Pathfinder Honour:

Trainer’s Notes

Photography (Digital) 1

Instructions to Trainers / Instructors of this Honour

Thankyou for being involved with this Honour. These notes have been developed to assist in teaching / instructing this honour. We recognise that there is much more information available and we are grateful that you should share your expertise.

Please remember that Honours are designed to develop our Pathfinders in many ways; their interests, their knowledge and their relationship with their Saviour and Creator. Your enthusiasm and creativity will have a huge impact on those doing the honour.

To complete an Honour, the following (where applicable) must be completed satisfactorily:

- Physical and Practical Requirements.
- Honour Workbook.
- Honour Assessment Sheet. *(On SPD Honour Website but Leader’s level access is required)*

Additional Reference Material

Please see ADDITIONAL REFERENCES on the final page of these notes

Acknowledgements

Please refer to acknowledgements listed in the text of these notes

Photography (Digital) 1 Honour: Trainer's Notes

BEFORE YOU START

There is a considerable amount of technical information in the following pages. Participants of this honour are not expected to absorb all of it in detail. However, a good understanding of the principles is expected. It is fundamental to taking first-rate photos. Have fun!

REQUIREMENT 1: Explain the following:

a. The principles of digital camera construction and how a digital camera works.

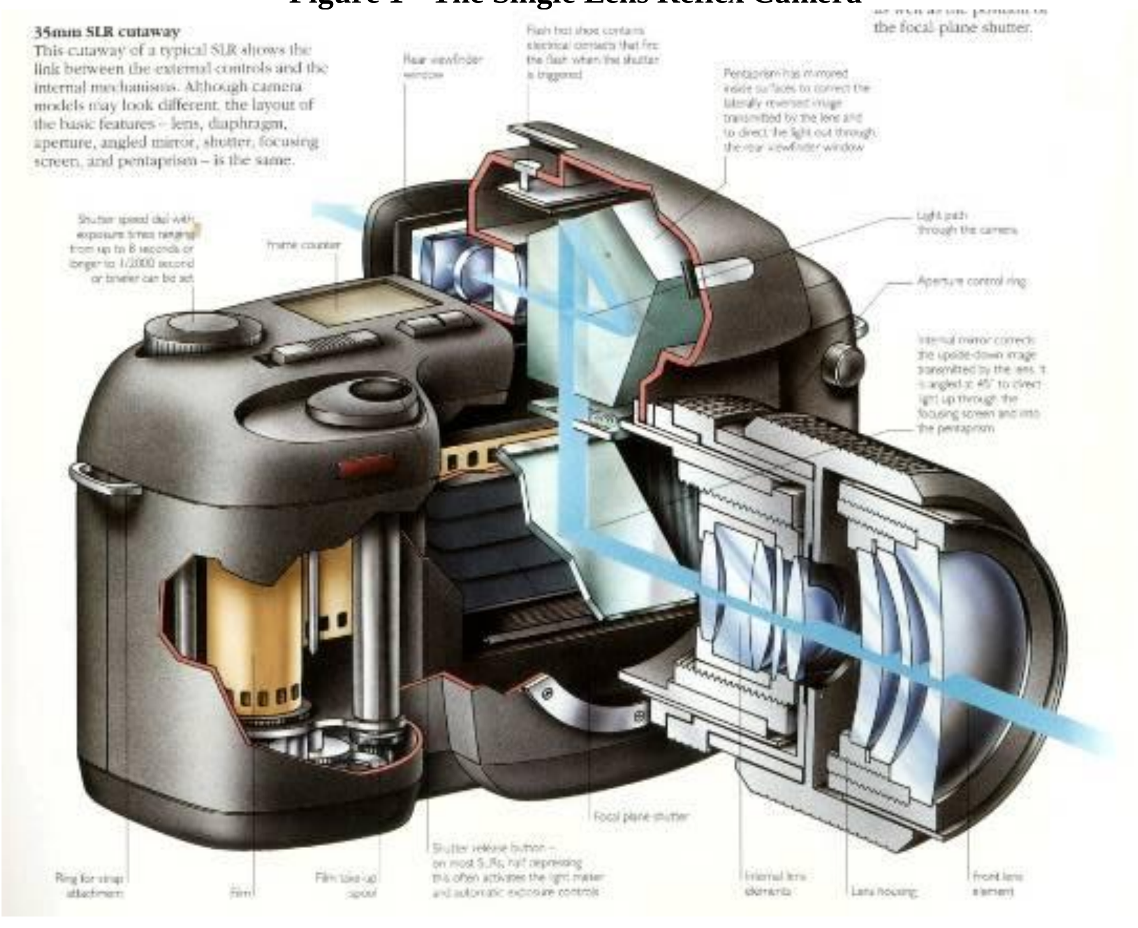
The Single Lens Reflex (SLR) Camera

With the SLR camera what you see is what you get, literally. Light travelling from the subject enters the lens and strikes the mirror which is angled at 45 degrees. It is then reflected upward, through the focusing screen and into the pentaprism, where it exits the camera via the rear mounted viewfinder window. This means that the view the photographer sees in the viewfinder corresponds exactly with what is seen by the lens. When a photo is taken the mirror retracts and the shutter opens to expose the film or the sensor.

The Traditional Film Camera

Light sensitive film is stored behind the shutter in a completely dark environment. When a photo is taken, the shutter opens and exposes the one frame of the film to light which "burns" the image into the film. Then the film is developed in a dark room using a chemical process.

Figure 1 - The Single Lens Reflex Camera



Source: Hedgecoe, J 1994, *John Hedgecoe's New Book of Photography*, Dorling Kindersley, London.

The Digital Camera

The light entering the camera is converted into electrons using an image sensor. The image sensor samples the intensity of the light and converts it to electrical signals which are then converted into binary data (1's and 0's).

