LENSES

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THEORY

Q.: Do the words “aperture” and “f-number” mean the same thing?
A.: Not quite. Webster gives two definitions: (a) The aperture is the opening in a photographic lens that admits the light. (b) The aperture is the diameter of a stop in an optical system. The ratio of the aperture to the focal length of the lens is expressed as the f-number, written as a fraction, for example f/4 or F/4. The numbers marked on a lens diaphragm are the reciprocals, like 4, 5.6, 8 etc. Commonly, these numbers are called f-numbers as well. One may have wondered why a larger number means less light.

Quite often, the words f-number and aperture are used interchangeably. However, if lenses of different focal lengths are compared, these words do not have the same meaning. The lenses having the same f-number will have different apertures. For example, a 50mm f/2 lens has a smaller aperture than a 200mm f/4 lens. The interchangeable use of apertures and f-numbers confuses the theory of photography, especially the understanding of the depth-of-field, and should be avoided.

Interestingly, the German language avoids this confusion. The ratio of the maximum aperture of a lens to its focal length is called the “die Lichtstärke”, the diaphragm of a lens is the “die Blende” and a number on the diaphragm of the lens are called the “die Blendenzahl”. We need an English word like the German word “Lichtstärke” to describe a lens. The speed of the lens is not a very descriptive term but is used already and some lenses are said to be fast. Unless somebody has a better idea, we should differentiate between (a) the aperture of a lens which is the opening in the diaphragm of the lens, and (b) the ratio of the maximum aperture to the focal length, which we should call the speed of the lens. Accordingly, the speed of a 50mm f/2 lens is faster than that of a 200mm f/4 lens but the 200mm lens has the larger maximum aperture.

Q.: What is the depth-of-field?
A.: Not everything is sharp on the film or the sensor. A lens forms a sharp plane between unsharp regions on either side of the plane. The zone close to the sharp plane appears to be sharp. The depth-of-field is the width of the apparently sharp zone form its edge closest to the camera and the edge farthest away.

The depth-of-field is illusory. Optical geometry dictates that rays coming form two points at different distances cannot focus at one point. In reality only one of the two points can be in sharp focus. When the light rays are not in sharp focus, they form a circle on the film plane. However, if the circle is extremely small it appears to be a point. The largest circle which appears as a point, is called the circle of confusion. The size of the circle of confusion is arbitrary, depending on the resolution of the eye and the viewing conditions.

The depth-of-field scales and tables assume that circles which are smaller than the circle of confusion are perceptually seen as a point. The depth-of-field depends on the arbitrary size of the circle of confusion, the distance of the object from the optical center of the lens and its aperture. The meaning of the word "aperture" is here the size of the opening in the diaphragm of the lens, not the f-number. The assumed circle of confusion is usually 0.025 or 0.033 mm for a 35mm frame. If the sensor of a digital camera is smaller than the 35mm frame, the circle of confusion is smaller as well because the image must be enlarged more to make a print of the same size. Consequently, the circle of confusion for the APS-C size sensor is 0.020mm.

Q.: What is the narrow depth-of-field?
A.: The term "narrow depth-of-field" means simply that the apparently sharp zone is narrow. A narrow depth-of-field works either for the photographer (selective focus) or against (inadequate depth-of-field). Selective focus is used to separate the subject from a disturbing background or from the foreground as well. Inadequate depth-of- field is a common problem, especially in close-up photography.

Q.: Do telephoto lenses have a narrow depth-of-field?
A.: The belief hat long focal length lenses have a narrow depth-of-field is a common misconception. The depth-of-field depends on the aperture but is independent of the focal length.

The misconception has probably arrived from the fact that for the same f-number longer lenses have a larger aperture and consequently a narrower depth-of-field. The f-number is the ratio of the aperture to the focal length. If we increase the focal length, let us say by a factor of 2, the aperture has to increase by a factor of 2 as well for the f-number to stay the same.

The depth-of-field, W, is given by the equation

$$W = \frac{L2}{(D/k) - L}$$

Where L is the distance from the optical center of the lens, D is the aperture, and k is the required angular resolution (circle of confusion). The aperture D is the diameter of the opening in the lens that admits light to the film or sensor.

