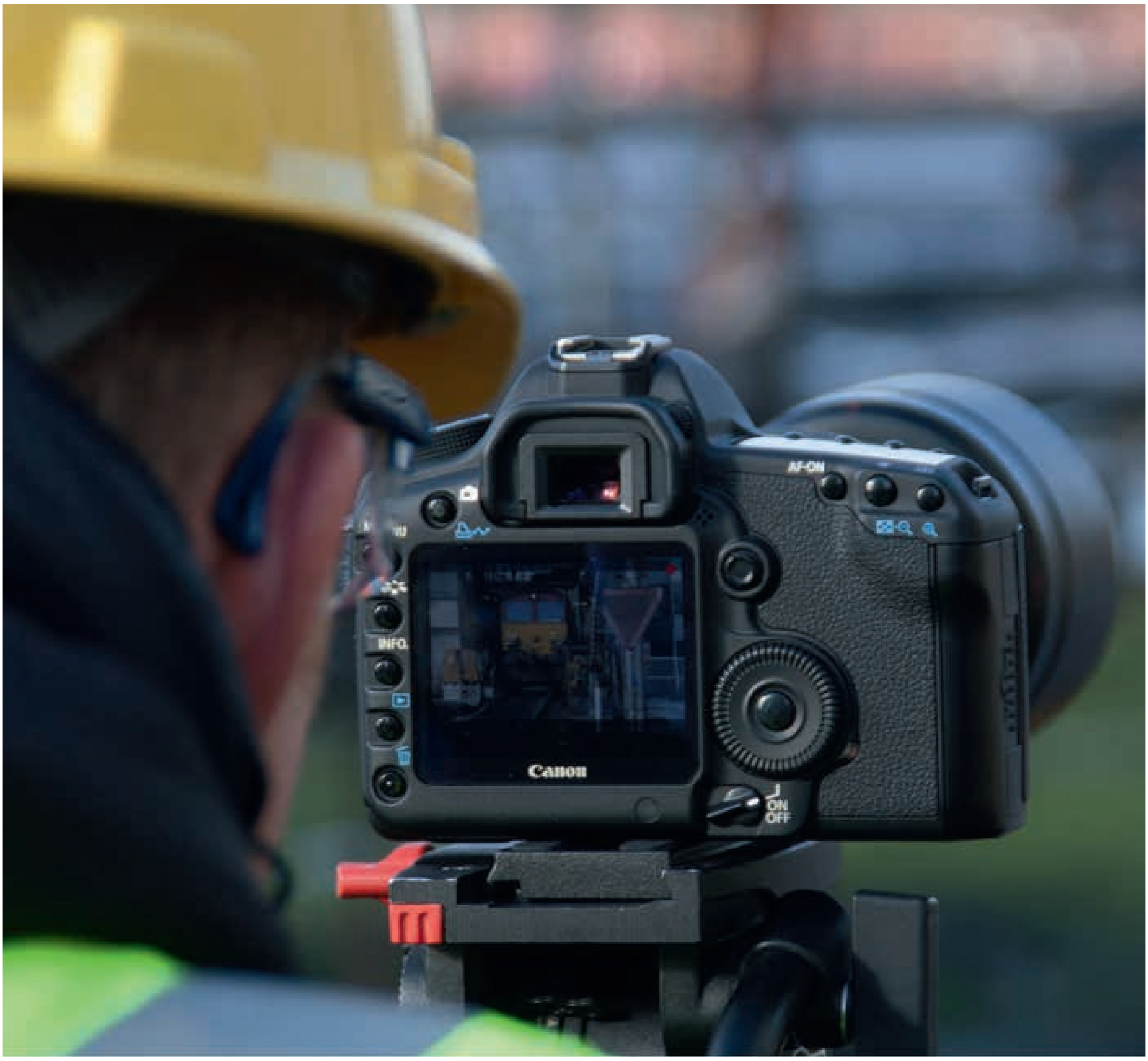
Historic England

Digital Image Capture and File Storage

Guidelines for Best Practice



Summary

The silver-based emulsion and chemical process used successfully for many years for the capture and storage of images has now largely been superseded by the introduction of digital technology. The widespread use of digital cameras among imaging professionals, archaeologists and the general public has created a vast array of digital information. If this information is to be of use now and for future generations, it requires the application of a systematic approach to how it is captured and stored.