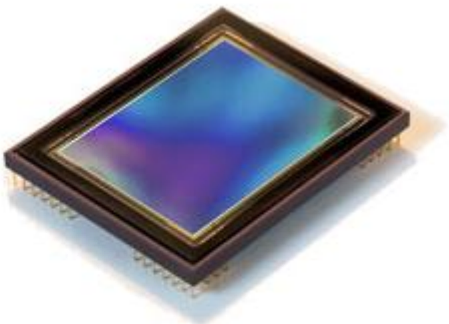
b. The effect of light on an image sensor.

Image Sensors

There are two types of image sensors used by digital camera, the Complementary Metal Oxide Semiconductor (CMOS) and the Charge Coupled Device (CCD). Both types of sensors convert light into electrons in a similar way to solar cells. A simple way to think of it is an array of millions of tiny solar cells. The sensor reads the accumulated charge of each cell in the image.

- The CCD transports the charge across the chip and reads it at one corner of the array. An analog-to-digital converter (ADC) then turns each pixel's value into a digital value by measuring the amount of charge at each photosite and converting that measurement to binary form.

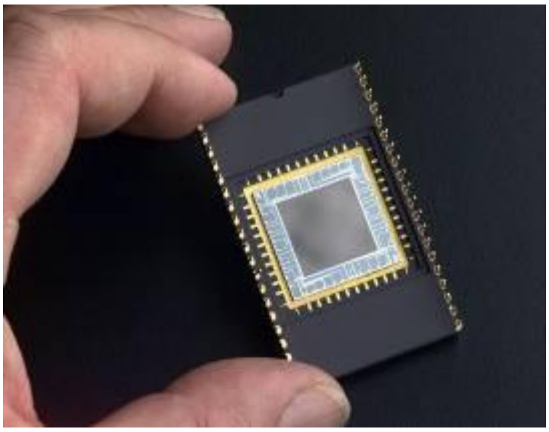
Figure 2 - CCD Sensor



Source: http://www.photo.net.ph/blogalicious/main/cmos-sensor-vs-cd-sensor-which-one-is-better-for-digital-cameras/

- The CMOS uses several transistors at each pixel to amplify and move the charge using more traditional wires.

Figure 3 - CMOS Sensor



Source: http://www.photo.net.ph/blogalicious/main/cmos-sensor-vs-cd-sensor-which-one-is-better-for-digital-cameras/

Pros and Cons of CMOS and CCD sensors

- CCD sensors create high-quality, low-noise images. CMOS sensors are generally more susceptible to noise.
- Because each pixel on a CMOS sensor has several transistors located next to it, the light sensitivity of a CMOS chip is lower. Many of the photons hit the transistors instead of the photodiode.
- CMOS sensors traditionally consume little power. CCDs, on the other hand, use a process that consumes lots of power. CCDs consume as much as 100 times more power than an equivalent CMOS sensor.
- CCD sensors have been mass produced for a longer period of time, so they are more mature. They tend to have higher quality pixels, and more of them.

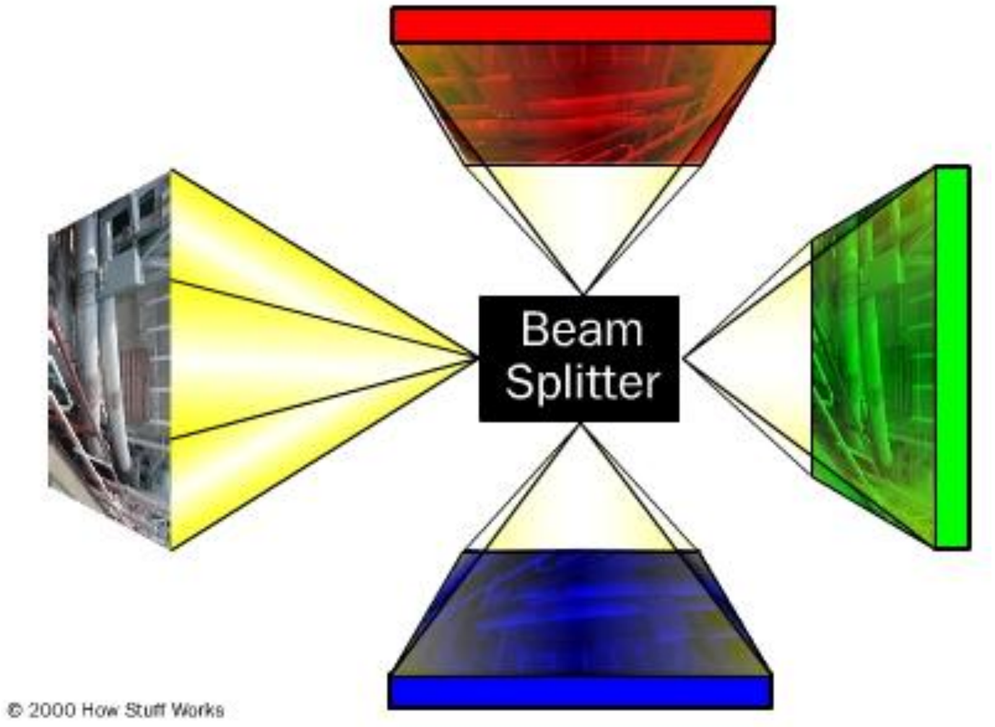
c. How colour images are created from the BW image the sensor captures.

How a Digital Camera Captures Colour

Unfortunately, each photo site is colour-blind. It only keeps track of the total intensity of the light that strikes its surface. In order to get a full colour image, most sensors use filtering to look at the light in its three primary colours. Once the camera records all three colours, it combines them to create the full spectrum.

There are several ways of recording the three colours in a digital camera. The highest quality cameras use three separate sensors, each with a different filter. A beam splitter directs light to the different sensors. Think of the light entering the camera as water flowing through a pipe. Using a beam splitter would be like dividing an identical amount of water into three different pipes. Each sensor gets an identical look at the image; but because of the filters, each sensor only responds to one of the primary colours.