The equation shows that the depth-of-field depends only on the aperture of the lens and the distance of the object being photographed, the required resolution k being constant. A large aperture, D, and a short distance, L, give a shallow depth-of-field. Stopping the lens down will make all faraway objects to appear sharp. The distance L = D/k is the hyperfocal distance, because W is then infinity. Everything appears equally sharp beyond this distance.

Q.: Does the print size affect the depth-of-field?
A.: Yes and no. A depth-of-field does not exist, it is an optical illusion. Only one point can be truly sharp. The out of focus point forms a circle. When a circle is viewed from long distance, the circle appears to be a dot. If a print is made larger, more detail can be seen and a dot on a small print may now appear as a circle. This means, the depth-of-field of the image on the print has been decreased. However, if the larger print is viewed from a proportionally larger distance, the print size does not change the depth-of-field. Some judges like to "sniff" the print and upset the normal depth-of-field relationship.

Q.: I like to use the hyperfocal distance for photographing landscapes but only one of my lenses has a depth-of-field scale. I could use depth-of-field tables but the other lenses do not have sufficient distance marks to set the hyperfocal distance. My camera (Elan 7E) can set the hyperfocal distance automatically but is there a more accurate way to set the hyperfocal distance?
A.: The hyperfocal concept shortens the distance to infinite focus and maximizes the depth-of-field for a given aperture. The hyperfocal distance is the nearest distance which appears to be sharp when the lens is

focused at infinity. Focusing the lens on the hyperfocal distance creates a wide depth-of-field for "focus-free" shooting.

The infinity symbol on the distance scale of a lens indicates the distance beyond which everything appears to be in focus at the maximum aperture of the lens. When stopping the lens down, the depth-of-field increases. The distance of infinite focus decreases to a distance called the hyperfocal distance for the given aperture. The resulting gain in depth-of-field can be doubled by focusing the lens on the hyperfocal distance. The hyperfocal distance can be found by using the depth-of-field scale of a lens. If the lens has a depth-of-field scale, the lens barrel has aperture marking on both side of the focus index line.

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             ∞ 30  15  10
_____________________________
 16   8   |   8   16
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The focusing ring is turned until the infinity symbol lines up with one of the aperture markings

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        ∞ 30  15  10  5
_______________________
 16   8   |  8   16
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For example, when the aperture of the lens is selected to be f/16, then the focusing ring is rotated to place the infinity symbol opposite to the 16 mark on the depth-of-field scale. The other 16 mark of the scale (on the other side of the focus index line) shows the closest distance beyond everything is acceptably sharp. As a cautionary measure, the lens is usually stopped down by another stop or two.

The hyperfocal setting requires that the lens is kept at a constant aperture. This means that the camera must be operated in the aperture preferred or manual mode. The focal length must be constant as well. The focal length of zoom lenses varies with zooming and may change with focusing, if the lens has internal focusing. Some push-pull type zoom lenses had depth-of-field curves on their barrels but this is now a past history. Hence, the hyperfocal focusing is useful mainly for single focal length lenses which have a depth-of field scale. If a lens does not have a depth-of-field scale, tables can be used to set the hyperfocal distance. This procedure requires a detailed distance scale of the lens. Unfortunately, the AF lenses have a short focus throw and a coarse distance scale. Some lenses do not even have a distance scale!

If the hyperfocal distance cannot be determined, the maximum depth-of-field can be estimated approximately. The lens is focused at about 1/3 of the distance between the nearest and farthest points needed to be in sharp focus. The lens is then gradually stopped down while checking the sharpness with the depth-of-field preview button. This is not a very exact procedure because the depth-of-field preview is difficult to see at small apertures and the 1/3 for/aft distance ratio is distance dependent. These uncertainties can be avoided by stopping the lens down to a very small aperture but this has its limitations as well. The resolution of a lens decreases at very small apertures, usually below f/16, and as a result, the useful depth-of-field may actually decrease.

The depth-of-field mode (DEP) of some Canon cameras functions only in the autofocus mode. The DEP mode is activated by the Main Dial. Then the point of the closest desired distance and the farthest point are selected. If the desired depth-of-field cannot be achieved, the aperture indicator in the viewfinder will flash as a warning. If a Canon lens does not have a depth-of-field scale, the DEP mode is the most practical way to get the maximum depth-of-field.

