Digital SLR Lens

Understanding Lens Functions

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Introduction

The intent of this workshop is to give you an overview of all the areas you need to consider in buying and using lens for your DSLR camera/s . I have not included specifics on how lens are constructed and the physics of light. There are many good reference sites on the Web that cover this. One very good site is

http://www.cambridgeincolour.com/tutorials/camera-lenses.htm

Understanding Lens Functions

Focal length

The most important lens specification is the focal length. This defines the coverage of the lens, and how much you'll fit into the photo. Focal length is measured in mm, and the number which closest matches the magnification of the human eye is 50mm. Our eyes have a much bigger field of view, but if you were to look at something in person, and then through a 50mm lens, the actual magnification would be similar. This is why 50mm lenses are known as standard lenses – they're suited to a wide variety of subjects from landscapes to portraits.

Lenses with focal lengths smaller than 50mm are known as wide angle because they fit more into your photo. If you're stood in the same position, a 25mm lens will have twice the diagonal field of view of a 50mm, and could therefore be used to squeeze in large buildings, landscapes or even big group shots – ideal when you can't step back any further. 24mm is the most common wide angle focal length and is ideal for landscape and architecture shots, but you can go much wider still if desired, and anything below 20mm is typically known as an ultra-wide angle lens.

Squeezing in such a big view means wide angle lenses inevitably suffer from some distortion, especially towards the edges, but this can be used to exaggerate subjects for a special effect; indeed a special type of ultra-wide angle lens called a fish-eye deliberately uses distortion to deliver a highly curved result. Lenses with shorter focal lengths also inherently have a larger depth-of-field, which means it's easier to get lots in focus from near to far.

Lenses with focal lengths bigger than 50mm are commonly known as telephoto models. These fit less in, and are therefore ideal for getting closer to distant subjects or picking out detail; they also give a more flattering effect when taking photos of people. In contrast to wide angle, lenses with longer focal lengths have an inherently smaller depth of field, which means it's easier to get a blurred background effect – again ideal for portrait, wildlife and sports photography.

Good focal lengths for portraits are typically between 85mm and 135mm – these are often known as short telephotos. Appropriate focal lengths for sports or wildlife are generally much longer – at least 200mm, and ideally 300mm or more. Professional sports and wildlife photographers often use 600mm lenses, or even longer still.

You can buy lenses with either a fixed focal length which doesn't vary, or a zoom lens which goes from one focal length to another. Zooms are very convenient, but generally aren't as good quality as a fixed lens. Fixed focal length or 'prime' lenses are also normally smaller, lighter and give a brighter view that's better for low light. It's all about weighing up convenience against quality, although some more expensive zooms are very good and can rate as well or better than the best primes.

General purpose zooms usually go from wide angle to short telephoto, such as 24-70mm, although some 'super-zooms' could give a range from 28-300mm, covering almost every photo opportunity. There are also wide angle zooms which normally offer an ultra-wide to normal range, such as 16-35mm. Similarly there are telephoto zooms which go from short to long telephoto focal lengths, such as 70-300mm.

The DSLR Crop Factor

One crucial point to note is the above focal lengths and rules only apply to DSLRs with full-frame sensors, or older 35mm film models. The vast majority of DSLRs however have physically smaller sensors which crop the field of view and effectively multiply the focal length by between 1.5 and two times. So-called 'cropped' models from Nikon, Sony and Pentax effectively multiply focal lengths by 1.5 times. Cropped models from Canon effectively multiply by 1.6x, while any DSLR based on the Four Thirds standard by Olympus or Panasonic, effectively multiply by two times.

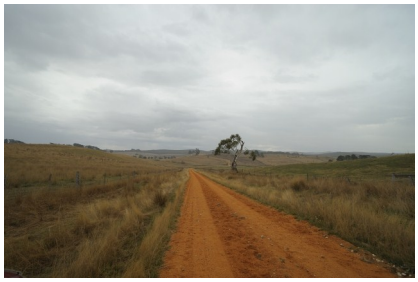
This is why digital photographers commonly talk about 'effective' focal lengths, where the actual lens focal length is multiplied by the DSLR's 'crop' value. So a standard DSLR kit zoom lens with a focal length of 18-55mm on, say, a Nikon cropped body, would actually give an equivalent coverage of 27-82mm.

