover a field of view roughly equal to the field of view covered by the human eye. They sit between tele lenses and wide-angle lenses and can be used in many different ways.

Some people use standard lenses for portraits, others find the results unflattering. Some photographers use them for architectural photographs, others think they are too wide/narrow.

Whether a standard zoom is right for you, can only be decided by yourself. It

definitely does open the door to a lot of creative photography, as wide aperture standard lenses are comparatively cheap/reasonably priced.

### 4.2.4 Tele

Tele lenses are often used for portraits or photographs of details.

With portraits, the narrow field of view allows for the visual isolation of the subject, while with for example architectural shots, tele lenses allow for shots of details that are otherwise out of reach.

### 4.2.5 Super Tele

In some cases, a “normal” tele lens is not enough, in this case super-tele lenses are used by photographers, which generally have a focal length in excess of 200-300mm. Such lenses can be used for portraits, but are generally used to shoot sport events where the subject is far away as well as wildlife or aircraft. The primary objective behind super-tele lenses is reach, while still collecting enough light to allow for fast shutter speeds. With good optical quality, these lenses require large lens elements, which make them large and very expensive.

While especially beginners might be tempted by cheap 70-300mm lenses from various manufacturers, their optical quality tends to be a so-so affair. I had a cheap 70-300mm f4.0-5.6 lens from Sigma, and while it was usable, and I got a couple of lovely shots from it, in retrospect I would not buy this lens again. At the same time, I got my lens in summer 2008, and since then lenses have become cheaper and optical qualities have been improved, on expensive as well as cheap lenses.

### 4.2.6 Fisheye

Fisheye lenses are a special type of wide-angle lens.

While distortion is generally unwanted, fisheye lenses create specific distortion, similar to a convex mirror. This is paired with very large viewing angles of up to 180 degrees on some fisheye lenses, which means you will see your feet if you are not careful.

Fisheye lenses have a primary use in artistic and creative photography. Only you can decide whether you have any use for them.

### 4.2.7 Macro lenses

Macro lenses are generally tele lenses with a very short minimum focussing distance. Hence you are able to resolve a lot of detail in photographs of tiny objects. Macro lenses will also focus at infinity, so they do not have any disadvantages over “normal” tele lenses. In fact, you will find that macro lenses are typically just a part of the regular lens line-up without a “non-macro equivalent”.

### 4.2.8 Tilt-shift lenses

Because conventional optics tend to lead to a “leaning towers effect” on buildings, architects required a lens that would show parallel lines/edges on buildings. The tilt-shift lens was born.

By physically misaligning the lens elements, the photographer is able to ensure parallel lines on buildings. The disadvantage: tilt-shift lenses are not weather sealed and are manual focus only.

Today they have also been discovered by artistic photographers who make creative use of the effects created by a tilt-shift lens.

## 4.3 What Lens should I buy?

If you ask this question like this, without any context, I suggest you read section 4.2 again. Choosing a lens is such an individual task, that nobody can give you the “right” answer.

If you are starting out, the kit lens on a DSLR is a good starting point. A reasonably priced tele-zoom can be an idea, but is not a must have. From the kit lens you need to decide if your interest requires a wider angle or a tele-lens and then choose the appropriate lens.

Alternatively, if you have an exact idea what you want to shoot, you can ask for a recommendation for this specific task, but keep in mind, that sometimes different people take different approaches to the same task.

Once you have decided which focal length you aim to buy, the next point of concern would be the aperture, as often multiple lenses with different apertures but the same focal length are available. Well, this latter part is easy. The wider the aperture, the heavier and also more expensive the lens. Consider the widest aperture you can afford or are willing to afford and are willing to carry on any lens and research it.

Unless you can find any specific issues with the model you researched, it will always have superior glass compared to the smaller aperture model of the same focal length. This does become a bit trickier, if your choice is between a lens with IS or without, and the question you need to ask yourself is, how important is IS to you. Keep in mind though, that a lack of IS can be compensated for by a tripod in most situations, while a wider aperture would require significant postprocessing work if it can be realistically simulated at all.

At the same time, obviously, if you need a lens “now” and cannot afford say a 50mm f1.2 lens, a f1.4 or f1.8 will be a good choice, though they are optically inferior.

Lastly, sometimes across different manufacturers, focal lengths vary slightly, by which I mean that competing lenses do not have identical focal lengths. Expect competing lenses between manufacturers to show a difference of 1 to 3mm on the wide end, and even up to 5mm on the long end.



## 5 Composition Basics

The standard rule everybody talks about in photography is the rule of thirds. Divide the height and width into 3 segments as shown in figure 5.1.

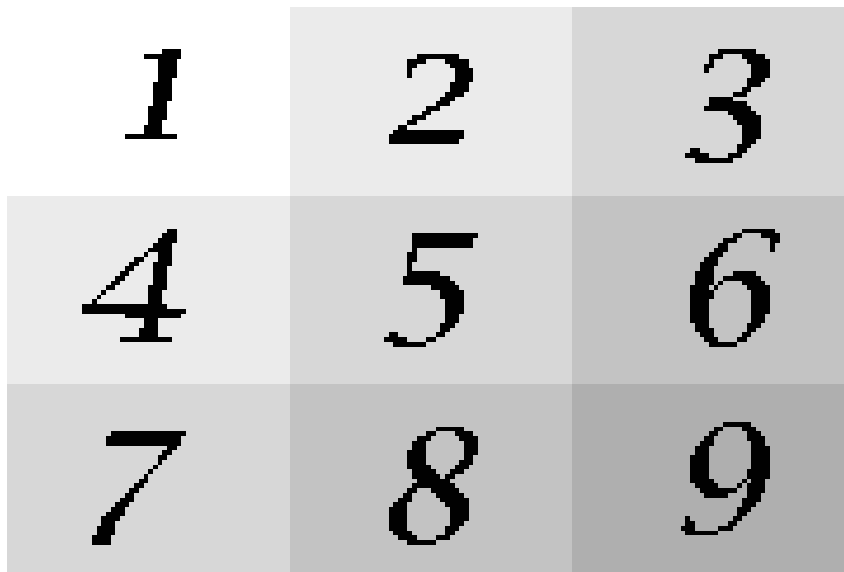


Figure 5.1: grid from rule of thirds

The idea is, that you try to frame the image in a manner such, that every one of the nine areas in figure 5.1 contain something of interest.

An example would be the interior photograph from Lincoln Cathedral in figure 5.3 with the rule of thirds marked clearly in the image. Alternatively, the image is available to you without the overlay in figure 5.2.

You have the organ in the middle, the columns at the side, the floor in the foreground, and the roof in the middle.

You can live by the rule of thirds, but then photography is an art - why should you?