Wide angle lenses benefit more from hyperfocal focusing than long focal length lenses. For a 17mm lens at f/11, the hyperfocal distance is at 3 ft and with the lens focused on the hyperfocal distance everything beyond 1.7 ft is acceptably sharp.

The hyperfocal focus is a useful but not a universal technique for controlling the depth-of-field. In pictorial photography a maximum depth-of-field is not always desirable. The exact placement of the depth-of-field is more important.

Q.: What is a normal lens?
A.: A normal lens is assumed to have the same view angle as the human eye. The focal length of the normal lens depends on the size of the film or the sensor and is the length of the diagonal.

	Calculated	Used
3:4 sensor	23mm	24mm
APS-C sensor	28mm	30mm
24x36mm	43mm	50mm
6 cm x 4.5 cm	68mm	70mm
6 x 6 cm	78mm	80mm

The importance of the normal lens concept is its function as the dividing line between wide angle and tele lenses. Instead of grappling with conversion factors, the normal focal length tells immediately the effect of the focal length on the picture angle of different format cameras. A lens having a focal length longer than the normal focal length is a tele lens. A lens having a focal length shorter than the normal focal length is a wide angle lens.

DESIGN OF LENSES

Q.: What is an aspheric lens?
A.: A conventional lens consists of several elements (single lenses), which have surfaces shaped like a section of a sphere. The shape of the element is defined by the surface area of the lens and the radius of the curvature. Usually the front and the back surfaces of a element are not similar. The element does not have to be symmetrical. To correct various aberrations of the lens, several elements are needed, especially for wide angle lenses of a large aperture. This adds to the weight and the cost of the lens but may not cure all optical problems entirely.

The aspherical lenses contain one or two aspherical elements which are not shaped like a section of a sphere but have an irregular curvature. Hence the name is aspherical. The aspherical elements can effectively correct aberrations and minimize distortion. A lens can be designed with a smaller number of elements, a smaller size, and a lower weight of the lens. Aspherical lenses are found mainly in wide angle lenses but in some telezooms as well. As an example, the Sigma APO 135-400mm and the 170-500mm zoom lenses are aspherical.

Some aspheric al elements are made by precision grinding of a glass element. This is a very costly process. The aspherical Nikkor f/1.4 24mm costs about $ 1500 and the Nikkor f/2.8 20-35mm about $ 2200. In contrast, molding of glass or a resin is a low cost operation for making aspherical elements. Most aspherical elements used in consumer quality lenses are hybrids made by molding a resin onto a glass element to give it an aspherical shape.

Q.: Are aspherical lenses sharper than the conventional lenses?
A.: Not necessarily, aspherical is not synonymous with high quality. For example, the super sharp Nikkor f/2.8 28mm is not aspherical. The aspherical elements are used mainly to reduce aberrations and distortion. As an example, almost all Sigma wide angle lenses and zooms with a wide angle are aspherical. The aspherical elements allow the lens to be made smaller and lighter. They improve the overall optical performance, of which sharpness is only one facet.

Q.: What are the low dispersion elements in some lenses?
A.: One of the common aberrations in telephoto lenses is chromatic, the rays of different wavelength (color) do not focus at the same point. Chromatic aberrations are corrected with one to three low dispersion elements. Calcium fluoride (fluorite) used in the past for making low dispersion elements is brittle and

temperature sensitive. Nowadays special low dispersion glasses are used instead. As an example, the Sigma APO f/4-5.6 70-300mm zoom has three low dispersion elements, while the DL version of this lens has only one. The price difference is $80.

Q.: The Nikon G lenses do not have an aperture ring. Can the G lenses be used on older Nikon cameras?
A.: The Nikon G lenses can be used on older Nikon cameras which have the Program (P) or the Shutter Preferred (S) exposure automation. The f-stop can be varied by shifting the program or varying the shutter speed.

Q.: Does the D designation of a lens indicate rapid focusing?
A.: The D designation has nothing to do with the focusing speed. The D lenses relay the distance to the camera body for improved matrix metering and fill-flash.

