LESSON 1

INTRODUCTION TO DIGITAL TECHNOLOGY

Aim

To understand the scope and nature of digital photography.

Conventional and digital photography are in many ways very similar, but in just as many ways, quite different. Both have their advantages, so in the foreseeable future, there will remain applications for each.
Conventional photography using chemically photo-sensitive film is a well known and highly developed quantity – very close to a perfected technology.
We know how to use it, how to get the best out of it, and how its life span can be optimised because it has been around for so long, used so much and had so much effort and expense spent on its development.

Digital photography is, on the other hand, a relatively new and radically different technique which records images in the form of digital (i.e. 2 digit or binary) codes. In simple terms digital codes are similar to Morse code. One number or digit is indicated by a pulse of electricity, a second digit is indicated by no electrical pulse. By combining these pulses and lack of pulses into codes, we can, for example, create representations for letters of the alphabet; allowing us to write language or text on a computer. When we combine these electrical "pulses" and "no pulses" (or ‘ones’ and ‘zeros’) in more complex combinations, we can create more complex representations. These can include the colour, and degree of darkness or brightness in a single spot on a picture. When huge quantities of such dots are combined together, into a grid or array, we can then create a digital picture. (This is basically how digital photography works!) Each dot is referred to as a pixel (PICTURE ELEMENT) and is represented by ‘bits’ of data – thus the digital image array is often referred to as a ‘bitmap’.

As time passes, digital photography is becoming better and better and its imagery now rivals that of traditional silver halide based photography. However, due to its nature, it is unclear at this point whether it will ever make traditional photography totally redundant, particularly in situations where extreme resolution or detail is required. Current levels of technology suggest digital will eventually become the technology we rely on for creating still images. However, in the shorter term silver image systems will actually be cheaper to use in many applications.

Photo chemical photography, based on the light sensitive silver compounds silver bromide, silver chloride and silver iodide (known collectively as silver halides) has been with us since William Fox Talbot pioneered the negative/positive process in the first half of the nineteenth century. For most users this system has become synonymous with 35mm photography.

Equipment available has achieved a very high level of sophistication and produces very high quality images. The shutter and aperture exposure control system on film cameras, co-ordinated with a film speed (or sensitivity) system based on a simple geometric progression (the ISO system), allow the photographer to select combinations of film speed, shutter speed and aperture to creatively increase or decrease depth of field, enhance or reduce movement and operate in virtually any lighting conditions. The disadvantages of 'old style' photography lie principally in the areas of the requirement for elaborate facilities to process the image, the delays processing entails and the long-term storage of finished images. The Polaroid process provides an integrated shooting and processing medium but is expensive and limited in its applications.

Advances in archival processing have improved storage options for photo-chemical imagery but it is still easily damaged by such everyday hazards as dust and moisture. Making a print from a negative involves copying one analogue system to another similar system and physical problems, such as those previously mentioned, constantly cause difficulties.

Digital photography largely avoids these pitfalls. Storage media for digital image files (generally magnetic or optical in nature eg. diskettes, CD ROM or hard disk) have long been shown to be reasonably resistant to physical problems and to often still be readable and/or repairable after damage that would render a film negative useless. For example, scratches on CDs can generally be repaired. A scratch on an original film negative usually means disaster.

Apart from this, a digital code stays a code until it is interpreted into an analogue artefact by the use of hardware and software. Consequently digital can be copied directly to digital. Reading the code is largely unaffected by physical factors which trouble analogue copying and this opens the way for simple, cheap archiving of digital imagery. Digital storage systems can even be arranged so that if data is lost through damage or equipment failure, the missing code can be reconstructed by analysis and comparison of the remaining pieces of data. In essence this means that the digital image you create today can be preserved with no loss or deterioration into the foreseeable future by simply copying the file to new media. With the exception of some very simple and relatively cheap cameras, many of the early problems of digital have been eliminated or have become largely irrelevant.