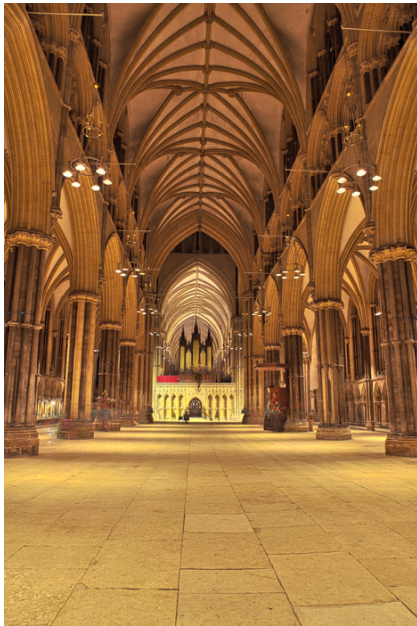


Figure 5.2: Lincoln Cathedral



Figure 5.3: overlaid



However, there are some other points that you should think about.

## 5.1 Framing

Do not frame your subject too tightly when taking the photograph. On today's high resolution sensors, one can always crop away parts of an image, but one can never add something. Especially if you decide to print, you need a small border, which will be covered by the frame. The same goes for canvas prints. Only cards can get away with tight framing, and even then, consider the aesthetics of the image.

## 5.2 Photographer's versus Viewer's Vision

Think about what you want to show and what the viewer will see.

Thinking about what the viewer sees is important but also difficult. You know the area, the environment, the atmosphere, the viewer in most cases does not. While a scene may look interesting to you, the viewer might be desperately searching for a focal point, a point of interest.

For example take a look at the image in figure 5.4, what do you think?

On this specific image, I asked for critique and learned a lesson; if I follow it is another topic though.

In terms of exposure, the image in figure 5.4 is perfect, it has a nice saturation, nice dynamic range, but what does it show? What you see in this image is the forecourt of Sheffield Station in the UK at sunset. I know the area; I know what is of interest. The lighting of the sandstone station, the lighting of the fountain, the reflections on the ground.

What did you focus on? You were most likely lost in the image, unsure where to look, what to focus on. I was shooting what I saw, what I want to see because I know the area, but a random viewer does not see the same image. One of the suggestions I got in the critique was to focus for example on the bike because, as a piece of detail, it is significantly more interesting.

Unless selective focus (via the depth of field) guides the viewer to the object of interest, are you sure, the viewer will focus on what you are focussing on? It is also easy to overlook something and have it drop off the frame as "not important" while the viewer is immediately drawn to it.



Figure 5.4: Sheffield Station at sunset

### 5.3 Composition Conclusion

If you stick to the suggestions in this chapter you should be fine. Just let your imagination lead you, because photography is also an art and not only pure science. Feel free to do what you like and to break the rules as often as you like to explore the medium. Often the crazy little experiments can lead to the most interesting photographs.

## 6 Computer based Techniques

Due to the nature of digital images and the constant advances of computing power, image manipulation has become a tool accessible to everybody.

The two topics I would like to focus on in this chapter are panoramas and HDR images, both valuable techniques, which deserve their own chapter.

### 6.1 HDR - High Dynamic Range

If you have read the earlier chapters, you should remember that the human eye can resolve about 18 stops of dynamic range, while a camera may at best resolve about 8 stops of dynamic range. In many scenes this is not a large issue, but some scenes lose all their magic as a result of losing highlight and shadow detail. The solution is to shoot an HDR image, which consists of several images, covering the dynamic range of the scene, layered on top of each other to resolve the full dynamic range.

The irony of this is, that while the image created during the post processing steps is a true high dynamic range image, the final result, though named “high dynamic range” is not as it is a compressed JPEG.

A most basic HDR can be created from 2 images, but 3 or more are common. The most images I have ever used were over 40 images on a church window, to capture the interior as well as the beautiful stained glass.

You may have guessed, that a tripod is vital when shooting HDR images. Although an HDR image can be created from images shot without a tripod, I would not recommend doing it at all, as your success rate will be extremely low.

In most cases, you will want a series of images, from between 2-1 stops underexposed to 2-1 stops overexposed. However, again, only experience and “on scene metering” will give you an idea of the dynamic range and number of images you need.

Creating an HDR image is reasonably simple. The RAW images are loaded into your “HDR creator” of choice and you can await the result. Personally I use Photoshop CS4, but Oloneo is also a great alternative that works with Photoshop. Many

other utilities are available, from paid to free, such as Picturenaut, to open source, the choice is, eventually, yours.

When using Photoshop, you need to convert your image from a 32bit colour depth to a 16bit colour depth to expose the tone mapping functionality. This is more easily accessible on other HDR editors, and hence more intuitive. If you are using a photo editor other than Photoshop, such as Oloneo, edit your image until it “looks right” to you and export to your favourite format, if you aspire to do further editing, this should be a 16bit TIFF file or other lossless format with a high bit depth.. Also retain the settings and original file in case you want to get back to it later.

## 6.2 HDR Examples

Maybe it isn’t yet quite clear to you why HDR is a great tool. Let me help you visualize the advantages of HDR with some examples.

### 6.2.1 Doncaster Minster

A church is a lovely building for photography, the history of centuries, elaborate ornaments, masterpieces of engineering and art. At the same time, the stained glass, is extremely difficult to photograph well if you want to be able to distinguish more than just the window or just the interior. A challenging, highly dynamic, scene that requires a technique such as HDRs.

The following 3 images are examples of the 45 images used to create the final image shown in figure 6.4. I have chosen the shortest, “middle” and longest exposure of the series for the example images. If you read the captions, you should spot that the exposure times are  $\frac{1}{15}s$  for the image in figure 6.1,  $1s$  for the image in figure 6.2 and lastly  $15s$  for the image in figure 6.3.

Referring you back to the chapter on dynamic range, you should be able to spot that the difference between the shortest and longest exposure is a factor of 225. ( $\frac{15s}{\frac{1}{15}s} = 225$ ) This means that at the longest exposure, the sensor collected 225 times as much light as it did on the shortest exposure, which translates to a difference in exposure of about 7.8 stops. (7 stops are 128 times as much light, 8 stops are 256 times as much light).

Of course, each image will in itself contain about 5-8 stops of dynamic range from the darkest to the brightest elements.

Inspecting the images, you should see, and agree, that a single exposure would not be able to capture the full dynamic range of the scene presented by the interior of Doncaster Minster.

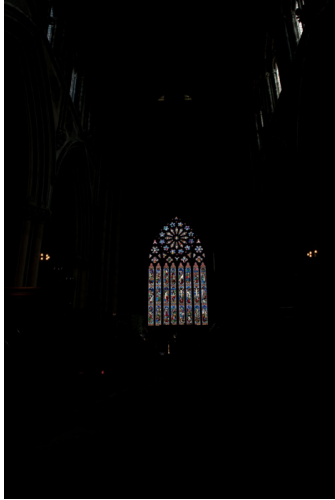


Figure 6.1: 1/15 s

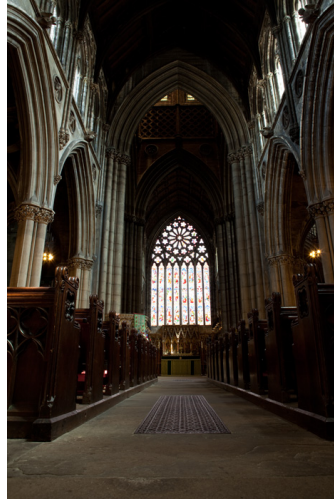


Figure 6.2: 1s



Figure 6.3: 15s

The final HDR image, shown in figure 6.4 displays the difficult to capture dynamic range in the image beautifully. However, the name is deceiving, as the image you see on the screen is not an HDR image, considering it is an 8bit JPEG. What has happened is, that the 32bit HDR image was compressed down to 16bit and then 8bit, which is a standard dynamic range image.