This means if you want 50mm standard coverage on a Nikon cropped DSLR, you'll actually need to use a lens with a 33mm focal length (35mm models are closest). If you want 28mm wide angle coverage, you'll need to use a lens with an 18mm focal length, and so on. So always remember to multiply the actual lens focal length by the crop factor of your particular DSLR – that way, you'll know what you're getting.

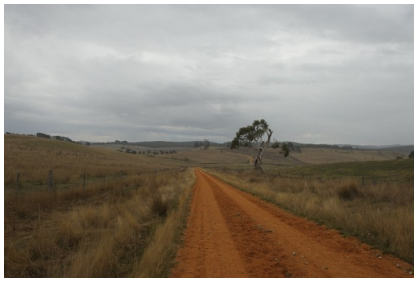
Note: since cropped-frame DSLRs aren't using the full area of normal lenses, many manufacturers additionally offer models which are only corrected for this smaller frame. Canon, Nikon, Sony and Pentax refer to these types of lenses as EF-S, DX, DT and DA respectively. These aren't suitable for full-frame DSLRs though, so if you're thinking of upgrading to full-frame in the future, try to avoid these models.

Lens coverage

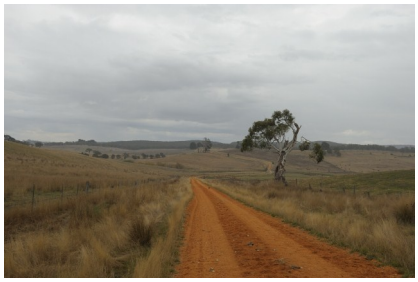
To illustrate the views you can expect at different focal lengths I took the following images from the same spot with different lenses. Remember the focal lengths quoted here are effective for a full-frame body, so to match the coverage with a typical DSLR, you'll need to divide them by the crop factor of your particular model . So if you have a Nikon, Sony or Pentax cropped body, divide the following focal lengths by 1.5 times. If you have a Canon cropped body, divide them by 1.6 times, and if you have a Four Thirds body, divide them by two times. So if you like the coverage of the 24mm example below and want it with a cropped Nikon DSLR, you'd divide it by 1.5 times to give you 16mm. Conversely, if you want to see what a Nikon DX 18-200mm lens would give you in practice, just multiply it by 1.5 times to give 27-300mm.



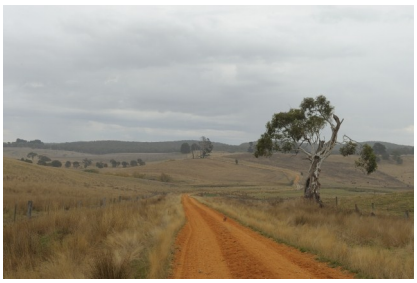
17mm



24mm



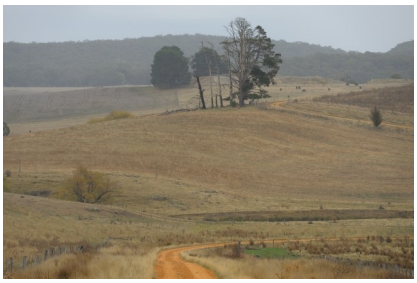
35mm



50mm

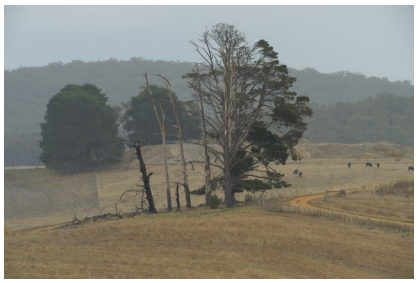
70mm

135mm



200mm

300mm



420mm

Above are a series of images taken with my full frame Nikon D700 on a tripod from the same spot, using a variety of lens.

Aperture

The second most important lens specification is the aperture – this refers to its light gathering capabilities. The bigger the aperture, the more light it can capture, and the better it can work in dimmer conditions. Lenses with bigger apertures also allow you to take photos with a smaller depth of field which allows you to better blur backgrounds. Big apertures are undoubtedly nice to have, but they involve physically bigger pieces of glass in the lens which makes them bigger, heavier and much more expensive.