For example, all but the most basic digital cameras now have image sensors capable of giving high enough resolution for good quality postcard-size prints; or in other words, to meet the 'holiday snap' expectations of most non-professionals. When you take a digital photo the image is captured by a sensor (more on these in Lesson 2) which is actually an analogue device. The digitising process and writing of the image data to memory take time. This means that many digital cameras cannot shoot a rapid sequence of photos - you have to wait 10 or more seconds between shots. For most people this presents no more problem than waiting for the flash unit to recycle on a conventional camera if you were, for example, shooting in dim light. However for the professional, where 'motor-drive' shots are an expectation of their shooting hardware , high end digital cameras now employ fast memory buffers and new sensors to allow sequences of five or more images to be fired-off at a time. Increases in the speed with which an image can be scanned from the sensor and processed have also helped eliminate this problem. These facilities come at a price and digital cameras are still more expensive than their conventional counterparts. As time progresses, this price gap is diminishing.

Significantly, digital cameras are based on conventional cameras for their exposure systems and allow, depending on the degree of sophistication, the same image controls as any standard film camera. The film speed, shutter and aperture systems of ‘old style’ cameras are an integral part of all but the simplest point-and-shoot digital hardware. The range of digital cameras now covers the same sort of scope as that of 35 millimetre cameras. Consequently choosing a camera tailored to suit your needs is easier, even if the number available may seem daunting.

Digital cameras store images on compact ‘cards’, which are essentially computer memory chips. The most common way to store images from a digital camera long-term is to 'download' them from the camera’s memory card (the digital ‘film’) onto a computer hard drive. This then allows the camera memory card to be re-used over and over again. High quality images use a lot of memory space and can run anywhere from 1 megabyte compressed files to the 8 megabytes of space or more for uncompressed files (see Lesson 3 – File formats, for more info). This sounds a lot, particularly when a large word processor document (say 30 to 60 pages) is only in the 100 to 200 kilobyte range. However, this means that lower quality images (or smaller sized images) usually are in a similar file size range to that of the large word processor file. This means even the lowly (and ageing) floppy disc can store 2 to 4 smaller images or 1 compressed high-quality image. Beyond this, very few computers produced in the past few years do not have a CD rewritable/recordable drive or cannot be fitted with one for a reasonable sum. Even with uncompressed images of 8 megabytes you can store 85 shots, on one CD/R disk. That's economical in anyone's language.

The only other worry people sometimes express about digital images is the future compatibility and accessibility of today's file formats for long-term storage. The nature of digital imagery means all current digital image formats are based on the concept of the bitmap mentioned earlier. Consequently programmes like Adobe Photoshop or JASC Paint Shop Pro will perform conversions of one format to another. Given this feature of digital photography it seems likely that we will be looking at today's images, albeit copied digitally (but without loss of quality) to new formats, long into the next generations.

Digital photography is computer friendly and inexpensive, once you have the equipment. You can take any number of photos, place them onto a computer, and manipulate the images to use them in different ways, change effects and even send the image via the internet quickly to any part of the world.

THE DIGITAL REVOLUTION

In recent times, the most important technological breakthroughs in consumer electronics have been part of one larger breakthrough. CD's, DVD's, Digital TV are all built around the same basic process of converting conventional analogue information (represented by a fluctuating wave) into digital information (represented by 1s and 0s, or bits).

The digital camera is one of the most notable instances of this shift because it is by far different from its predecessor. Conventional cameras depend entirely on chemical and mechanical processes. All digital cameras have a built-in computer and all of them record images in an entirely electronic form.

The new approach has proved very successful at both consumer and industry level. It will probably be decades before digital cameras completely replace film cameras.

Here are some advantages and disadvantages of working with digital cameras.

Advantages

- Gain quality control over your pictures**.** Conventional photos have no input into an image after it leaves the camera. With a digital photo, image-editing software can be used to restore your pictures, if necessary.
- Send an image to friends, family members, and clients almost instantaneously by attaching it to an e-mail message.
- Explore your artistic side. Using image editing program you can apply special effects.
- Include pictures of your products and other items on your company's site or the World Wide Web.