### 6.2.2 Sunset in the Pennines

Another scene which in its natural beauty is very dynamic is sunsets. It may not be intuitive to apply the HDR technique to a sunset, but it has significant benefits for the resulting image. Because the sunset contains many highlight details, a photograph that captures the overall scene, does not capture the intricate details of the sunset.

In this case, only three exposures were used:  
It may not be obvious, but it is visible in figure 6.5, that the sunset contains some “very bright” spots, that require a short exposure. At the same time, darker details

on the clouds are better exposed in the images in figure 6.6 and figure 6.7. An HDR image allows the photographer to retain this detail in the clouds. Lastly, the additional information helps to improve the colours in the image. Just upping the saturation on a regular single photograph will not have the same effect. The resulting image can be seen in figure 6.8.

### 6.3 Panoramas

Panoramas are merged images, mainly to resolve more detail than is possible with a conventional camera. It is also used to create resolution records, or to allow for a wider field of view than the lens permits, though the latter should be used with caution.

Again Photoshop can merge photographs, as can Microsoft ICE or other utilities, the choice is yours. I personally find ICE to be more accurate and definitely quicker than Photoshop.

In terms of image overlap (which you need to merge images), a guideline is to have at least a  $\frac{1}{3}$  overlap between two images. You can try with less, but it reduces the success rate and increases the chance of merging errors, experience will again be your best guide.

If accuracy is your first concern, you should use a tripod to rotate your camera around fixed axis in space. Alternatively, you can try handholding, but be aware that the possibility of failure increases a lot with a handheld panorama. Overall I have had reasonable results when shooting handheld panoramas, however a tripod is definitely a more failsafe method of creating a panorama. If you are desperate for gigapixel images, a gigapan robot will be a worthwhile investment, but I must say that I have not used one myself.

If you try to widen the field of view of a wide angle lens in confined space, for example indoors, this may lead to strange distortion effects, or if it is a symmetrical scene, a fisheye effect. So beware when creating a panorama, it is not a perfect solution in every situation.

Although the term panorama traditionally refers to an image with a large aspect ratio, such as for example 16:9 or 21:9 over the standard 3:2 in photography, with the

availability of merging tools to anybody, a panorama is not tied to a specific format. In fact, because photographs may and are merged in any direction, the function in Photoshop is called “Photomerge”, rather than something along the lines of “create panorama”.

### **6.3.1 Examples**

An example of distortion is the interior panorama shot in De Nieuwe Kerk, Amsterdam, in figure 6.9. However, as the distortion is symmetrical, it resembles a fisheye lens and is not too unpleasing. A distortion-free image would however be significantly better.

An example for a perfect panorama is the harbour in Mallaig, Scotland, shot in Winter 2008, shown in figure 6.10. If I remember this image correctly, it consists of eight individual images in portrait mode.

The major difference between the image in figure 6.9 and figure 6.10, is subject distance. In Mallaig the subject was significantly further away, and hence a longer focal length was used, resulting in a panorama with less distortion.





Figure 6.4: Doncaster Minster - HDR





Figure 6.5: 1/20 s, -1 stop



Figure 6.6: 1/10 s



Figure 6.7: 1/5 s, +1 stop



Figure 6.8: Sunset in the Pennines - HDR



Figure 6.9: De Nieuwe Kerk - distortion

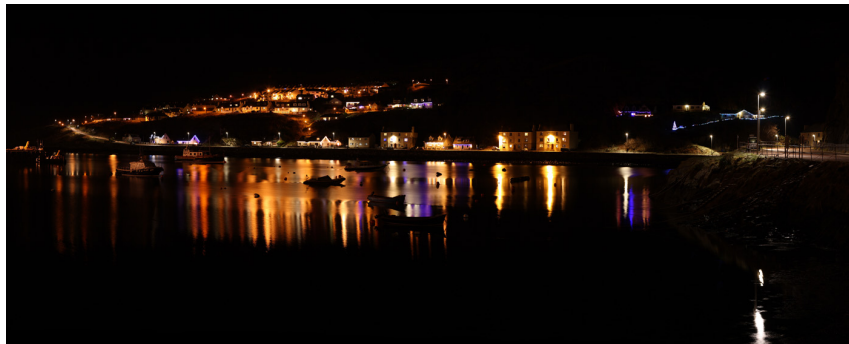


Figure 6.10: Mallaig Harbour at Christmas at night

## 7 Some Pointers with Respect to File Management

### 7.1 Why think about File Management

Many people will often not experience a harddrive failure if they regularly upgrade devices or take good care of their equipment. Plus, most home storage seldom requires more than one harddrive when it comes to storage capacity. Nevertheless, harddrives can fail anytime, with or without a clear reason and the more data you store, and trust me, once you get into photography it will be a lot, the more drives you need, increasing your chance to experience a harddrive failure. Given that you will most likely need to deal with thousands of files, it can also become to bothersome to manually ensure you have backup copies.

Therefore planning a sustainable approach to redundant file management is one of the many behind the scenes aspects of photography.

### 7.2 Harddrive Failures

I have personally experienced one harddrive failure (with data loss) in my laptop where the drive just died. Two more server drives have gone bad and needed replacing (without data loss) and in my family three interface boards failed in quick succession requiring a docking station to get data off the thankfully intact harddrive. So harddrive problems are not restricted to big server farms. In fact, if you check specification sheets for for example Seagate, you will possibly find that harddrives have a predicted annualized failure rate of less than 1% and 0.34% for some drives (accurate at time of writing, November 2012). This means that somewhere around less than 1% of all drives are expected to fail every year based on the results of some proprietary testing methodology which will be based around a specific usage pattern and most likely involved extrapolation on the basis of a limited number of test cases under more severe conditions. And that is assuming only the failure of the drive because of a defect occurring in the drive itself, ignoring external factors.

As a result, you should consider how you can reduce or eliminate the risk of data loss in a most cost efficient and accessible manner. Having said that, your demands will most likely differ depending on whether you practice photography professionally or whether it is a hobby for you only. The views of people as to what constitutes acceptable backup or a backup in the first place differ. Hence this is only supposed to allow you to think about the approach you will take managing your photos.