STABILIZATION (VIBRATION REDUCTION)

Q.: Would image stabilization help me to get sharper pictures?
A.: Image stabilization (IS), alias vibration reduction (VR), is very helpful when you

- cannot use a tripod
- can not use a monopod
- do not use a fast film or a high ISO setting of a digital camera
- the movement of the object being photographed does not require a fast shutter speed

This means, image stabilization is useful for hand held shots, especially with telephoto lenses.

The objective of image stabilization is not only to reduce the minimum acceptable shutter speed, as emphasized by the lens manufacturers. The real objective is to get sharper pictures. To use the image stabilization always for hand held shots assures sharpness but drains the batteries. Image stabilization is not instantaneous but requires about a second to stabilize the lens.

Image stabilization (IS or VR) does not make the tripod obsolete. A tripod does not only stop or reduce vibrations. A tripod helps to compose the picture, use graduated filters, and meter the exposure carefully. A tripod makes it easier to use off-camera flash and reflectors. Heavy telelenses need a tripod anyhow. The image stabilization of some lenses does not function when the camera is on tripod. Vibrations are reduced when the tripod is unstable or when the camera is on a monopod. New telelenses can reduce vibrations on a tripod as well.

Q.: Does the vibration reduction feature of a lens still function when a teleconverter is attached to the lens?
A.: Yes, I have obtained sharp images at a shutter speed of 1/40 s by hand holding the Nikon 70-200mm VR lens with the 1.4x Kenko Teleplus Pro 300 teleconverter (teleextender) attached (200 x 1.4 = 280mm effective focal length). When the VR mode was switched off, the blur caused by the camera movement was noticeable.

LENSES FOR DIGITAL CAMERAS

Focal Length Increase by a Digital Camera – a Myth.

Q.: I share a 28-135mm IS USM Canon zoom lens between the Canon Elan7E and the digital Canon 10D. How does the lens behave differently between the two bodies and how is the distance scale affected?
A.: The distance scale should be the same for both cameras. Contrary what you may have read, the focal length of a lens does not increase when attached to a digital camera having a sensor smaller than 24 x

36mm. Statements suggesting a focal length increase, such as “200mm becomes a 320mm on a digital camera”, are quite common but incorrect.

The Canon 10D has a 15.1 x 22.7mm digital sensor. Consequently, the sensor covers only the center part of the 35mm frame recorded by the Elan7E on film. The picture angle is therefore narrower and identical to that of a 35mm camera lens with a 1.6x longer focal length.

The focal length is not defined by the picture angle but by the distance between the optical center of the lens and the film plane. The focal length is an intrinsic optical property of a lens and does not change when the lens is mounted on different cameras. Hence the infinity setting and the distance markings do not change when mounting the lens on the digital camera.

A similar effect can be achieved by cropping the image obtained by the Elan 7E to the size of the digital sensor. A print made from the cropped image will be similar to a print made with a lens of a 1.6 times longer focal length.

Q.: Have you seen a difference between the digital and the non-digital lenses?
A.: No, I have not. I do not have the digital and the unmodified versions of the same lens to make a comparison. It is possible that a digital modification improves wide angle photography under certain conditions. The lens manufacturers have not come forward with a comparison demonstrating the benefit of the digital modification. Recently Canon has published two pictures as a comparative test. Although the modified lens exhibited less flare, the comparison does not prove that digital cameras need a special lens design. .

Better coatings and refinements of the optical design can be expected to improve the performance of a lens on any camera, a digital or a film camera.

Q.: Have you seen any artifacts when using a 35mm film camera lens on a digital camera?
A.: No, although I use a 24mm wide-angle lens quite frequently. The theoretically predicted increase of the light fall-off may not happen for two reasons. Firstly, the sensors have been improved and are now less sensitive to the direction of light rays. Micro lenses on the photosites angle the light rays toward the center. Secondly, the digital cameras with an APS-C sized sensor use only the center area of the field. Perhaps the limitations of unmodified wide angle lenses could be observed on the full-sized sensors of some Canon and Kodak cameras. It is difficult to compare the performance of a lens on a digital camera to the performance on a film camera because other variables are involved.

Q.: I have a Nikon D70 camera with the 18-70mm zoom and need a longer zoom lens. Which lens would you recommend?
A.: You have several options for extending the focal length range of your D70 camera. The 70-200mm/2.8 VR Nikkor is an outstanding lens but if you prefer a lighter lens, consider a 70-300mm zoom lens made by Nikon, Sigma, or Tamron. Both Sigma lenses and the Tamron lens can reach the 1.33x life size in the macro mode. The Tamron 70-300mm LD lens costs less than the Sigma APO but does not match the performance of the Sigma APO.