The aperture of DSLR lenses is commonly described as a focal ratio, or f-number. This is the ratio between the focal length of the lens over the diameter of the opening in the lens. So as the opening gets bigger on larger aperture lenses, the f-number gets smaller. An iris built-into every lens actually lets you reduce the size of the opening to control exposure and depth of field, but the important figure is the maximum aperture – or the smallest f-number.

On fixed focal length lenses, there'll be one number – for example, 50mm f1.8. On zoom lenses, there'll typically be two numbers, one for each end of the range – for example 18-55mm f3.5-5.6 – which means f3.5 at 18mm and f5.6 at 55mm. Note some premium zoom lenses have a fixed aperture throughout their range – for example 17-55mm f2.8 which is f2.8 regardless of the zoom setting.

F-numbers of 1.4, 2.8 and 4 may sound similar, but they actually represent a significant difference in light gathering power. For example, an f1.4 lens can gather twice as much light as an f2.0 model, or four times more than an f2.8 model. Similarly, an f2.8 lens can gather twice as much light as an f4 model, or four times more light than an f5.6 model.

A lens which gathers twice as much light lets you use a shutter speed that's twice as quick, or the same shutter speed when it's twice as dark. A lens which gathers four times more light lets you use a shutter speed that's four times quicker, or the same shutter speed when it's four times darker. Clearly lenses with big apertures, and therefore smaller f-numbers, are ideal when you're taking photos in low light or of quick action.

Again though, the price you pay is a bigger, heavier and more expensive lens, especially if it's a zoom. The exception to the rule are standard 50mm lenses (which thanks to the crop factor on most DSLRs act like a short telephoto of 75mm to 100mm).

These can be surprisingly affordable, and with most models offering f1.8 apertures, they'll actually gather over eight times more light than a typical 18-55mm kit lens when it's zoomed-in to the same focal length. Their small f-numbers also mean you can easily blur the background. That's why standard 50mm lenses make a perfect introduction to low light and portrait photography.

Things to be Aware Of

1. Focusing

Focusing is obviously a crucial aspect of any lens, and some models do it better than others. While the auto-focusing decisions are normally made within the DSLR, the actual focusing itself is performed by the lens, and there's several things to look out for.

Some lenses feature built-in focusing motors, whereas others rely on a motor that's built into the DSLR. In most situations you won't need to worry too much about this, but there are a couple of important exceptions.

To save weight and money, Nikon removed the internal focusing motor from its budget model DSLRs, so they will only auto-focus with newer lenses that have their own focusing motors. In Nikon's own range, you'll need a lens with AF-S to auto-focus with the D3000 or D5000 range. If it doesn't have AF-S then you'll be manually focusing. If you're buying a Sigma or Tamron lens, look out for models specifically compatible with the D3000/D5000 models.

All of Canon's current lenses have built-in focusing motors, but again some are better than others. Canon lenses with USM in their title have special ultrasonic motors which are quicker and much quieter than non-USM models. So if you're buying a Canon lens and want quick and quiet focusing, buy a model with USM.

Nikon's equivalent technology is called Silent Wave Motor, or SWM for short. This is the S in AF-S, so for quick and quiet focusing on a Nikkor lens, choose an AF-S model. The equivalent technology from Sony, Pentax, Olympus and Sigma is called SSM, SDM, SWD and HSM respectively; note to fully exploit SDM (DA*) lenses from Pentax though, you'll need a compatible body like the K10D.

It's also worth mentioning internal focusing which as its name suggests takes place within the lens. This means the end section of the lens barrel doesn't rotate while focusing, which is important for users of polarising filters.

Auto-focusing has become so dominant that good manual focusing facilities are frequently neglected on cheaper lenses. Some budget models feature little more than a tiny ring on the end for manual focusing. If manual focusing is important to you, look for a model with a decent manual focusing ring.

2. Macro

While on the subject of focusing, so-called macro lenses are optimised for close-up photography of subjects like flowers and insects. Typical macro lenses have focal lengths between 50 and 105mm and can also be used for other subjects, although they are optimised to perform best at close range. So if you're into close-up photography, a dedicated macro lens is the way forward.