### 7.3 Suggestions for File Management

So, some first pointers that do not require any special equipment first:

1. Ensure that you have copies of every file on at least two harddrives.  
Some people prefer to also use copies on optical media (CD, DVDs, BlueRay) or use even more harddrives, such as external harddrives.
2. If you are really worried about your data, consider off-site backup in the form of a portable harddrive.
3. The first thing you should do when you get home after a photography session is duplicating your files on multiple storage media.
4. Never work on the only copy of a file that you have.
5. Consider maintaining a full copy of all photos and a set of edited photos.
6. Use a well structured and organized approach to storing your photos that does not require any special software, I prefer Year, Month, Day folders.
7. Potentially consider adding relevant metadata to your photos.

If you are the geeky type, consider the following:

1. A NAS can offer RAID solutions to maintaining and automated backup.
2. A windows Home Server allows easy file storage with duplication on multiple drives.
3. A self built Linux file server will offer huge scaling potential.
4. After you have considered the privacy implications, cloud based backup services may be an option.

Now I have heard people claim that RAID is not a backup, which would require us to focus on what we mean with a backup. Backup solutions can be designed to protect against two types of events. One is data loss due to hardware failure, which is covered by a setup such as RAID or a home server. The second type of backup is protection against user error and requires that a periodic copy of all data is made and archived from which data may be restored at a later date. Enterprise solutions tend to take the second approach, while many home users will be perfectly happy with protection against hardware failure only.

Whichever events you wish to protect yourself against, you need to decide what works for you and how much money you are willing to invest into your information technology infrastructure.



## 8 A few Words on Editing Photographs

### 8.1 Introduction to Editing

Editing photographs becomes an essential part of photography, the only exception being for example sports photography where photographers compete to have their image available first and hence do not have time to edit photographs.

Even in photojournalism, most situations will require a little bit of post processing (editing), however only in a manner such that it does not distort reality. Hence cropping, sharpening and minor colour corrections would be acceptable, but significant changes such as digital filters or significant colour changes would not be.

If however, your interest lies with photography as an art, you are free to do whatever you want.

Before you start, please ensure you do not edit your only photograph destructively. Programs such as CameraRAW can edit images non-destructively, by writing changes into a separate file. Canon's Digital Photo Professional is also non-destructive on RAW files. However, Photoshop edits images destructively unless you use layers skilfully, and hence save images as a .psd file and not as a flat image file such as for example .jpg.

It is always best practice to retain a backup copy before you start any editing on any file.

### 8.2 Key Steps for Post Processing

The most basic post processing steps that you should consider are

1. White balance - is the colour temperature right or not?
2. Exposure - is the image exposed correctly?
3. Highlights and shadows - do they show how you want them to show; you have not lost any detail that you want to keep?

### 4. Saturation - does the image look dull?

While you might hope there is an “always right and applicable” rule to editing photographs, I must say that there is not. Any steps you undertake when editing a photograph represent your evaluation of the scene and your interpretation. While there are settings you should generally avoid, there is no perfect solution when editing images.

If you do not have a clear idea where you want to go when editing the image, I would highly recommend you aim for a natural look in your photographs.

In the following images, I would like to introduce you to some visualisations of key settings. Figure 8.1 shows an unedited conversion of the RAW file depicting the scene. Figure 8.2 shows my interpretation of the scene, which I can tell you, is a sunrise in Sheffield.

Specifically, I increased the colour temperature (made the image warmer), increased the saturation and pushed (hence brightened) the shadows a bit.



Figure 8.1: initial file



Figure 8.2: my interpretation

### 8.2.1 Colour Temperature

Colour temperature describes how warm or cold light, or an image is. A low colour temperature corresponds to a cold or blueish image while a high colour temperature corresponds to a warm or yellow/orange image.

Colour temperature is measured in Kelvin, K.



The image in figure 8.3 shows a temperature of 2000K, while the image in figure 8.4 shows a colour temperature of 50000K. In most typical photographs you will be looking at a range of 4000-7000K on the extremes, however, just like many other settings, this is such an individual setting that only you can chose the appropriate colour temperature for your image.



Figure 8.3: cold colour temperature



Figure 8.4: colour temperature too warm

### 8.2.2 Digital Exposure

Digital exposure works very much like “real exposure”, adding or removing stops or fractions of stops of light. However, contrary to when you are exposing the actual sensor, increasing the exposure in post processing adds noise, while reducing the exposure can not always recover lost highlights.

How far you can go either way depends on many factors, amongst them the camera’s age and manufacturer. Experience is again your best guide in this respect. However, as a general rule, you should aim to expose as perfectly as possible in the camera, as this will always yield the best results in the final image. Correctly exposing in the first place is nearly always better than adding exposure later on in post processing

The image in figure 8.5 depicts one extreme, with four stops of light added in post processing. As a result the station is clearly visible, but the sky is just plain white. Conversely, the image in figure 8.6 has four stops of light removed from it, resulting in a station which is absolute black but cloud detail visible.

When you edit your photographs, you will want to balance the exposure, shadow and highlights slider to try to find an ideal solution. The shadow slider will brighten

up the underexposed parts of the image only, while the highlights slider will only darken then brighter parts of the image.

Please note that the naming convention depends on the manufacturer/supplier of the software. Canon's DPP calls them "shadow" and "highlight", while Adobe's CameraRAW calls them "Fill Light" and "Repair".



Figure 8.5: severely overexposed



Figure 8.6: severely underexposed

### 8.2.3 Saturation

Saturation is, in a rough description, the intensity of colour. You may know that a completely desaturated image will be a black and white image, shown in figure 8.8. If you oversaturate an image, the colours will look very brilliant as seen in figure 8.7, but also lose highlight detail and the image will look unnatural.

An image can be desaturated or (over)saturated for artistic purposes. You need to decide what looks good in your eyes and what you think fits the image.

## 8.3 Further Steps for Post Processing

Further steps are contrast (via tonal curves) and sharpening. Do not over-sharpen the image, even if you are used to this look from compact cameras. Together with sharpening, you will also want to apply some noise reduction, but only in a manner such that noise is reduced while detail is not lost excessively. Again, experience is valuable, and experimenting with different settings is highly recommended.



Figure 8.7: overly saturated



Figure 8.8: desaturated

#### 8.3.1 An Example on how to Make an Image Interesting

When photography is practised as an art, your post processing is only limited by your imagination and skill. Maybe the image did not turn out as expected; maybe nature disappointed you and did not give you the magnificent sunset you had hoped for. In the following images, figure 8.9 and figure 8.10, I will give you a brief introduction how a set of basic steps will turn a dull boring image into something at least acceptable.

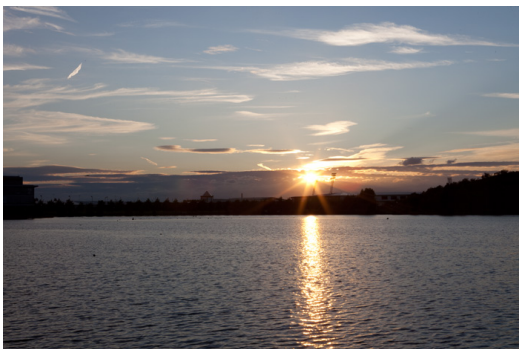


Figure 8.9: Before Editing



Figure 8.10: After Editing

This image was shot at Lakeside in Doncaster in the United Kingdom. The weather looked great and I had hoped for a nice sunset, instead the sunset was one of the duller ones I have experienced. Later at home, I started to play a bit.