Digital technology is still in its infancy compared with the long-established technique of using silver-based emulsions on glass plate or film to produce images that have, with suitable development and storage, proven to be stable and enduring. Some would argue that our records should still be made in this way, but film is becoming more difficult to source. In addition, film-processing laboratories are disappearing from our high streets, making local processing a thing of the past in all but the largest cities. The tide has turned in favour of digital image capture, which offers many benefits that offset its unproven longevity. However, part of the problem with the digital environment is that its boundaries and possibilities are constantly changing. This publication offers guidance on digital image capture and storage to assist those involved with the making and keeping of images of the historic environment. It does not provide definitive answers regarding the problems of taking and storing digital images but does provide an overview of current recommendations.

This guidance note has been prepared by Steve Cole and Paul Backhouse

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www.HistoricEngland.org.uk/advice/technical-advice/

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1 The Digital Image Capture Process

To enable the capture of an image, millions of pixels (short for picture element) are gathered together into an array to form an image sensor. Image sensors can be the widely used charge-coupled device (CCD), the also widely used complementary metal oxide semiconductor (CMOS) sensor, or the less widely used Foveon sensor, which is a derivative of the CMOS sensor. Pixels embed information about the scene projected onto the image sensor. Individual pixels only record how much light reaches them and not the characteristics of the light, for example its colour. In order to record colour information, each pixel needs to be shown one colour of light through a filter. Three different coloured filters are used to record and reconstruct the image: red, green and blue. These primary colours of light can be mixed in different quantities to form any other colour of light. An array with a pattern of red, green and blue (RGB) filters is therefore placed in front of the image sensor to achieve colour information.

Each pixel needs to record information about the light that reaches it through the filter. That light will be one colour but the pixel needs to record how much of that colour there is (its saturation) and how bright or dark it is (its luminance). The image sensor needs to record where the light came from by knowing the position of the pixel that recorded it. The light from each of the red, green and blue-filtered pixels is interpreted and processed to form the colour image (Foveon sensors work differently).

The quality of the image produced by any sensor is determined by the characteristics of the light present at the time of exposure, the settings of the camera, how the image is processed and treated during capture and post-capture, the quality of the camera lens, and the skill of the photographer in using the equipment. Larger image sensors with greater pixel counts will provide more information but, for the reasons just given, it is not quite as simple as more pixels means more information and therefore a better image is produced, although more pixels will often lead to better tonal (the display of different levels of brightness contained within the image) graduation and detail in the image.

1.1 Cameras

While it is possible to give a minimum resolution for the capture of digital images based on the sensor size in megapixels, it should not be regarded as a definitive measure of image quality, as so much depends on other factors. However, assuming a sensor size of not less than 10 megapixels (and preferably larger), it is possible to define the type of camera that is likely to give the most appropriate image quality by understanding the following technical characteristics.

Digital Single Lens Reflex (DSLR) camera

These cameras usually offer the best optics and versatility. They generally provide the user with a good interface and control over the image capture process, and the engineering provides a rapid response once the shutter release is activated. The range of interchangeable lenses available from the camera manufacturers and third-party producers offers great potential for good results.

Compact digital camera

Compact cameras can offer high-quality image capture but lack the versatility of DSLRs. Their small form makes them convenient to carry and easy to use. More recent models of both compact and DSLR cameras have the ability to embed global positioning system (GPS) data and applications to simplify making panoramic and moving images. The complete automation of image capture can be an additional attraction of compact cameras but this should be approached with caution. It is important to be able to turn off the full automation of any camera so that you can control it to suit the characteristics of the image you want to capture.

Rugged compact designs are available that protect the camera to some degree against the elements and accidents. Many compact and ruggedised digital cameras are used on archaeological sites.

Aperture

Aperture is the size of the opening in the in the diaphragm placed in front of the sensor to control how much light is transmitted through to the sensor. It is expressed as a ratio of the focal length of the lens in terms of f numbers or fstops. The higher value f numbers (F: 8, F: 11, F:16) are smaller openings and pass less light through to the sensor. Lower value f numbers (F:2, F:4, F:5.6) are wider openings and pass more light through to the sensor.

Shutter Speed

Shutter speed is a measurement of the amount of time that light is shown to the sensor expressed in seconds or fractions of a second. Exposure is based on the combination of both aperture and shutter speed, how much light is shown to the sensor (controlled by aperture) and how long it is shown to the sensor (controlled by shutter speed).