Q.: Are film camera lenses sharp on a digital camera with a small sensor?
A.: Probably even sharper. The sharpness of an image produced by a lens is the highest in the center. The edge sharpness is noticeably lower. A digital camera with a small APS size sensor (all Nikon, Konica Minolta, and most Canon DSLR cameras) crops the image created by a 35mm film camera lens and uses only the center area where the sharpness is highest. Cropping reduces the light fall off (vignetting) as well.

Some photographers were disappointed when they expected the Canon 5D camera with a full 35mm sensor to create much sharper images than the Canon 20D camera, equipped with the APS size sensor. The full size sensor includes the edges as well and demands high quality optics with good edge sharpness to show an advantage over the small sensor.

Q.: Are lenses made by independent manufacturers inferior to the main brand lenses?
A.: Not necessarily, some lenses made by independent manufacturers have better optics or more features than some main brand lenses. In other words, the camera manufacturers make high quality lenses for processional use and lower priced lenses of a satisfactory quality for the consumer market. The quality of the lenses made by the independent manufacturers also depends on the intended use of the lens. As an example, the Sigma 70-300mm lens is optically superior to the corresponding lower priced lens without the APO optics.

When new camera models arrive, the independent manufacturers may not be ready for the changes affecting the function of the lens but will upgrade an old lens, if possible. As an example, a 170-500mm Sigma lens used on the Canon EOS-3 film camera was compatible with the Canon 20D digital camera only at the maximum aperture of f/5.6. Sigma upgraded the lens for a charge of only $10.

Q.: During a lens change the digital camera is open for dust to enter. I would like to use a lens with a long zoom ratio to reduce the frequency of lens changes. Which lens would you recommend for my Nikon camera?
A.: Lenses with a 11x or 14x zoom ratio are available from Nikon, Sigma, and Tamron for digital cameras with the APS-C size sensor. Sigma and Tamron make 18-200mm f/3.5-6.3 lenses in Canon, Nikon, Pentax, and Sony (Minolta) mounts. Recently Tamron has introduced an 18-250mm lens which has the widest zoom ratio of any DSLR camera lens. The Sigma and Tamron lenses are compact but the dim f/6.3 makes autofocusing at the long end of the zoom difficult. Nikon has an 18-200mm VR zoom lens with a slightly wider f/3.5-5.6 aperture. The Nikon lens costs almost twice as much as the Sigma or the Tamron lens but for the higher price you will get better optics, a sturdier construction, and stabilization.

An 18-200mm lens is a very convenient travel lens but not a universal tool for a discriminating photographer. Wide angle photography needs a lens with a focal length shorter than 18mm which is like the 28mm lens on a 35mm camera. The 200mm focal length is sufficient for general tele photography but the resolution drops at the long end of the lens.

A better way to decrease the number of lens changes is to use two cameras: One camera with a 12-24mm zoom lens for wide angle photography and the other camera with a longer zoom lens in the 24-120mm focal length range..

The Nikon 24-120mm f/3.5-5.6 VR lens was designed for a 35mm film camera. A digital camera with the APS size sensor uses only the center area of the 24-120mm lens, where the optical performance of the lens has its optimum. The resolution of the 24-120mm lens on a Nikon D200 camera is adequate for a sharp 24x36” print.

The 120mm focal length (the 35mm film camera equivalent is 180mm) is long enough for most photography. When a longer tele lens is needed, I replace the the wide angle lens with the 70-200mm f/2.8 VR HSM lens. A lens change cannot be avoided, only the frequency of lens changes can be reduced.

The fear of contamination with dust should not hamper photography. It is true, that some pros get excellent results with only one or two lenses. Most photographers use several lenses and do not hesitate to change lenses in the field. The number of lenses needed is determined by the variety of photography and the personal work style. I needed twelve lenses for my film cameras. I use now seven lenses with my digital cameras but the number may be increasing.