3. Anti-shake

Some lenses feature anti-shake facilities which allow you to typically handhold at shutter speeds three to four times slower than normal. This won't stop a moving subject from blurring, but it can greatly reduce the effect of camera shake.

Lens-based anti-shake systems all work in the same way by detecting wobbles and adjusting a special optical element inside the lens to counteract them in real-time. The benefit of fitting it inside the lens is you'll see the stabilising effect through the viewfinder, which can be very reassuring, especially at longer focal lengths.

While stabilisation is most commonly employed on telephoto lenses, it can be equally useful on standard or even wide angle focal lengths. Regardless of the focal length, stabilisation will still let you handhold at shutter speeds three to four times slower than normal, so for wide angle, that gives you the chance to handhold some seriously slow exposures. Ideal if you want to blur waterfalls and rivers.

Stabilisation systems can however get confused in certain circumstances. If you're panning the camera to follow something the stabilisation could mistake it for a wobble and try and counteract the motion.

Some anti-shake lenses offer a panning mode which ignores horizontal motion and only stabilises vertically. Some of the latest models can even detect this motion and switch their mode accordingly. Older, or more basic anti-shake lenses won't work with panning though and the feature should be temporarily switched off. Likewise if you're using a tripod, you should switch the stabilisation off or the system could actually introduce wobbling (some of the latest release lens do not requires this).

Each manufacturer has a different name for anti-shake. Canon calls it Image Stabilisation or IS for short. Nikon calls it Vibration Reduction, or VR for short. Sigma calls it Optical Stabilisation, or OS for short. So if you want a lens with anti-shake, these are the letters you should be looking for in its name.

4. Lens mount

One final note: each DSLR manufacturer uses a different lens mount, so if you have a Canon body, you'll need a lens with a Canon mount and so on. The major manufacturers of DSLR bodies also only produce lenses for their own systems, so Canon lenses will only work on Canon bodies and Nikkor lenses on Nikon bodies. Some adapters may be available, but to support all the features, you should stick by this rule.

The exception are third party manufacturers like Sigma and Tamron which produce different versions of their lenses for different mounts. So a Sigma lens for example may be available in Canon, Nikon and Pentax lens mounts

Buying and Using Lens

Lens Quality

Learning and understanding all you can about lens is equally as important if not more important than the camera you choose. It is very important that you take into account the lens system for the brand of camera you are considering as it is most likely you will be tied to that choice for many years to come. Cameras come and go and are relatively cheap to change as new models are introduced, a good lens collection takes years to build and a large amount of money to acquire.

By ignoring the lens quality when considering new lens, you may as well forget the quality of camera too. You may buy the latest and best camera, but if you put a cheap lens on the front, you lose all the benefits that the camera has. Some of the cheaper lenses can have a permanent effect on the quality of your images. They can cause the edges of the picture to be blurry, purple fringing (Chromatic Aberration), poor autofocus, poor perspective on walls and buildings, poor resolution...the list is a long one.

The major things you need to consider when buying a lens fall into four categories

1. **The optical quality of the lens:** The better the lens, the better it can capture - resolve - fine details. In most cases, the optical quality of digital camera lenses go hand in hand with the price of the camera and the resolution of the sensor. At higher price levels, camera lenses have better-quality optics, which are necessary to keep up with the detail capturing capabilities of higher megapixel image sensors.
2. **The speed of the lens:** A lens' speed is determined by the maximum amount of light the lens is capable of transmitting—the largest f-stop value. Some camera lenses can capture larger amounts of light than others, generally because they have a greater diameter that can transmit more light. Think of a 1-inch-diameter pipe and a 2-inch-diameter pipe and visualize how much more water (or light) the wider pipe can conduct. Lens speed, in part, controls how low of a light level you can take pictures in and separates lenses into two categories - fast and slow. Fast camera lenses allow photographers to shoot at higher shutter speeds in low-light conditions. If you take many pictures in dim light, you will want a faster lens. For example, camera lenses with maximum f-stop values between 1.0 and 2.8 are considered fast
3. **The focusing range of the lens:** The minimum focus distance of a lens determines how close you can get to a subject. If too close, the image will be blurry. Some camera lenses can focus closer than others. The ability to get up-close and personal with your subject can be very important in some types of photography.
4. **The magnification range of the lens:** The zoom range determines how much or how little of a particular subject you can include in an image from a particular shooting distance. You might be able to take your basic image and double it in size (a 2:1 zoom ratio), triple it (a 3:1 zoom), or magnify it 12X or more (a 12:1 zoom). As you might expect, the ability to zoom enhances your creative options significantly. At the widest settings (wide-angle settings), you can take in broad sweeps of landscape, whereas in the narrowest view (telephoto), you can reach out and bring a distant object much closer.