Figure 4 - Beam Splitter



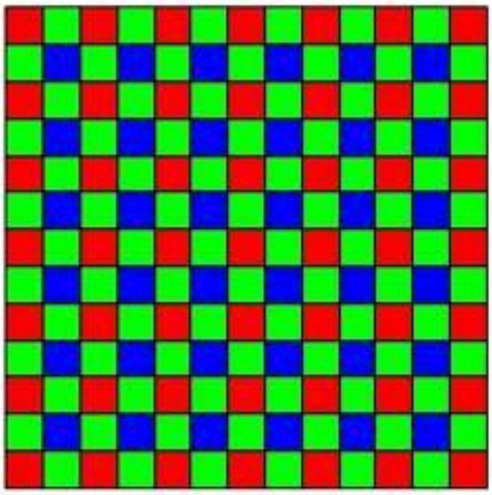
Source: http://electronics.howstuffworks.com/cameras-photography/digital/digital-camera4.htm

The advantage of this method is that the camera records each of the three colours at each pixel location. Unfortunately, cameras that use this method tend to be bulky and expensive.
Another method is to rotate a series of red, blue and green filters in front of a single sensor. The sensor records three separate images in rapid succession. This method also provides information on all three colours at each pixel location; but since the three images aren't taken at precisely the same moment, both the camera and the target of the photo must remain stationary for all three readings. This isn't practical for candid photography or handheld cameras.

A more economical and practical way to record the primary colours is to permanently place a filter called a colour filter array over each individual photo site. By breaking up the sensor into a variety of red, blue and green pixels, it is possible to get enough information in the general vicinity of each sensor to make very accurate guesses about the true colour at that location. This process of looking at the other pixels in the neighbourhood of a sensor and making an educated guess is called interpolation.

The most common pattern of filters is the Bayer filter pattern. This pattern alternates a row of red and green filters with a row of blue and green filters. The pixels are not evenly divided -- there are as many green pixels as there are blue and red combined. This is because the human eye is not equally sensitive to all three colours. It's necessary to include more information from the green pixels in order to create an image that the eye will perceive as a "true colour."

Figure 5 - Bayer Filter



Source: http://electronics.howstuffworks.com/cameras-photography/digital/digital-camera5.htm

The advantages of this method are that only one sensor is required, and all the colour information (red, green and blue) is recorded at the same moment. That means the camera can be smaller, cheaper, and useful in a wider variety of situations. The raw output from a sensor with a Bayer filter is a mosaic of red, green and blue pixels of different intensity.

Digital cameras use specialized demosaicing algorithms to convert this mosaic into an equally sized mosaic of true colours. The key is that each coloured pixel can be used more than once. The true colour of a single pixel can be determined by averaging the values from the closest surrounding pixels.

d. What the camera lens does; what focal length means.

The Lens
A lens can be detachable/replaceable (e.g. the lens for a Digital SLR camera) or built into the camera (e.g. the lens for a compact digital camera).

The three main controls that Digital SLR camera lenses have are the aperture ring, the focus ring, and the zoom. The amount of light reaching the sensor can be controlled using the shutter speed or aperture. The focus ring allows and image to be adjusted until it is in focus. The zoom ring allows an image to be enlarged or reduced by using optical magnification.
Compact digital cameras have all the same adjustments as a Digital SLR camera lens however, the adjustments are usually made in the camera's settings and by pressing buttons rather than twisting rings on the lens.

Shutter speed
The shutter is the window at the back of the camera that opens and closes when you take a photo to allow light to reach the image sensor. The shutter speed is the amount of time that light can pass through the aperture. Faster shutter speeds (e.g. 1/2000 second) let less light in; slower shutter speeds (e.g. 1/60 second) allow more light in.

Aperture
The aperture is a ring in the camera that operates similar to the pupil in your eye; it expands and contracts to control the amount of light that can reach the camera. The aperture is the size of the opening in the camera. The unit of measure for aperture size is the f-stop. For example, a typical lens may range between f2 (almost fully open) and f16 (almost fully closed).

Focal Length
The focal length is the distance between the lens and the surface of the sensor. Sensors from different manufacturers vary widely in size, but in general they're smaller than a piece of 35mm film. In order to project the image onto a smaller sensor, the focal length is shortened by the same proportion. For additional information on sensor sizes and comparisons to 35mm film, you can visit the Photo.net Web site.

Focal length also determines the magnification, or zoom, when you look through the camera. In 35mm cameras, a 50mm lens gives a natural view of the subject. Increasing the focal length increases the magnification, and objects appear to get closer. The reverse happens when decreasing the focal length. A zoom lens is any lens that has an adjustable focal length, and digital cameras can have optical or digital zoom. Some have both. Some cameras also have macro focusing capability, meaning that the camera can take pictures from very close to the subject.