If dust gets into the camera, one or two dust specks may be easier to remove with the Spot Healing Brush in the Photoshop than to clean the sensor. The real solution of the dust problem is a self cleaning sensor in the camera.. Eventually, all DSLR cameras will have a self cleaning sensor and lenses will be changed without having to worry about dust on the sensor.

LENSES FOR 35MM CAMERAS

Q.: How can I determine if a Nikon lens is an AIS and not an AI lens?
A.: The AI lenses have a meter coupling ridge and the indexing (meter coupling) prong has two holes. The prong is for older non-AI cameras. The AIS (Automatic Indexing Shutter) has a lens-type signal groove providing information for Program and Shutter Priority modes. If the number corresponding to the smallest aperture (the largest number) is orange on both the main aperture and the ADR (aperture direct readout) lines, the lens has an AIS mount. If only the main aperture line has an orange number, the lens is probably not an AIS lens. The lens-type groove on the rear flange of the AIS lenses is another distinction. The AI and AIS lenses fit digital Nikon cameras but function only in the manual mode of the camera, without in camera exposure metering. The Nikon D2X, D2Xs, and D200 are an exception and provide aperture preferred auto (A), as well as manual exposure metering in the color, spot, and center weighted mode.

MACRO LENSES

Q.: How do the macro lenses differ from conventional close focusing lenses?
A.: Conventional lenses are optimized for producing images which are much smaller than their life-size. The distance between optical center of the lens and the film (sensor) plane is much smaller than the distance between the lens and the object photographed. Macro lenses are optimized for close-up photography and can focus to a 1:1 reproduction ratio without close-up accessories. In close-up photography, the distance between the lens and the film (sensor) plane is almost as long as the distance between the lens and the object. At the 1:1 reproduction ratio, the distances become equal. Macro lenses have focal lengths ranging from 50 to 200mm. A longer focal length has the advantage of a longer working distance, especially useful for photographing easily frightened insects.

A good macro lens has a flat field of low distortion, essential for copy work

Q.: I am planning to buy the new Nikon 105mm VR (vibration reduction) macro lens. Is the stabilization of a macro lens useful?
A.: No, macro photography does not need an optical stabilization of the lens. The optical image stabilization, called vibration reduction by Nikon, shifts elements of the lens to compensate for the camera movement. In macro photography (a reproduction ratio larger than one) or close-up photography (a reproduction ratio larger than 1:4) the main sharpness problem is the extremely shallow depth-of-field. This has two consequences. Firstly, it is very difficult to focus a handheld camera accurately. The camera has to be mounted on a tripod and focused by moving the camera back and forth, usually with a focusing rail. Secondly, the narrow depth-of-field necessitates a small aperture. At very small apertures the exposure times are too long for hand held shooting. With the ISO value at 400 in bright light, the exposure times may be short enough to attempt handheld photography with vibration reduction. However, the stabilization of the lens does not reduce the unsharpness caused by the movement of an insect or the wind-driven drift of a flower. The movement of the subject is stopped with an electronic flash. The short exposure time of the electronic flash eliminates the loss of sharpness caused by the vibration of the camera as well. The close-up photography of insects is usually done with an electronic flash to eliminate blur and to have enough light for shooting with a small aperture.

One disadvantage of the optical stabilization is the higher cost of the VR lens: almost $200 higher than the corresponding Nikon AF lens and about twice the price of a very good lens of independent manufacturers, Sigma, Tamron, and Tokina.

The Nikon macro VR lens, called the Micro Nikkor, is heavier than the other macro lenses (focal length, weight and filter size):

Micro Nikkor VR 105mm	1.6 lb	62mm
Micro Nikkor AF 105mm	1.2 lb	52mm
Sigma 105mm	15.1 oz.	58mm
Tamron 90mm	14.3 oz.	55mm
Tokina Pro D 105mm	1.2 lb	55mm

The Nikon VR 105mm lens is a high quality lens with virtually no distortion (0.03%). The slightly higher (0.3%) distortion of the very sharp Tokina macro lens is insignificant in most applications.

The high cost of optical vibration reduction may be justifiable when the lens is used for general photography (a reproduction ratio smaller than 1:4) and portraiture as well. For true macro and close-up photography, an optical stabilization of the lens is usually not needed.