Other capture devices

At this point in time a suitable image is unlikely to be produced using a mobile phone or a camera within a pad or tablet computer. The cameras within these devices may have the pixel count to record sufficient information but do not offer the essential refinements that are used to control other elements of image capture, such as the choice of focal length of the lens, the aperture and

ISO

The sensitivity of a sensor, how much it reacts to light, can be increased or decreased electronically by adjustment. The sensitivity of the sensor is expressed by the use of a standard numerical setting issued by the International Standards Organisation (ISO). Low numbers 50, 100, 200 etc. are considered low sensitivities. High numbers 1000, 1600, 2500 and up are considered high sensitivity settings.

shutter speed and the ability to synchronise with off-camera lighting, including electronic flash. The images produced by these devices have a very noticeable distortion that is caused by the small lenses used. In addition, the image produced by a pad/tablet or mobile phone camera is designed to be viewed on similar devices at a resolution suitable for viewing on a screen (currently at 72 pixels per inch) and lacks the flexibility and resolution for printed reproduction (which should be 240–1,200 dots per inch) at anything but the smallest size.

Other considerations

The image sensor should not produce intrusive noise in the processed image. Noise is unwanted interference and degrading of the image caused by a number of factors during the processing of the image at the time of capture. One of the main causes of noise arises when the images are taken in low levels of light or when the sensitivity of the image sensor is increased [by increasing the International Standards Organisation (ISO) setting] to obtain images in low levels of light. Using lower ISO sensitivity settings and turning off any automatic facility on the camera to increase the sensitivity at low light levels helps reduce this problem.

Image sensors should be free of dust and dirt because such contaminants will be visible on the processed image.

The camera should be exchangeable image file format (EXIF) compliant so that appropriate metadata about how and when the image was captured will be embedded in the image. EXIF data records what type of camera is used, what the camera settings are when the image is taken, what colour space is used and how large the file is, so that the image can be described accurately to the computer program that will open it. Most modern cameras will be EXIF compliant. For time and date information to be accurate, this information has to be input when the camera is initially set up and re-entered should such information be lost for any reason. GPS data may also be stored in the EXIF data if the image capture device is able to include it during exposure or if it is added subsequently.

1.2 Lenses

Wide-angle lenses

Architectural photography, unless a detail of something larger, is about capturing and conveying to the viewer information about large things, ie elevations or interiors of buildings. A wide-angle lens can be used to take a view of a whole building elevation, most of a room or a large area of an archaeological site.

Camera lenses, particularly wide-angle lenses, have characteristics that produce a distorted image, most notably in the bending of elements of a view that should be straight. These elements then appear to be bending outwards (barrel distortion) or bending inwards (pin cushion distortion) (Figure 1). Using the correct computer program post-capture enables the removal or reduction of this unwanted distortion.

Special wide-angle lenses called perspective control lenses can be useful. These lenses are used mainly in architectural photography to correct the distortion of perspective. This distortion becomes apparent when a camera is used in a plane that is not parallel to the walls of a building, usually when a camera is tilted backwards in order to capture the uppermost parts of the building. This changes the representation of the relationship or proportion of the parts of a building, making parallel lines appear to converge. The distortion of the perspective within an image makes a building appear as if it is leaning backwards or falling over. A perspective control lens eliminates this distortion; some cameras have a perspective control adaptor that can be used with more than one lens. The perspective control lens, also known as a shift lens, has mechanical movements that allow the camera to be set in a plane parallel to a building's vertical axis; mechanical adjustments on the lens casing enable capture of the uppermost elements of a large object without the need to tilt the camera. This advantage is only gained if the camera is set up accurately so that it is vertical to the plane being focussed on usually achieved by mounting the camera on a tripod and adjusting it to be level using a spirit level.