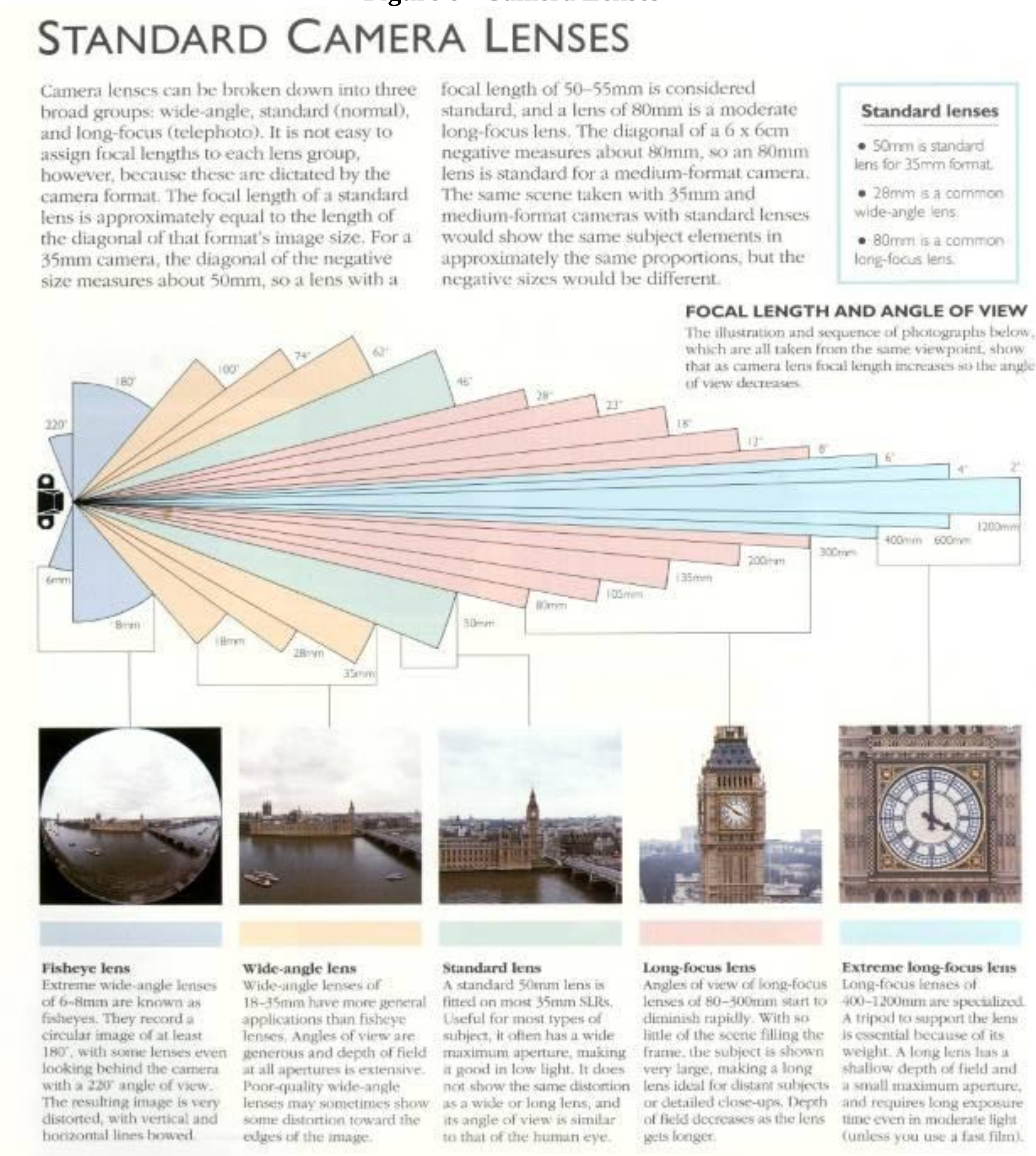
Two camera settings control the amount of light that reaches the image sensor. They are shutter speed and the aperture.

Digital cameras have one of four types of lenses:

- Fixed-focus, fixed-zoom lenses - These are the kinds of lenses on disposable and inexpensive film cameras -- inexpensive and great for snapshots, but fairly limited.
- Optical-zoom lenses with automatic focus - Similar to the lens on a video camcorder, these have "wide" and "telephoto" options and automatic focus. The camera may or may not support manual focus. These actually change the focal length of the lens rather than just magnifying the information that hits the sensor.

- Digital zoom - With digital zoom, the camera takes pixels from the center of the image sensor and interpolates them to make a full-sized image. Depending on the resolution of the image and the sensor, this approach may create a grainy or fuzzy image. You can manually do the same thing with image processing software -- simply snap a picture, cut out the center and magnify it.
- Replaceable lens systems - These are similar to the replaceable lenses on a 35mm camera. Some digital cameras can use 35mm camera lenses. There are several types of replaceable lenses: Fisheye, Wide-Angle, Standard, Telephoto or long-focus

Figure 6 - Camera Lenses



STANDARD CAMERA LENSES

Camera lenses can be broken down into three broad groups: wide-angle, standard (normal), and long-focus (telephoto). It is not easy to assign focal lengths to each lens group, however, because these are dictated by the camera format. The focal length of a standard lens is approximately equal to the length of the diagonal of that format's image size. For a 35mm camera, the diagonal of the negative size measures about 50mm, so a lens with a focal length of 50–55mm is considered standard, and a lens of 80mm is a moderate long-focus lens. The diagonal of a 6 x 6cm negative measures about 80mm, so an 80mm lens is standard for a medium-format camera. The same scene taken with 35mm and medium-format cameras with standard lenses would show the same subject elements in approximately the same proportions, but the negative sizes would be different.

Standard lenses

- 50mm is standard lens for 35mm format.
- 28mm is a common wide-angle lens.
- 80mm is a common long-focus lens.

FOCAL LENGTH AND ANGLE OF VIEW

The illustration and sequence of photographs below, which are all taken from the same viewpoint, show that as camera lens focal length increases so the angle of view decreases.

Fisheye lens
Extreme wide-angle lenses of 6–8mm are known as fisheyes. They record a circular image of at least 180°, with some lenses even looking behind the camera with a 220° angle of view. The resulting image is very distorted, with vertical and horizontal lines bowed.

Wide-angle lens
Wide-angle lenses of 18–35mm have more general applications than fisheye lenses. Angles of view are generous and depth of field at all apertures is extensive. Poor-quality wide-angle lenses may sometimes show some distortion toward the edges of the image.

Standard lens
A standard 50mm lens is fitted on most 35mm SLRs. Useful for most types of subject, it often has a wide maximum aperture, making it good in low light. It does not show the same distortion as a wide or long lens, and its angle of view is similar to that of the human eye.

Long-focus lens
Angles of view of long-focus lenses of 80–300mm start to diminish rapidly. With so little of the scene filling the frame, the subject is shown very large, making a long lens ideal for distant subjects or detailed close-ups. Depth of field decreases as the lens gets longer.

Extreme long-focus lens
Long-focus lenses of 400–1200mm are specialized. A tripod to support the lens is essential because of its weight. A long lens has a shallow depth of field and a small maximum aperture, and requires long exposure time even in moderate light (unless you use a fast film).