Before you continue to read, try to guess what I have done to the image, and then compare your expectations to what I tell you I have done.

1. I slightly increased the colour temperature to make the image warmer, especially as warm tones tend to dominate sunsets and hence give it a more inviting look.
2. Next I slightly increased the contrast.
3. Sharpness and noise reduction were left unchanged, as there is no need for either in this image.
4. In the fourth step I increased vignetting in CameraRAW, this is the darkening of the corners that you see.
5. The last step is the most important. I simulated a gradual neutral density filter, which means that I added a gradual change in brightness. When applying this change, I also significantly increased the saturation.

I added one gradient from  $-1.55$  stops to  $0$  stops from the top to the waterline to darken the sky and reduce the overexposure created by the sun. If you consult figure 8.11, the red line marks the lower boundary of the gradient.

And I added another gradient from  $-0.70$  stops to  $0$  stops which runs from the bottom of the image, to a horizontal line drawn through the sun. If you consult figure 8.11, the green line marks the upper boundary of the gradient.

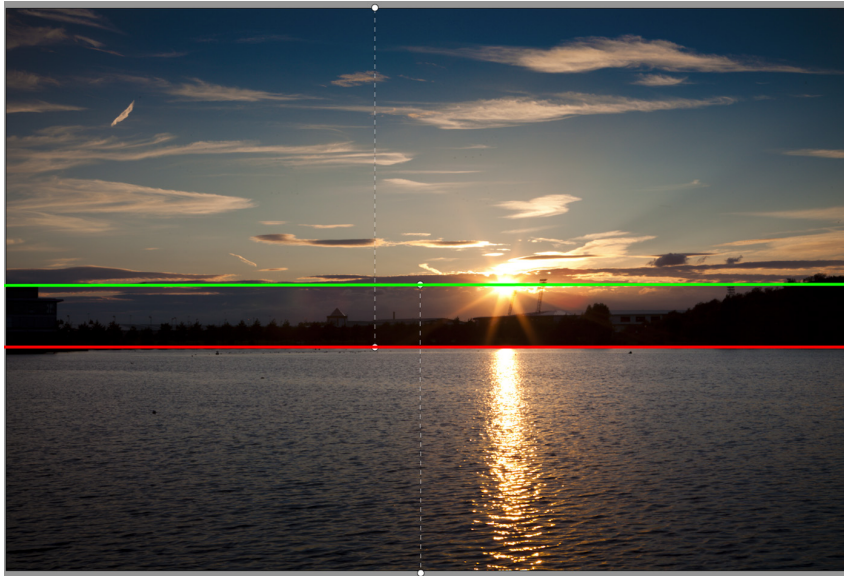


Figure 8.11: gradient boundaries



## 9 Colour Management, Monitors

### 9.1 Colour Management

Colour management refers to the management of colour spaces. So first, let me give you an introduction to what colour spaces are.

#### 9.1.1 Colourspace

In a quick accurate description, the colour space defines how colours are mapped and how many colours are included and thus may be displayed and recorded in an image.

Specifically, because technology works with linear light intensity, while humans perceive light intensity logarithmically, as well as different sensitivity to different wavelengths (colours) of light, there is no reason why for example (133,73,231) is a certain colour, namely the colour shown in figure 9.1. In fact, there is no reason why this colour should look the same on different monitors or printers without a colour space.



Figure 9.1: The colour (133,73,231)

What is required, is a map that maps the numerical values to a predefined colour. As a result, for example sRGB and Adobe RGB are similar colour spaces but not identical. Further, this map will also define what dynamic range can be displayed as well as how fine the steps between different colours are, although the latter is more directly related to bit depth than colour space.

For web use, sRGB is the standard colour space, for printing sRGB tends to be the colour space of choice. If you do not use sRGB on a website and a user visits that site with a non-colour managed browser, they will not see the same colours you see. In addition, even if the browser supports colour management, it does not always work well. Personally, I have seen skies turn purple because my colour managed



browser, Firefox, did not register that the image it is displaying used Adobe RGB rather than sRGB for some reason.

### 9.1.2 Managing Colour

Colour management just means ensuring that the applications respect the colour space information, and that colour space information is retained. It also means embedding the appropriate colour space into the resulting image file, so that later viewers are able to reconstruct what you see, with the colours that you saw.

Let me give you an example. If you look at the images presented in figure 9.2 and figure 9.3, you might be able to detect a difference in colour, depending on the quality of your monitor. The source image was present in the Adobe RGB colour space, in figure 9.2 this was converted to sRGB, while in figure 9.3 the colour space was ignored and the numerical values at every pixels were treated as if they were from the sRGB colour space.

Because the colours are mapped slightly differently, the images look similar but not identical. Specifically, if your monitor is good at displaying blue and violet or colour accurate, you should be able to discern a more violet tint in the image, which has ignored the colour space, over the image in which the colour space was adhered to.



Figure 9.2: colourspace converted



Figure 9.3: colourspace ignored

While the differences are small between sRGB and Adobe RGB, other colour spaces can have a significant impact on the resulting image. Colour spaces based on other “colour systems” than RGB such as Lab CMYK can result in completely different images. You might have spotted, that the Lab CMYK colours match the contents of your printer, even though your home printer will have an RGB colour profile on your



computer. This is because the colour space is converted along the way, which will result in images looking either very similar, or ideally identical with respect to colour.

For your entertainment, figure 9.4 shows the ProPhoto RGB colour space assigned to the same Adobe RGB source image. Figure 9.5 shows the colours changed to CMYK and then the Agfa Swoop Standard applied again to the same source image. While one can argue that ProPhoto RGB actually improves the colours in this specific image (but also oversaturates them), switching to CMYK and just assigning the Agfa Swoop Standard results in a colour disaster.

Whenever you change colour space, make sure you explicitly convert the colours. However, you should still be aware of some things.



Figure 9.4: ProPhoto RGB assigned



Figure 9.5: CMYK Agfa assigned

While randomly assigning colour spaces might seem like harmless playing around, switching between colour spaces can lose you colour. Because some colour spaces are wider, they cover colours that cannot be displayed by another colour space. A Specific example would be Adobe RGB compared to sRGB. Adobe RGB is significantly wider than sRGB, so switching between these colour spaces can lead to a loss of highlight detail, especially if you went Adobe RGB to sRGB to Adobe RGB.

If you work on images, you should generally decide between sRGB and Adobe RGB. If you do not want to think about colour management, just stick with sRGB. Nevertheless, whatever you do, ensure that colour space conversions, if they need to be made, are made as late and seldom as possible.

Just in case you have not guessed it. All of the above images have been converted to sRGB for the PDF document, to ensure you can see the results even without using

a colour managed application.

### 9.1.3 Colour “Systems”

Different applications require different approaches to displaying colour, of which the two approaches presented are the most common.