Q.: I have an f/2.8 105mm macro lens. When I use it for close-up work, the f/number shown in the viewfinder is 3.5 or even larger. Why has the f/number changed?
A.: The display in the viewfinder shows the effective f/number during picture taking. The f/number is the ratio of the aperture size over the focal length. The focal length is the distance between the optical center of the lens and the sensor or film. Because the aperture size is always smaller than the focal length, the f/number is a reciprocal number, such as 1/2.8, 1/3.5 and so on. The aperture size means here the diameter of the circular opening which allows light to fall on the film or sensor.

For people loving details, the aperture usually does not stay circular when the diaphragm is closed down. The aperture size is then the diameter of a circle representing the area of the opening in the diaphragm.

The nominal f/number engraved on the lens is determined by focusing the lens at infinity. When the lens is focused to a closer distance, the lens is moved away from the sensor or film and the actual focal length increases. Because the aperture size remains the same, the ratio of the aperture size to the focal length decreases. The effective f/number increases because the f/number is a reciprocal number.

Macro lenses with an internal focus mechanism do not move the lens barrel. Instead, some lens elements in the lens barrel move when the lens is focused. The optical principles are still the same. The f/number displayed in the viewfinder increases when the macro lens is focused to a close-up distance.

TELECONVERTERS

Q.: Are teleconverters useful?
A.: Yes, if they match the lens, not only optically but physically as well. Vignetting of the image or insufficient clearance between the rear element of the lens and the converter may be problems. Teleconverters, or teleextenders as they are sometimes called, degrade the optical performance of the lens to some extent. With a matching 1.4x teleconverter the image quality is quite acceptable but the 2x teleconverters degrade the image quality noticeably.

Teleconverters reduce the speed of the lens, one stop by the 1.4x teleconverter and 2 stops by the 2x teleconverter. As a consequence, the AF response is slower.

The teleconverter should be attached first to the lens and the assembly mounted onto the camera. The reverse procedure may confuse the camera electronics. Some camera makers recommend switching off the camera every time when changing lenses, with or without the teleconverter.

Q.: I have a Sigma 50-500mm EX zoom lens and plan to buy the Kenko Pro300 series rather than the Sigma teleextenders. I have read that the Kenko teleextenders have a negative effect on the matrix metering in a

Nikon camera. Although I am using a Canon EOS 1VHS camera I am concerned.
A.: When selecting a teleextender (teleconverter) two factors must be considered: the optical performance and the physical compatibility. The optical performance depends on the optical match between the teleextender and the lens. The Sigma teleextenders have been designed for the Sigma 70-200mm/2.8 zoom lens and according to Sigma the compatibility for this lens is “exclusive”. The Sigma teleextenders are compatible with the Sigma 50-500mm EX zoom but the optical match is only “useful”.

I have used the Kenko Pro300 1.4x and 2x teleextenders with my Sigma APO 70-300mm/4-5.6 and Nikon 80-200/2.8 lenses on a Nikon F100 camera. The optical performance has been very good without any matrix metering problems. I would not hesitate to buy a Kenko Pro300 teleextender with the understanding that the teleextender can be returned if it is not compatible.

Q.: Are the Kenko AF teleconverters good?
A.: The quality of an image made with a teleconverter depends on the lens to which it is attached. Any optical faults of the lens will be magnified. If the match is good, the results can be quite rewarding.

Kenko AF Teleplus PRO 300 1.4x and 2x teleconverters are very good performers. They have multicoated 5 and 7 elements, respectively, made of high quality Hoya glass. Kenko teleconverters provide autofocusing for Nikon lenses which can be focused only manually with Nikon teleconverters.

USE OF LENSES

Q.: Why do you need many lenses?
A.: It is true, that some pros get excellent results with only one or two lenses. Most photographers use several lenses, even in the field. The number of lenses needed is determined by the variety of photography and the personal work style.

For film cameras my bag contains usually the 24-120mm/3.5-5.6VR lens and the70-200mm/2.8 VR lens. A 28-70mm/2.8 zoom lens replaces the 24-120mm lens when a wide aperture and a constant f-number are needed. A wide aperture lens is in the bag for night photography and available light shots, the 50mm f/1.4, the 35mm f/2.0, or the 85mm f/1.8 lens. Sometimes the 17mm super wide-angle lens comes along.