Source: Hedgecoe, J 1994, *John Hedgecoe's New Book of Photography*, Dorling Kindersley, London.

REQUIREMENT 2: How are lens aperture and depth of field related?

Aperture

The aperture is a ring in the camera that operates similar to the pupil in your eye; it expands and contracts to control the amount of light that can reach the camera. The aperture is the size of the opening in the camera. The unit of measure for aperture size is the f-stop. For example, a typical lens may range between f2 (almost fully open) and f16 (almost fully closed).

Depth of Field

Three things affect depth of field, the aperture, the subject-to-camera distance and the focal length of the lens. The greatest depth of field results from the smallest available aperture on the shortest lens, focused to infinity. As aperture gets larger, focal lengths longer, and the subject gets nearer the depth of field diminishes.

Figure 7 - The Camera Lens, Aperture and Depth of Field.

OPTICAL PRINCIPLES

The main lens controls are the focus control and aperture ring. Most lenses also have a distance indicator, telling you how far away the lens is focused, and a depth of field scale, indicating the extent of the zone of sharp focus. The three factors affecting depth of field are aperture, subject-to-camera distance, and the focal length of the lens. Greatest depth of field results from the smallest available aperture on the shortest lens, focused on infinity (∞). As apertures get larger, focal lengths longer, and subject distances nearer, so depth of field diminishes.

The aperture setting is a key element in film exposure. The best setting to select depends on how much depth of field a scene requires and also the shutter speed setting. A fast shutter speed freezes subject movement and keeps camera shake from affecting the image, while a slow setting produces a blurred image.

Choosing a lens

Choose the "fastest" lens you can afford – that is, one with the widest maximum aperture. The speed of a lens affects exposure in low-light situations.

FOCUSING AND APERTURE

Depth of field

The zone of acceptably sharp focus surrounding a subject is critical to the appearance of the final image. To make full use of all apertures a lens offers, position the camera on a tripod to prevent camera shake. The two pictures shown here are identical in terms of exposure, but while the first one (*below*) was shot at 1/60 second at f2, the second one (*bottom*) was shot at 1 second at f16. All other aperture and shutter speed combinations in between would also produce a correctly exposed image.

Exposure: 1/60 second at f2

Exposure: 1 second at f16

The f-stop and aperture size

Any type or size of lens set at a specific f-stop transmits an image of near identical luminance, because the diameter of the aperture is directly related to focal lenth. For example, an 80 mm lens used with an aperture 5 mm in diameter must be set at f16. Thus, the focal length of the lens, divided by the diameter of the aperture, gives the corresponding f-stop number.

Focusing distance indicator

The lens extends from the camera by means of a screw thread operated by the focusing ring. As you turn the ring, you can see the distances being focused on by reading the indicator against the fixed reference mark.

Aperture settings

Moving the aperture ring up to the next f-stop (from f4 to f5.6, for example) halves the aperture size (and so halves the amount of light reaching the film); while moving the ring down (from f4 to f2.8, for example) doubles the aperture size.

Depth of field scale

With the lens focused on the subject, look for the aperture numbers on either side of the fixed reference mark that correspond to (or approximate to) the f-stop of the set aperture. Read these against the focusing distance indicator below to determine the effective depth of field.

Source: Hedgecoe, J 1994, *John Hedgecoe's New Book of Photography*, Dorling Kindersley, London.

Figure 8 - Lenses

STANDARD LENS

A standard, or normal, lens produces an image that is roughly equivalent to the way a scene appears when viewed with the naked eye. Most 35mm SLRs come with a standard lens, but this can be swapped for a shorter or longer lens. Standard lenses often have wide maximum apertures, making them useful in low-light situations.

Depth of field scale

Lens

Aperture ring

Focusing ring

Standard 50mm lens

Standard lenses are useful for most outdoor subjects

WIDE-ANGLE LENS

A wide-angle lens takes in a larger angle of view than a standard lens, and is ideal for photographing a group of people or when you are working in confined space. If used too close to a subject, however, distortion may be a problem. Depth of field at each aperture setting is generous, which is useful when all parts of a subject must be sharply rendered.

Depth of field scale

Lens

Aperture ring

Focusing ring

28mm wide-angle lens

Wide-angle lenses are useful for interiors

ZOOM LENS

A zoom lens allows you to fine-tune subject framing by adjusting the focal length of the lens. Each zoom lens covers a range of three or four fixed focal length lenses, giving you great flexibility at a reasonable cost. Since you do not have to think about changing lenses, there is less chance you will miss an important shot.

Depth of field scale

Lens

Aperture ring

Focusing ring

28–85mm zoom lens

Zooms are useful for action shots

LONG-FOCUS LENS

Long-focus lenses are useful for large images of distant subjects or when you cannot move close enough to use a shorter lens. Long lenses tend to be heavy, which makes the use of fast shutter speeds to avoid camera shake more important than with lighter, shorter lenses. A telephoto lens is a long-focus lens with a compact design that makes it shorter.

Depth of field scale

Focusing ring

Lens

Aperture ring

135mm long-focus lens

Long-focus lenses are useful for natural history subjects

Source: Hedgecoe, J 1994, *John Hedgecoe's New Book of Photography*, Dorling Kindersley, London.

Figure 9 - Special Lenses

SPECIAL CAMERA LENSES

A 35mm SLR or medium-format camera body can be thought of simply as the film holder and control center for a vast array of different add-on attachments, including lenses, each with its own application. The lenses shown on these pages, all designed for the 35mm format, are just a selection of the many focal lengths and designs available.

ZOOMS AND SPECIALIZED LENSES

A zoom lens allows you to vary subject magnification without moving your camera position, which makes it popular with SLR users. Zoom lenses are also fitted as a standard feature on some advanced compact cameras.