These are:

1. RGB - Red/Green/Blue
2. CMYK - Cyan/Magenta/Yellow/Black

#### RGB

RGB is used for “glowing media”, such as screens on LCDs, TVs or large displays. While a large display at say a station may show visibly discernible diodes in the colours RGB on closer inspection, your average monitor will require a magnifying glass to see the different colour channels per pixel.

All “glowing screens” that physically emit light use an RGB approach to reproducing images. No matter whether it is a cathode-ray tube, a TN or IPS monitor (both are LCD displays) or an OLED or AMOLED based phone. What does differ however is the exact shape or distribution of the pixels. On LCD displays as well as cathode-ray-tube-based monitors and OLED displays, each colour occupies the same proportion of space in a pixel.

On AMOLED and Super-AMOLED the area occupied per pixel is no longer split equally, and steps have been taken away from square pixels too. This is done to reflect the different sensitivity of the human eye to different colours (wavelengths of light).

#### CMYK

CMYK is used for all sorts of printed media, which do not emit light themselves. No matter whether the pages you print at home, the CD label or a professionally printed photograph, they are all created using ink coloured yellow, cyan, magenta and black, though one can argue that black is not a colour. If white needs to be represented, this is done via a white substrate. For example, magazines first coat their pages with a white substrate, which is effectively a “white paint” which also contains finely ground marble, on which the colour is then printed on.

### How colour works

If you have read this far, you must now wonder why the two systems. Well, thankfully the explanation is simple enough and in fact implicitly part of any physics class at school. (At least in Germany when I went to school there.)

You should know that “white light” such as sunlight, can be split into its colour channels using a prism, which will give you a rainbow. Different wavelengths of light are refracted (or bent in plain English) by a different angle when entering the prism which is a medium optically denser than air. (Refraction occurs at every interface between optically transparent media with different densities.) At the same time, this setup also works the other way, hence if you “mix” the colours, you get white light. Red has the longest wavelength of visible light, green is somewhere in the middle, and blue has the shortest. By mixing those three channels you can thus create “in between” colours.

While RGB is used with light sources, CYMK is more passive. We see objects because they reflect white light that hits them, absorbing some of it. Different surfaces reflect different wavelengths and amounts of light. Black reflects very little, and the energy absorbed is translated into heat, while white reflects most of the light hitting it. This is why dark clothes in summer are warmer than white clothes. To see colour, as mentioned above, we need to add or remove colour channels. While with emitting light we could add a colour channel, on reflected light, we can only remove a colour channel when reflecting light. A yellow object absorbs all light that is not yellow and reflects only yellow light. Conversely, a red object reflects red light and a blue object reflects blue light.

Therefore, if you print red and yellow, you reflect yellow and red which mix to form orange. Just like watercolours in fact.

## 9.2 Monitors

### 9.2.1 Why think about Monitors

One of the details that is easy to neglect is your monitor. If you aspire to become a professional, you will need to spend somewhere between 500€ minimum to several 1000€ on a colour accurate monitor. The choice you will need to make is between a “normal monitor” which covers the RGB gamut and a wide gamut monitor which covers a colour space larger than sRGB (such as Adobe RGB or NTSC).

Gamut in a most basic description is similar to dynamic range, but the topic is a

bit more extensive as it also refers to a reference colour space. What should be important to you is that most printers, even professional printers, only print colours in the sRGB colour space.

However, if you are a hobbyist or just starting in photography, buying expensive monitors will be, and possibly should be, low on your list, unless you need a new monitor anyway.

### 9.2.2 Calibration

Calibration of your monitor requires hardware to be accurate, even if some people try to tell you otherwise. One such piece of hardware is marketed under the name of Spyder3 by datacolor from Switzerland.

However, as with any product, there are other manufacturers too and I cannot tell you which is best.

Calibrating your monitor will give you colour accuracy within the gamut of your monitor. This means it ensures you see the colour you are supposed to see at a given input signal. It further ensures that the white balance of the monitor is accurate and hence, you can expect an image that is printed to look very much like the image on the monitor.

If you do not calibrate your monitor, your image will most likely look fine on many monitors, unless your monitor desaturates the image displayed. The human eye is surprisingly flexible at adapting to different environments, and hence will be able to see a range of colour temperatures as white. This is why calibration is only valid with hardware; your eyes would deceive you.

Please do not try to calibrate your monitor by looking at it. If you calibrate your monitor, it must be a hardware calibration.

In addition, even if you do not care about colour accuracy that much (although you should), a benefit of calibration on especially laptop monitors is reduced eye-strain through a warmer image.

### 9.2.3 Get a new monitor or use your current one?

A reasonably priced monitor, which covers around 94% of the sRGB colour space, is the HP ZR24w, which is the monitor I use. (Or succeeding models.) However, as time progresses, more, good, low cost options will become available. If you are willing to spend more money on a monitor, the number of choices increases with the price.

However, what if you already have a monitor and do not wish to buy a new one? In this case, you need to be aware what the key limitations of your monitor are. If you have calibrated it, a lower gamut monitor will result in a loss of detail in highlights and shadows, but otherwise not have any other ill effects. If you shoot mainly evenly lit landscapes with few highlight details, this is not too much of an issue, however if highlights are crucial to you, for example shooting church windows, a monitor that covers close to 100% of at least sRGB becomes a must have. Specifically what happens on a lower gamut monitor is, that for example a piece of red stained glass at say (250,0,0) will just look like absolute red (255,0,0) without detail, when in fact it does still contain detail.



## 10 Accessories

This is one of the most difficult topics with photography, accessories. One can easily buy hundreds of items and then find they have not helped at all in improving one's photography. This is because accessories are not everything, however some are highly recommended.

This chapter should give the reader some suggestions where to look and is held in a most general fashion to make it applicable to most users. In the end, only individual experience can determine which accessories you specifically require, there simply is no standard lists.

Having said that, please do not buy a pile of accessories beforehand just in case you need them, as you will waste your money. Buy your accessories step by step as you need them.

### 10.1 Miscellaneous

Little stuff that I highly recommended and cannot list under another category.

- i At least one spare battery.
- ii Enough flash memory cards to store a reasonable amount of photographs. Multiple cards are better than one in case one fails, however do not make them too small, especially considering the video capabilities available in modern SLRs. 4GB or 8GB cards are my suggestion.
- iii A microfibre cloth to clean lenses if they need a quick clean. Microfibre cloths can be had cheaply as household products or from an optician.
- iv If you are near or far sighted a correction lens for the viewfinder.

## 10.2 Storage and Transport - Bags

I personally like shoulder bags, some people prefer rucksacks and other use trolleys. Only you can decide what you want as a bag, but a couple of things you should look out for.

- i Does it have enough space if you add some accessories or one or two lenses?  
Buying a bag for only the equipment you have now will mean you need to buy a new one when you change your equipment.
- ii Is the material hard wearing? This may seem like a minor point, but you need a bag that will survive abuse. It is also protection for your camera, you do not want it falling apart.
- iii Is the bag well padded? If the padding is too thin it will not protect the contents well, but if it is too thick you will lose space.
- iv How heavy is the bag? Can you carry it for as long as you need to?
- v If you buy a rucksack, can you attach a tripod to it.