Disadvantages

- Print quality. To get high quality such as traditional film prints you need a high resolution digital camera, which can be expensive. Lower priced cameras deliver lower resolution images.
- Images from lower priced digital cameras often require touch up work you correct problems with colour balance focus and contrast.
- Once you press the shutter button on a digital camera, the camera requires a few seconds to store the image to its memory.

CHARACTERISTICS OF DIGITAL

Analogue versus Digital – what's the difference?

Analogue systems record information about the world by creating an analogue of the reality we perceive normally through our senses. For example, when we take a silver image photograph we create a pattern of latent chemical changes in the emulsion layer of the film which through development can be made visible.

The camera negative, in the case of a black and white image, resembles the original to the extent that we can hold up the image to the original scene and, although the tones are reversed and the colours turned to shades of grey, we can see obvious similarities between the two - so much so that we usually can recognise the negative as a representation in two dimensions of that original scene. The recorded scene is similar to, but not the same as, the original.

If you have ever played a vinyl phonograph record without the sound being amplified, you will still hear, coming from the needle (or stylus) a thin but recognisable version of the music on the disk. This is because the original sound captured by a microphone has been through a series of analogue changes to eventually become the analogue groove on the record which vibrates the stylus to create the sound. Again, the recording is close to, but not completely identical to, the original sound in its form. There are analogue systems where this is much less obvious. For example, analogue audio or videotape recording requires some hardware to make it obvious that the recording contains analogue elements similar to, but not identical to the original. If you have ever seen a sound or video image represented on an oscilloscope you will know what I'm talking about.

So what about digital? The key word with digital, the word behind all aspects of computing, is "code". Did you ever as a child make up sentences by transposing letters to a pattern? You couldn't understand the sentence until you had the code key - the secret to how it was encrypted. Have you dialled onto the internet lately? The sound you hear coming from your modem (a device to turn digital code into audio signals that the phone system has sufficient bandwidth to cope with) is your computer 'talking' to the server at your internet provider. That storm of noise you hear if you accidentally pick up the phone while you're on the net is the audio, video, text and graphics data being fed through your computer to your screen. The important thing about this is that, unlike an analogue system, the information <u>bears no logical resemblance to what you are seeing and hearing on your computer monitor.</u> Without the necessary hardware and software we cannot interpret digital information as anything but 'noise' or, if it could be printed out in its raw form, page after page of coded figures.

Compared to human beings computers really are very stupid. Computers are only capable of recognising two basic states. Computers work with binary code, a system of ones and zeros or 'ons' and 'offs'. Every piece of information that the computer represents as text, graphics or even video is still made up of a code consisting of ones and zeros which are given meaning and value by the computer software. Computers attain their complexity of operation by being incredibly fast at processing these 'on' and 'off' signals and being able to decode them to a logical meaning. The simplest element of the code is a 'bit' which can have the value 1 or 0. If we have two bits the range of values we can represent goes up from two to four as we can have the two bits combined as 00, 10, 01 or 11. Three bits gives us 2 X 2 X 2 possibilities, and so on. The smallest block of data normally dealt with by a computer is a 'byte' (<u>B</u>INAR<u>Y</u> <u>T</u>ABL<u>E</u>) which, at 8 bits, is enough to represent a character in text or to give us 256 colour possibilities ("codes" if you prefer) in a digital image. Digital imaging is literally painting by numbers!

Pixels, bits and colour depth

Digital images, as we have already discovered, are made up of a large number of <u>picture elements</u> called "pixels".

Pixels are assigned colour and brightness values by the process and encoding of the raw information from the camera's image sensor.

Most cameras (and most monitors with newer computers) operate at the level of 24 bit colour. This means the image can contain 16,777,215 different colour shadings as opposed to the 256 possible with 8 bit colour or the 65,536 possibilities with 16 bit colour.

Recent advances in high end cameras have taken us to the level of 36 bit colour and therefore into literally billions of colour shadings. As a rule , the higher the colour depth (also referred to as the bit depth) , the better the image's colour quality , and , in fact , the more detail that will actually be visible in the final image, as increasing the number of colour shades available increases the subtlety and accuracy with which any detail can be represented.