Specialized lenses, such as extreme long-focus lenses and ultra wide-angle fisheye lenses, have more limited applications. These lenses are expensive to buy, but they can also be rented for short periods. Macro lenses are designed for taking close-ups of small subjects or isolating details of larger subjects. These lenses allow the camera to focus extremely close to a subject to record a detailed image. Used for photographing buildings, shift lenses correct perspective to overcome the problem of converging vertical lines.

MIRROR LENS

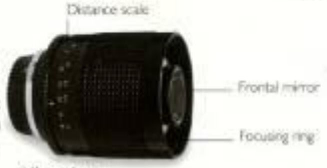
Instead of using groups of glass elements to bend light rays entering the lens and traveling down the barrel, a mirror lens uses a combination of glass elements and mirrors. These mirrors bounce the light up and down the lens barrel, manipulating the light rays to allow a long focal length to be contained within a physically short space.

Mirror lens image

600mm mirror lens with colored filters

Advantages of a mirror lens

The compact design of a mirror lens reduces the bulk and weight associated with extreme long-focus lenses. Whereas the traditional 500mm long-focus lens (*below right*) is 9.25in (235mm) long and weighs 35.25oz (1,000g), the mirror lens (*right*) of equivalent focal length weighs only 17oz (485g) and is 3.4in (87mm) long.



Mirror lens

Long-focus lens

WIDE-ANGLE ZOOM

A wide-angle zoom ranging from 21–35mm is effectively three lenses – 21mm, 28mm, and 35mm – with the added advantage of being able to select any intermediate focal length setting. However, a wide-angle zoom is likely to be slower and heavier and to show more image distortion than a wide-angle fixed focal length lens.

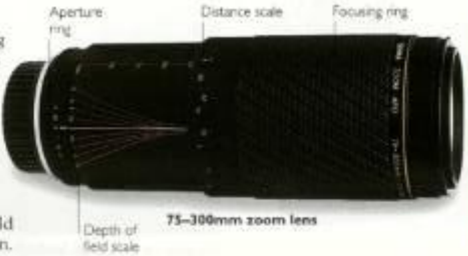
21–35mm zoom lens

21mm setting

35mm setting

TELEPHOTO ZOOM

A telephoto zoom lens ranging from 75–300mm encompasses about six fixed focal length lenses. This type of zoom is popular with sports and wildlife photographers. It is also useful for portraits and for moving subjects such as children. Unlike a wide-angle zoom, a telephoto zoom should not show any obvious distortion.



75–300mm zoom lens

75mm setting

300mm setting

Source: Hedgecoe, J 1994, *John Hedgecoe's New Book of Photography*, Dorling Kindersley, London.

Figure 10 - More Special Lenses

ULTRA WIDE-ANGLE LENS

A good quality lens of this type for a 35mm format camera tends to be very expensive. Linearly corrected ultra wide-angle lenses have a focal length ranging from around 21mm down to 15mm. The latter type approaches the extreme limits of design to maximum aperture may be limited to about f8.

Lens mount
Focusing ring
Aperture ring
Distance scale
15mm ultra wide-angle lens
Standard lens image
Ultra wide-angle lens image

SHIFT LENS

A shift lens (also known as a perspective control lens) gets its name because it can be shifted off-center in relation to the film frame. Instead of tilting the camera back to include the top of a tall structure and so distorting the perspective, with a shift lens you can keep the camera parallel and shift the lens upward to record an undistorted image.

Aperture ring
Shift control
Lens mount
Focusing ring
28mm shift lens
Standard lens image
Shift lens image

MACRO LENS

This type of specialized lens is designed primarily to be used at very close focusing distances (*see pages 188–189*). Macro lenses are available in focal lengths ranging from 50mm to 200mm. When taking close-ups outdoors, longer macro lenses produce a large image from farther back. Moving in close with a shorter macro lens may block out the light.

Aperture ring
Distance scale
Focusing ring
Lens mount
50mm macro lens
Standard lens image
Macro lens image

TELEPHOTO LENS

A telephoto lens has specially designed optics that allow it to have a long focal length in a relatively short barrel. This name has become so widespread that it is commonly applied to all long-focus lenses irrespective of their design. Telephotos of 400mm, even lightweight ones, require some sort of camera support.

Camera body
Focusing ring
1000mm telephoto lens
Focusing ring
400mm telephoto lens
Tripod mount
Standard lens image
1000mm lens image

Source: Hedgecoe, J 1994, *John Hedgecoe's New Book of Photography*, Dorling Kindersley, London.

Photography (Digital) 1 Honour: Trainer's Notes

Lenses and Sensor Sizes:

Cameras with digital sensors that are smaller than the typical 35mm film size will have a smaller field or angle of view when used with a lens of the same focal length. This is because angle of view is a function of both focal length and the sensor or film size used.

If a sensor smaller than the full-frame 35mm film format is used, such as the use of APS-C-sized digital sensors in DSLRs, then the field of view is cropped by the sensor to smaller than the 35mm full-frame format's field of view. This narrowing of the field of view is often described in terms of a focal length multiplier or crop factor, a factor by which a longer focal length lens would be needed to get the same field of view on a full-frame camera.

If the digital sensor has approximately the same resolution (effective pixels per unit area) as the 35mm film surface (24 x 36 mm), then the result is similar to taking the image from the film camera and cutting it down (cropping) to the size of the sensor. For an APS-C size sensor, this would be a reduction to approximately the centre 50% of the image. The cheaper, non-SLR models of digital cameras typically use much smaller sensor sizes and the reduction would be greater.

If the digital sensor has a higher or lower density of pixels per unit area than the film equivalent, then the amount of information captured will differ correspondingly. While resolution can be estimated in pixels per unit area, the comparison is complex since most types of digital sensor record only a single colour at each pixel location, and different types of film will have different effective resolutions.

There are various trade-offs involved, since larger sensors are more expensive to manufacture and require larger lenses, while sensors with higher numbers of pixels per unit area are likely to suffer higher noise levels.