## 10.3 Tripod and/or Monopod

Tripods are one of the more general accessories that most photographers have a use for, often if they do not use a tripod they use a monopod.

Tripods are essential for long exposures, practical for time lapse videos or self portraits. If you are required to position the camera awkwardly, a tripod can also help to support it.

The following are a couple of points to consider when choosing a tripod.

- i Figure out the weight of your camera and consider any realistic upgrades.  
Keep in mind any super tele lenses or more professional SLRs you might use. An example would be upgrading from a 600D with the 55-200mm lens to a 7D with the 70-200mm f2.8. However do not overdo it. You do not need to consider say a medium format Hasselblad as by that time the 400-500€ you would spend on a tripod to support that kind of weight will be small compared to the 10.000€ or more price of such equipment. But spending another 150-200€ because you followed the above mentioned realistic upgrade path is a waste of money.



Lastly, always keep a safety margin - so if your camera weights 3kg (5D MK II + Grip + 70-200mm 2.8), getting a head for at least 4kg is a good idea.

- ii Decide how much mobility you need from your tripod. Do you want a column that can be levelled horizontally, do you need multiple adjustment angles per leg? The more flexible a tripod, the more useful it becomes but also the more expensive it becomes. Also decide whether you want screw locks or snap locks on your legs. Snap locks can be fastened on good tripods should they become loose.
- iii Decide how much weight you are willing to carry. Carbon Fibre tripods are lighter than aluminium but a lot more expensive. The heavier the tripod, the cheaper. But heavy tripods are difficult to travel with. Some people feel that carbon fibre tripods are more fragile than aluminium tripods. Personally I would go for aluminium because they are a lot cheaper.
- iv Decide on the height of the tripod - it needs to be comfortable to use, but if you are tall you need to compromise.
- v Decide on what kind of head you want and consider that the head also has a weight limit just as the tripod.

A video head for fluid movement?

An "old fashioned" head for exact orientation (useful for panoramas).

A ball head, easily quickly adjusted, but does not allow consistent changes, such as one would use for a panorama.

Numerous companies produce tripods, Manfrotto still produces in Europe as of writing this. Other names are Giotto's, Bogen. The choice is yours. Personally I use a Manfrotto 190 X Pro B with a 460MG head for a 5D MK II with a grip and 24-70 which weight about 2.4kg combined.

## 10.4 Filters

One of the most controversial topics possible. One side believe filters are a "must have" to "protect" lens elements, other had some bad experiences with "always on" filters.

Personally, I would recommend you use a filter in only two conditions.

1. You want the effect from it, such as a circular polarizer.

2. You know you will be in an area where hard particles may hit your lens, such as a desert, a rally track or similar.

Otherwise I would not recommend you buy a filter but rather invest in a lens hood if anything.

If you do decide to buy a filter, try to get high quality models. On circular polarizer the high quality filters let in a lot more light than the cheaper models, however both will achieve the same effect.

I think if you are desperate, I suggest you go and research this topic by yourself.

### 10.5 Flash and Diffusers

Only you know whether you need a flash or not. The “on-camera” flash on lower SLR models is better than nothing if it can get you the shot, however it is nowhere near as good as a dedicated flash unit.

If you feel you need to add light, a flash is often your only choice. If you buy a flash, consider the following points.

1. Can the flash tilt and swivel the head?
2. Do you have full manual control over the unit if you wish?
3. Does it support ETTL-II (Canon) or a similar technology?
4. Can it act as a slave or master.
5. Is the output power sufficient? (It is better to have more power as you can always reduce the output but never increase it.)

The slave/master point may seem like a minor one, however it is interesting in the long run. Buying a flash that can act at least as a slave allows you to later on buy a master and play with light creatively. If you buy a flash that cannot act as a slave you deprive yourself of that option unless you buy external triggers such as radio triggers.

In the end, flashes are a whole topic onto themselves and I would highly recommend you research them in detail.

If you do decide to buy one though, I suggest buying one with a swivel head, horizontally and vertically, which will allow you to bounce light off walls or ceilings as well as with a slave capacity should you decide to use a multi-flash setup in the future.

A diffuser is often a good advice too, these can be bought or self made from white plastic, I shall leave the choice unto you.



# Glossary

- AF** Automatic focus refers to a setting/mode where the camera focusses the image, as opposed to MF. This is done with the help of an AF sensor and a motor in the lens or body.  
Page(s). 5, 25, 86
- AF point** A specific point, marked in the viewfinder of an SLR, at which the light is directed to an AF sensor for focussing.  
More details can be found in section 3.1.  
Page(s). 4, 26
- AF sensor** Same as sensor, but specifically designed to measure a change in contrast. The bigger the change, the sharper the image. Older AF sensors measured in the red channel only, while newer cameras make use of multiple colour channels.  
Page(s). 25, 26, 81
- aperture** Diaphragm inside a lens which controls the depth of field and amount of light let in, described by f-stops.  
More details can be found in section 2.2.  
Page(s). 4, 5, 15, 17–23, 33, 40, 41, 85
- APS-C** The name for Canon's sensor size with a crop factor of 1.6.  
Page(s). 15, 34–36, 83
- APS-H** The name for Canon's sensor size with a crop factor of 1.3.  
Page(s). 15, 34, 35, 83
- bokeh** A term for the background blur created by lenses, coming from the Japanese.  
More details can be found in section 2.2.4.  
Page(s). 5, 21, 22
- CF** An old memory card format that has received constant backward compatible specification upgrades. CF stands for Compact Flash The fastest memory

cards on the market are CF cards.

Page(s). 1, 3, 86

**colour management** Colour management refers to managing the appearance of colours on screens and prints.

More details can be found in section 9.1.

Page(s). 67–69

**colour space** A predefined mapping of numerical values to specific colours.

More details can be found in section 9.1.1.

Page(s). 67–69, 71, 72

**crop** Crop is the short form for crop sensor or refers to the crop factor

Page(s). 34, 36, 83

**crop factor** A factor which defines the size of a crop sensor in relationship to a full frame sensor. Multiplying the length of the diagonal of the crop sensor with the crop factor will give the length of the diagonal of a full frame sensor.

Additionally, the crop factor describes the change in the field of view resulting from the smaller sensor.

More details can be found in section 4.1.

Page(s). 36, 81, 82

**crop sensor** A crop sensor is a sensor that is smaller than full frame, mainly to save costs. Crop sensors are defined by the crop factor, which describes their size in relation to full frame.

Page(s). 36, 82, 83

**DPP** Canon's basic but high quality RAW interpreted/converter, supplied for free with RAW-capable Canon cameras.

Page(s). 3, 7, 27

**DSLR** A description for a camera class with interchangeable lenses where the photographer looks through the lens. Contrary to an SLR, a DSLR is digital. Sometimes it is spelt dSLR too. Generally, the term DSLR is used instead of DSLR camera.

More details can be found in section 1.1.