Pixels and resolution

The resolution of a digital image is governed by the capabilities of the camera sensor used to capture it and by the way it is printed. The absolute resolution of an image depends on the number of pixels in the image sensor of the camera. Webcams and older digital cameras frequently have no better resolution than 640 by 480 pixels (640 wide X 480 high), or that of a PAL video image. Get close to your TV and you'll see that unless the image is kept small, this is not up to "photo quality". (Photo quality essentially means an image that has equal or better resolution than you would expect from an image on a 35 millimetre camera using medium speed – 200 ISO – film). Image sensors on digital cameras are quoted as having a maximum pixel resolution of, for example, 1.4 megapixels (or 1,400,000 pixels). Since most digital cameras use a frame size which is based loosely around a ratio of between 1.33 and 1.5 to 1 in terms of width versus height, this could also be referred to as 1400 X 1000 pixels.

In terms of actual resolution in the final print, a 1.4 megapixel camera should produce very good photo quality images at print sizes up to postcard (14 X 9 cms) and acceptable near photo images at up to 18 X 13 cms. Lower end cameras should be capable of at least this resolution. High end professional cameras of similar size and operation to a 35 mm SLR can use sensors as large as 14 megapixels , which are capable of image quality as good as a medium format film camera.

Colour and black and white

All colour images can be converted to black and white before printing, and so the issue of whether to shoot one or the other is irrelevant in digital photography.

The Two colour systems

Almost all colour images are made up in one of two ways, RGB or CMYK. In the early years of colour photographic processes such as the Lumiere autochrome utilised a process called additive colour. Additive colour uses the three primaries, red, green and blue to make up the image. If red, green and blue lights are projected onto a white object, where all three overlap white light will be created. Colour television systems utilise additive colour to produce colour images.

At the same time as it was realised that red, green and blue could be used to create full colour images it was also realised that a complementary set of colours, called the subtractive primaries, existed. These colours, cyan (blue-green), magenta and yellow when overlapped together effectively block white light and create black. Digital cameras, scanners and computer monitors utilise red, green and blue or RGB colour to produce their images. Colour printers utilise subtractive primaries to create colour on a page. This is logical as RGB colours work to reproduce colour when they can be made luminous together to create colour combinations for our eyes, out of what is essentially a black space. CMYK (the K stands for black, which is added to enhance the image as cyan, magenta and yellow tend to create a somewhat muddy black in actual printing) is the logical choice for printing where the background is usually white. This means that your screen image undergoes a re-encoding to allow the printer to make sense of the RGB image for CMYK printing. In reality this is a minor problem and, in high end digital imaging, calibration programs to make sure screen colour matches printed colour have been developed to ensure total colour accuracy. (see Lesson 3)

APPLICATIONS FOR DIGITAL PHOTOGRAPHY

Graphics

Until the recent years, computer graphics handling on home computers has been relatively primitive, but now programs and screens allow for images that rival silver image photography and generally surpass video in quality. Computer graphics, incorporating digital photography, can be used for creating business presentations, signs, newsletters, graphics for television and a host of other applications. You can also incorporate photos, logos and diagrams into word processor documents. With a computer, scanner, inkjet or laser printer, and some talent, you can replace the need for hiring a printing agency.

Computer-Aided Design (CAD)

Computer programs and systems have been developed which can be used in designing, planning, adjusting and outputting models and images for a range of fields such as engineering, manufacturing, architecture, interior design and science. Some products or concepts which are designed or planned using CAD applications are tools, cars, planes, residential and tourist developments, molecules and drugs, electronic circuits and hundreds of other things.

The process usually involves the direct input of information (lines, symbols, figures, etc.) using keyboard, mouse, light pen or graphics/digitising tablet. The CAD software enables the images to be viewed in two or three dimensions and to be manipulated by moving, twisting, editing or otherwise changing the data or image. The image can be displayed as a 'skeleton' or wire frame, shaded, or made solid.
Images and input from scanners can be utilised in CAD programs, particularly where walk-through and virtual environments are created and can be modelled around images acquired in the field.