For these reasons, it is possible to obtain cheap digital cameras with sensor sizes much smaller than 35mm film, but with high pixel counts, that can still produce high-resolution images. Such cameras are usually supplied with lenses that would be classed as extremely wide angle on a 35mm camera, and which can also be smaller size and less expensive, since there is a smaller sensor to illuminate. For example, a camera with a 1/1.8" sensor has a 5.0x field of view crop, and so a hypothetical 5-50mm zoom lens will produce images that look similar (again the differences mentioned above are important) to those produced by a 35mm film camera with a 25–250mm lens, while being much more compact than such a lens for a 35mm camera since the imaging circle is much smaller.

This can be useful if extra telephoto reach is desired, as a certain lens on an APS sensor will produce an equivalent image to a significantly longer lens on a 35mm film camera shot at the same distance from the subject, the equivalent length of which depends on the camera's field of view crop. This is sometimes referred to as the focal length multiplier, but the focal length is a physical attribute of the lens and not the camera system itself. The disadvantage of this is that wide angle photography is made somewhat more difficult, as the smaller sensor effectively and undesirably reduces the captured field of view. Some methods of compensating for this or otherwise producing much wider digital photographs involve using a fisheye lens and "defishing" the image in post processing to simulate a rectilinear wide angle lens.

Full-frame digital SLRs, that is, those with sensor size matching a frame of 35mm film, include Canon 1DS, 1DS II, and 5D, Kodak Pro DCS-14n, Nikon D3X (with a 24.5 megapixel sensor) and Contax N Digital. There are very few digital cameras with sensors that can approach the resolution of larger-format film cameras, with the possible exception of the Mamiya ZD (22MP) and the Hasselblad H3D series of DSLRs (22 to 39 MP).

Common values for field of view crop in DSLRs include 1.3x for some Canon sensors, 1.5x for Sony APS-C sensors used by Nikon, Pentax and Konica Minolta and for Fujifilm sensors, 1.6 (APS-C) for most Canon sensors, ~1.7x for Sigma's Foveon sensors and 2x for Kodak and Panasonic 4/3" sensors currently used by Olympus and Panasonic. Crop factors for non-SLR consumer compact and bridge cameras are larger, frequently 4x or more.

Figure 11 - Sensor Size and Lenses

Source: http://en.wikipedia.org/wiki/Digital_photography

REQUIREMENT 3: Describe pixels, image resolution, and image size.

The amount of detail that a digital camera can capture is called the resolution. It is measured in pixels. A pixel - also called a 'picture element'- is the smallest single component of a digital image.

Low-end cheaper cameras have a smaller number of pixels than high-end cameras. Thus high-end cameras with their greater number of pixels can capture superior detail. Larger pictures can be made without being as blurry or grainy as if created from cheaper cameras.

Pixel counts can be expressed as a single number as in a three-megapixel (3MP) digital camera which has a nominal three million pixels. Alternatively, pixel counts can be expressed as a pair of numbers. Consider a 640 by 480 display. This has 640 pixels from side to side and 480 from top to bottom. This gives 0.3 MP (640 × 480 = 307,200 pixels or 0.3 megapixels). Note that, as camera technology improves, so do the number of megapixels.

Some typical resolutions include:

- 640x480 pixels - This is the low end on most "real" cameras. This resolution is ideal for e-mailing pictures or posting pictures on a Web site.
- 1600x1200 - With almost 2 million total pixels, this is "higher resolution." You can print a 100 x 125 mm (4 x 5 inch) print taken at this resolution with the same quality that you would get from a photo lab.
- 2240x1680 - Found on 4 megapixel cameras. This allows even larger printed photos, with good quality for prints up to 400 x 500 mm (16x20 inches).
- 4064x2704 - A digital camera with 11.1 megapixels takes pictures at this resolution. At this setting, you can create 350 x 230 mm (13.5 x 9 inch) prints with no loss of picture quality.

Figure 12 - Image Size and Resolution

Source: http://digital.pho.to/

REQUIREMENT 4: What are the two types of image compression?
There are two types of image file compression algorithms: lossless and lossy.

Lossless compression algorithms reduce file size without losing image quality, though they are not compressed into as small a file as a lossy compression file. When image quality is valued above file size, lossless algorithms are typically chosen.

Lossy compression algorithms take advantage of the limitations of the human eye and discard invisible information. Most lossy compression algorithms allow for variable quality levels (compression) and as these levels are increased, file size is reduced. At the highest compression levels, image deterioration becomes noticeable as "*compression artefacting"*. The images below demonstrate the noticeable artefacting of lossy compression algorithms;

Figure 13 - Impact of Compression on Images

Source: http://www.biij.org/2006/1/e6/default.asp

(a), (b), (c) Lossy compression artefacts: the sample image is saved at progressively higher compression levels, starting at 1:1, then 1:10, then 1:30. Even at 1:30, the image remains very legible, though obvious visual glitches are present; (d) the 1:30 compressed image when zoomed at 5x. There is obvious smudging of detail, as well as a "blocking" artefact; a key characteristic of the JPEG lossy compression format.

REQUIREMENT 5: Name and describe three types of image formats.

JPEG – Joint Photographic Experts Group is the most common image format used by digital cameras. It offers good compression, and smooth variations in tone and colour. JPEG images use lossy compression so every time an image is saved it removes information and reduces the quality. JPEG images are not well suited for line drawings or text or icons.

TIFF – Tagged Image File Format is an image format that is uncompressed and therefore is lossless. It is popular for scanning, imaging, and desktop publishing. Most cameras no longer use this format.

RAW – A raw image file contains minimally processed data from the image sensor of a digital camera, image or motion-picture film scanner. Raw files are so named because they are not yet processed and therefore are not ready to be used with a bitmap graphics editor or printed.

Normally, the image is processed by a raw converter in a wide-gamut internal colour space where precise adjustments can be made before conversion to a "positive" file format

Such formats are TIFF or JPEG for storage, printing or further manipulation which often encodes the image in a device-dependent colour space.