Page(s). 2–4, 10, 11, 13, 40, 86

- EF** Name of a Canon mount that fits all cameras, hence APS-C, APS-H and FF sensors.  
Page(s). 36
- EF-S** Name of a Canon mount that will only fit crop cameras with an APS-C sensor. Because these lenses need to throw a smaller image circle, they tend to contain less or smaller glass and hence are lighter as well as cheaper.  
Page(s). 36
- exposure** The amount of time the sensor or film is exposed to light.  
More details can be found in section 2.1.  
Page(s). 4–6, 15–19, 48, 49, 61, 76, 86
- exposure compensation** A feature in SLR cameras, which allows the user to purposely over or underexpose a photograph by a predefined amount, described in stop.  
Page(s). 4, 5, 26
- FF** Mainly used on the web, FF is the abbreviation for full frame.  
Page(s). 34, 35, 83
- focal lenght** If parallel light were to enter a lens element, the focal length is the distance to the focal point. In simple lens elements, this is measured from the centre of the lens element, however in camera lenses this is more difficult.  
Page(s). 19, 22, 33, 34, 36, 38–41
- focal point** The point at which parallel light entering a lens element is bundled to meet in a single point.  
Page(s). 83
- full frame** Full frame is the short form for full frame sensor.  
Page(s). 34–36, 82, 83
- full frame sensor** A full frame sensor is a sensor which has the same physical dimensions as a slide of film, namely  $36mm \times 24mm$ . Because of its size, a full frame sensor is significantly more expensive than a crop sensor.  
Page(s). 33–36, 82, 83
- HDR** A technique by which multiple images with varying exposures are used to capture a scene beyond the dynamic range of the sensor.

More details can be found in chapter 6, section 6.1.

Page(s). 9, 29, 47–50

**image circle** The image circle, describes the diameter of the circular image thrown by the lens onto the sensor.

Page(s). 34, 36, 83

**IS** IS stands for Canon’s “image stabilization” technology built into lenses. Also see vibration control (VR) for Tamron.

Page(s). 15, 19, 41, 87

**ISO** A rating of film sensitivity or sensor gain.

More details can be found in section 2.3.

Page(s). 1, 4, 5, 15, 17, 18, 23

**JPEG** A lossy image compression algorithm which is widely adapted and supported. JPEG stands for “Joint Photographic Experts Group”.

More details can be found online [www.jpeg.org/](http://www.jpeg.org/).

Page(s). 3, 7, 10, 12, 27, 47, 49

**LCD** A display technology for flat screen panels.

Page(s). 84

**LiveView** LiveView refers to a setting in which the image seen by a sensor is displayed on the back liquid crystal display (LCD) screen, rather than in the viewfinder. When in LiveView, the viewfinder is blocked by the mirror and cannot be used.

Page(s). 3, 84

**MF** Manual focus refers to a setting/mode where the user has to focus the image in the viewfinder/on LiveView by hand.

Page(s). 25, 81

**minimum focussing distance** The minimum distance from the frontal lens element to the subject at which the lens will still focus. This is sometimes abbreviated to mfd.

Page(s). 36, 40



**panorama** A aspect ratio image, often the result of merging multiple images to form one large image. Also see photomerge.

More details can be found in section 6.3.

Page(s). 47, 50, 51, 85

**photojournalist** A photographer who shoots primarily to document events, hence shoots photographs for journalistic use or documentary purposes. As a result, it is required that these images are edited very little, or not edited at all.

Page(s). 3, 14

**photomerge** A technique by which multiple images are combined to form a single larger image. Photomerge is the specific term used by Photoshop for this function. Sometimes this is also referred to as a panorama, because it is mainly used to create very wide images.

More details can be found in section 6.3.

Page(s). 51, 85

**Point & Shoot** Description for a compact digital camera class which is fully automated.

Page(s). 86

**prime** A prime, also prime lens, is a lens with a fixed focal length. A key benefit of primes is their wider aperture and often superior optical quality over zoom lenses.

More details can be found in section 4.2.1.

Page(s). 38

**rangefinder** An interchangeable lens camera, where the viewfinder is used to estimate the distance to the subject. This information is then used to focus the lens.

The Leica M8 and M9 are iconic rangefinders and besides the Fujifilm X10 the only models available on the market at the point of writing in December 2011.

Page(s). 33, 87

**RAW** A generic term for raw sensor data. Being uncompressed (or losslessly compressed) and unprocessed, this retains the largest amount of information possible for further use.

More details can be found in section 1.5.

Page(s). 3, 4, 7, 10, 12, 13, 27, 47, 59, 60, 82

**SD** A memory card format that became popular in Point & Shoot cameras. Nowadays entry level DSLRs have started to use it too in favour of CF cards.

Page(s). 1, 3

**sensor** A device to measure something. In the context of cameras, this refers to measuring brightness in the RGB colour channels. Either how sudden the change is in the AF sensor, or the intensity

Page(s). 1, 7, 9–12, 15, 16, 23, 33–36, 48, 61, 81–84

**shutter** A curtain that controls how long the camera's sensor is exposed to light, by travelling in front of the sensor. Exposure is controlled by the shutter, hence also the term shutter speed to describe exposure time.

More details can be found in section 2.1.

Page(s). 17, 18

**shutter release** The button you depress to expose a single image or a series of images.

Page(s). 6

**shutter speed** Another way of referring to exposure.

Page(s). 5, 17–19, 86

**SLR** A description for a camera class with interchangeable lenses where the photographer looks through the lens. Generally, the term SLR is used instead of SLR camera.

More details can be found in the DSLR section 1.1.

Page(s). 1–4, 7, 15, 23, 25, 26, 33, 36, 81–83, 87

**stop** A relational measure of light. One stop difference equals half as much or twice as much light.

More details can be found in section 1.5.2.

Page(s). 4, 9, 10, 15, 19–23, 27, 47, 48, 61, 83

**time lapse** Time lapse refers to shooting a set of photographs over a significant amount of time and then combining them to a video that depicts the change in for example light at a sunset. Typically timelapse videos cover at least minutes but often hours.

Page(s). 76

**viewfinder** A window that offers the same field of view as the camera lens. On an SLR the viewfinder looks through the lens, on a rangefinder or older compact camera, the viewfinder functions independently of the main lens. .

Page(s). 1, 3, 6, 25, 75, 81, 84, 85, 87

**VR** VR is Tamron's name for "vibration control", which Canon calls IS.

Page(s). 84

**zoom** A zoom, also zoom lens, is a variable focal length lens.

More details can be found in section 4.2.1.

Page(s). 34, 36, 38, 85



## Thank you for Reading - Closing Words

Writing this text has been a lot of fun so far. I aim to continue the development of this text with time. There will always be options for improvement, as of writing this, several ideas are floating around in my head, some of them quite important.

I hope you have enjoyed reading this text and benefitted from the information presented herein. As mentioned on the initial page, I would appreciate any comments or suggestions by email, sent to [detlevcmphotography@live.de](mailto:detlevcmphotography@live.de).

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