Multimedia

Multimedia is a popular buzzword in the computer industry.
Multimedia combines the media of video, audio, text, animation and graphics, frequently incorporating user interaction.
One example of this is a multimedia encyclopaedia. All the data in the encyclopaedia is stored on a CD-ROM (<u>R</u>EAD <u>O</u>NLY <u>M</u>EMORY) that can be read by the PC (CD's can be used to store audio, such as that found on music CDs , but can also be used to store the data that computers read as program files). You read the encyclopaedia by using the computer to enter the topic you are interested in. Up pops a description and picture and, possibly a button to allow you to play a relevant audio or video associated with the entry.

Video games, providing multiple pathways through a story, are another example of interactive multimedia. In business, Microsoft PowerPoint presentations, another example, have largely superseded the overhead projector and the whiteboard. Digital imaging allows you to create such presentations with ease.

Digital terminology

APERTURE PRIORITY

Desired lens opening (f-stop) is manually selected and locked in; the camera then chooses an appropriate shutter speed for proper exposure.

ARTIFACTS

Unwanted effects in the image such as blotches (from over-compression), Christmas tree lights (multi-coloured speckles from bright highlights), noise (granularity from underexposure) and other aberrations that sometimes afflict digital images.

BUFFER

Temporary electronic storage area. Several already-exposed digital images can wait in line to be processed. This speeds the interval between shots since each photo does not have to be processed before the next one can be taken

CCD
Charge-coupled device. The sensor array that makes up the imaging surface of the digital camera. The more sensors a CCD has, the higher the image resolution will be.

CMOS
Complimentary Metal Oxide Semiconductor. Used in some digital cameras instead of CCDs because they have low power requirements and are less expensive.

COMPACT FLASH
A matchbook-sized memory card used in many digital cameras today and presently capable of storing over 200MB of information.

COMPRESSION
Reducing digital camera picture file sizes in the camera after they're shot, usually according to Joint Photographic Experts Group (JPEG) specifications so more images can be stored on the memory card.

DIGITAL ZOOM
An electronic enlargement of part of the image making it appear to be closer and bigger, simulating an optical zoom lens at a telephoto setting. The image is actually cropped, resulting in loss of surrounding pixels and decreased resolution.

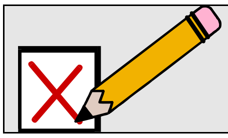
INFO-LITHIUM
A Lithium-Ion battery that indicates its remaining shooting time in minutes on the digital cameras LCD Monitor screen.

LCD MONITOR
The Liquid Crystal Display colour screen on most digital cameras usually 1.8 to 2.5 inches measured diagonally and used to check images after they are shot.

MEGAPIXEL (ALSO MP)
When the length times width of a digital camera pixel array reaches one million, its resolution is then described in MegaPixels. 1,300,000 pixels equals 1.3 MegaPixels.

NOISE:
The electronic equivalent of excessive grain in a film image.

OPTICAL ZOOM
Zoom lens which uses movement of lens elements to achieve various fields of view.



SELF ASSESSMENT
Perform the self assessment test titled 'Test 1.1'
If you answer incorrectly, review the notes and try the test again.

SET TASK

Investigate the scope of digital photography, at this point in time, in your locality.

- You might do this using any or all of the following methods:
- You might contact a photographic equipment supplier such as Kodak and ask them what they supply for digital photography, and how digital photography compares with film photography, and in what situations
- You might look at articles written about digital photography in magazines or newspapers.
- You might speak with people who work in industry (eg. Printing, publishing, graphics, advertising, or computing) and ask them what the latest is with digital photography and how it is used in their industry.
- Perhaps you will visit a shop that sells equipment used in digital photography, look at a demonstration of the equipment, and discuss its use with the salesperson
- Go onto the web and do a search for issues related to digital imaging – eg. new developments , new cameras, current applications, available software

Make notes of the things you learn and impressions you gain about digital photography.

ASSIGNMENT
Download and do the assignment called 'Lesson 1 Assignment'.