These images are often described as "RAW image files" based on the erroneous belief that they represent a single file format. In fact there are dozens if not hundreds of raw image formats in use by different models of digital equipment (like cameras or film scanners). A raw image cannot be viewed until it has been processed and saved in a positive file format.

REQUIREMENT 6: Give the principle uses of photography.

Typical uses are:

- To capture and record pictures for future reference (e.g. Sport or Entertainment)
- To preserve memories (e.g. Weddings and special occasions)
- As a career/profession

REQUIREMENT 7: Take pictures illustrating at least eight of the following techniques. Use comparison pictures for illustration:

a. Framing.

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b. Camera steadiness.

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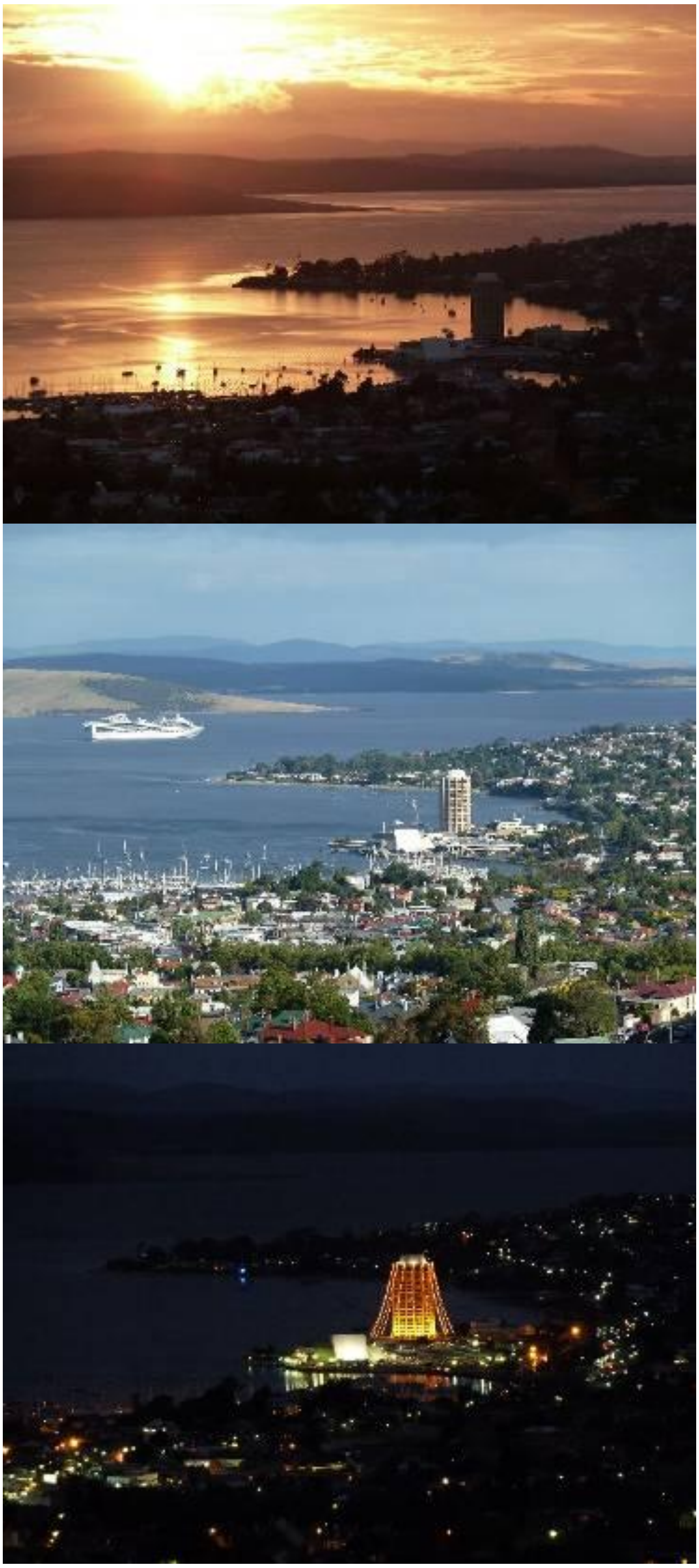
c. Direction of lighting - front, side, or backlighting.

d. Quality of light - shade, sunlight, and time of day.



e. Rule of thirds.

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f. Angle - eye level, high, and low level.

g. Level horizon.

h. Distance from subject - fill the frame.

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i. Use of leading lines.

j. Correct exposure - underexposed, overexposed, and correctly exposed.

k. Use of flash - proper distance and reflective objects.

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REQUIREMENT 8: Learn how to place photos in PowerPoint (or similar software) and create a presentation showing the pictures you took using the above techniques.

Some useful features to cover are:

- Slide layout
- Slide timings
- Animations / Slide Transitions
- Music

REQUIREMENT 9: Using a photo editing program on a computer, show ability to crop, colour correct, sharpen, and adjust brightness/contrast to photos.

Use a program such as Adobe Photoshop or Adobe Photoshop Lightroom to demonstrate photo editing and image correction principles.

REQUIREMENT 10: Complete at least three creative photographic projects in a photo editing program; such as a CD cover, a photo scrapbook page, a collage, etc.

Have the Pathfinders use their own software or a free program (such as Photoscape) to produce three photographic projects.

REQUIREMENT 11: Have a basic understanding of file organization techniques.

Explain to the Pathfinders the following concepts:

- Organisation into folders based on Year, Date, Event or Occasion
- Organisation in one folder based on Filename
- Using Software to catalogue, flag, rate and organise your photo library (e.g. Adobe Lightroom or similar software that is free)
- Backing up and Archiving Photos so they are not lost or damaged (e.g. file corruption)
- Storage of Photos (on Digital media or CDs, DVDs)

ADDITIONAL REFERENCES

The following references were used in compiling these notes. Please see citations listed with the relevant text. They are an additional source of useful information

- Hedgecoe, J. 1994, *John Hedgecoe's New Book of Photography*, Dorling Kindersley, London.
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