The amount you are prepared to spend or can spend on your lens selection is an important consideration. It does take time to build a set of quality lens but based on my personal experience I would rather have one quality lens than two cheaper ones if it was a matter of buy now or wait and save.

What Lens Do I Need

If you are just starting out and as yet do not have a particular style or a set range of photographic subjects you prefer then getting an 18 –200 mm f 3.5 - f5.6 zoom lens may be a great choice for you. On an entry level crop sensor camera this will give you a semi– wide angle to telephoto lens. You can take landscape to portrait shots and anything in between. The lens will be slow in low light and isolating the background will be a challenge but if you couple it with a 35mm f1.8 or 50mm f1.8 lens your kit will be good for most situations.

As you gain more experience and start to define your own personal style and preferences in photography you can look to upgrading or expanding your lens range. Below is a table that summarises the most common types of lens and the typical area of photography each lens is normally used for.

Lens Focal Lengths*	**Lens Type**	**Photography Type**
Less than 20mm	Extreme Wide Angle	Architecture/Landscape
21mm - 35mm	Wide Angle	Landscape
35mm-70mm	Normal	Street and Documentary
80mm-135mm	Medium Telephoto	Portraiture
135mm-300mm	Telephoto	Sports and Wildlife
Greater than 300mm	Super Telephoto	Wildlife

A further consideration is your potential upgrade path in terms of the camera. If you are thinking of upgrading to a full frame camera and you have a bag full of lens specific for a crop camera it will be an expensive exercise to upgrade your lens too. It is best to start planning your future needs now.

Which Lens to Use When

A normal (or "standard") lens for a 35mm camera usually refers to a fixed focal length lens of 50mm or a zoom lens zoomed in a little from its widest angle. The reason it is considered a standard lens is because a 50 mm lens is accepted as making the images of objects at different distances in a scene appear in about the same proportions as seen in real life. It is a good walk about lens for street photography, great for portrait work on a crop sensor and good in low light if it is a f 1.4 – f 2.8 lens.

Shooting in low lighting conditions: The maximum apertures of f/3.5 to f/4.5 in the basic camera lenses are much too "slow" to be useful in low light levels. When shooting in such conditions, you will be looking to use zoom lenses with maximum aperture of f/2.8 or selecting a fixed focal length lens (prime lens) with f/1.4 to f/2.0. You can invest in 20mm, 28mm, 30mm, 35mm, 50mm, or 85mm f/1.4 lenses that can shoot under very dark conditions.

Shooting sharper images: If you are after sharper images, you can often get better results with a special lens that was designed to produce sharper images. This would include the more expensive fast lens (f 2.8) from the major manufacturers. You might look into buying a close-up lens that is optimized for macro photography and produces especially sharp images at distances of a few inches or so. A tripod or monopod are also a must for sharp images.

Shooting wider angle scenes: Using a wide-angle lens lets you take in a broader field of view, which can be useful when there is not enough room to move farther away from your subject. With a shorter focal length lens (wide-angle), everything looks farther away.

Shooting farther away: A telephoto lens lets you bring distant objects that much closer to your camera and makes it especially useful when you cannot get close to your subject. Using a longer focal length lens (telephoto), everything appears closer than it actually is. Wildlife

Controlling Depth of Field (DOF): To achieve the creamy out of focus, non distracting backgrounds required in good portraiture requires a fast lens capable of shooting at f 2 to f 2.8 or at the most f4.

Shooting Architecture and/or Landscape: For this side of photography there are specialist ‘tilt and shift lens’ made by both Nikon and Canon. These lens allow one to shoot with little distortion and to achieve depth of field control to give critical sharpness front to back.