In addition to the basic assortment some special lenses are needed. When traveling light with a minimum load of gear, the 28-200mm f/3.5-5.6 Nikkor has performed very well. Close up work requires 50mm (or 60mm) and 105mm macro lenses. For travel photography and longer telephoto shots the 70-300mm f/4-5.6 Sigma APO zoom has been very useful. I could equip the 70-200mm f/2.8 lens with 1.4x and 2.0x teleconverters but the larger zoom ratio and the mobility of the Sigma are advantageous. The Sigma has been my favorite for flower photography as well and has produced many award winning images. The Sigma at the 1:2 reproduction ratio is an acceptable quality macro lens with a long working distance helpful for photographing insects.

The list of the lenses already includes 11 lenses but for photographing birds, wildlife, or sports a 400 or 500mm lens would have to be added

With a digital camera the situation is quite different and an arsenal of twelve lenses is out of question. Changing lenses allows dust to enter the camera and is therefore a potentially troublesome luxury. The need to clean the camera can be reduced by using a lens with a wide zoom ratio. A 24-120mm f/3.5-5.6 zoom lens (the 36-180mm 35mm film camera equivalent) covers the most frequently used picture angles. A fast lenses for available light photography may not be needed if boosting the digital sensitivity does not create an excessive noise.

Most digital SLR cameras are equipped with a small APS-C size sensor and this causes a problem with wide-angle photography. A 24mm lens has the same picture angle as a 35mm lens on a film SLR camera. A 12-24mm zoom is needed for wide angle shots. I use the Nikkor 12-24mm f/4.0 lens but the Tokina 12-24mm lens performs well for half of the price.

Q.: How do I buy a used lens?
A.: A good used lens can be a bargain at eBay.com. Admittedly, a new lens comes with a warranty and is up-to-date optically and mechanically. If the latest technology is not needed, the used lens market may be the place to find considerable savings. The price of used 35mm camera lenses has dropped recently because of the lenses dedicated to digital cameras. However, the optical superiority of the new digital only lenses has been difficult to demonstrate.

A used lens must be examined carefully. The appearance of the lens will tell you how the lens has been used. Examine the glass surfaces for scratches. Look through the lens to detect fungus or dust. Check the filter threads. Test the mechanical condition of the lens, the wobbliness of the lens barrel when extended (zoom lenses), and make sure that the diaphragm is operating freely. If everything appears to be satisfactory, photograph a brick wall at different apertures and focal lengths. This simple although somewhat crude test will tell you (i) the overall sharpness, (ii) distortion, (iii) uniformity of illumination (light fall-off, vigneting), and (iiii) exposure constancy. Use a fine grain film or a low ISO setting on a digital camera.

Q.: Which precautions should be taken to prevent damage to a lens?
A.: A lens is a sensitive optical instrument vulnerable to a mechanical shock and environmental stress. A lens on a camera must be protected against a blow to the lens, scratches of the front element, and the damage by water, sand, or dust. The front end of the lens can be protected against a blow by using a rubber lens hood. Unlike a metal hood, a rubber lens hood can absorb a bump.

Metal lens hoods screw into the lens or filter, slip on the lens, or have a bayonet mount. All rubber lens hoods screw into the lens or a filter. A polarizing filter can be adjusted by rotating the rubber lens hood. Most metal lens hood require the rotation of the filter inside the hood which is cumbersome and may leave fingerprints on the filter.

The protection of the front element against scratches by attaching a UV filter has been controversial. Theoretically, the filter introduces two glass-to-air surfaces and increases reflections and flare. With a multicoated filter the effect is insignificant for practical purposes. Purists can resolve this argument by testing the lens with and without the filter. When a polarizing filter is used most of the time outdoors, the debate is meaningless anyhow.

The lens can be protected against water with various sleeves and bags designed to cover the lens and the camera (Ewa-Marine, Kata, Lightware, OP/Tech, and Tenba) or with an umbrella (Probrella). The devices which shield the lens against rain protect the lens against sand and dust as well.

When mounting a lens, place the lens into the mount and feel gently that the lens has seated properly before rotating the lens. Do not force the lens if the fit seems to be tight. Avoid walking around with the zoom lens extended. An unexpected blow on the side of the barrel may end the useful life of the lens.