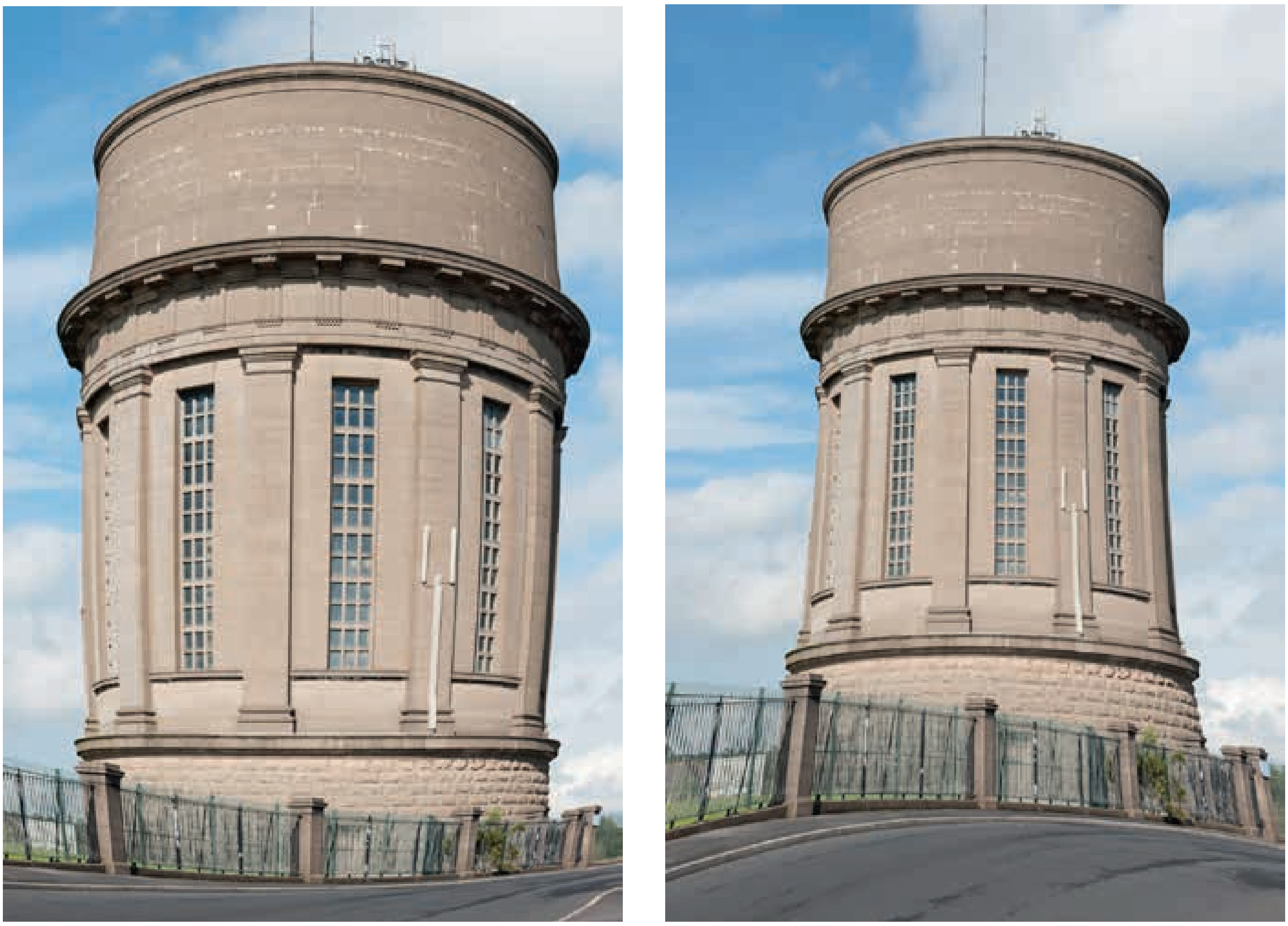

Figure 1
Examples of barrel distortion (left) and pin distortion (right)

Telephoto or long lenses

A telephoto lens is any lens with a focal length greater than the standard lens for the size of the image sensor. The focal length of the standard lens is based on the measurement across the diagonal of the sensor, typically between 50mm and 55mm on an FX-sized sensor. (Using these focal length lenses on the smaller DX sensor typically magnifies the focal length ×1.5, making them telephoto.) The effect of this greater focal length is to magnify the image and to narrow the angle of view. Telephoto or long lenses are useful for capturing distant or small subjects that cannot be approached.

Zoom lenses

It is often possible to combine wide-angle and telephoto lenses into one by using a lens of variable focal length, ie a zoom lens. Any photographic textbook will tell you that the quality of a zoom lens is always inferior to a fixed focal length lens. Modern zoom lenses do offer very acceptable quality, and the convenience of being able to vary the focal length probably outweighs the loss of quality. However, be wary of zoom lenses that offer a great range of focal lengths, as these are less likely to provide acceptable image quality throughout the range, even using modern computer programs post-capture.

Sensor

Sensor sizes are often defined in ratio to the size of a 35mm film frame. DX sensors are smaller (by various amounts) than a 35mm frame and FX sensors about the same size as a 35mm frame.

Specialist lenses

Photography at archaeological sites, or more specifically of artefacts found during excavation that can range in size from very large to very small, may require the use of a macro lens or a lens with the ability to focus very close to an object, to render the object at a suitable size and quality on the image sensor. Macro photography is defined as the reproduction of an object at its actual size or larger. This may not be necessary in many cases but the ability to focus near to an object may be advantageous.

In general, the use of good-quality lenses that are able to produce a sharp image across the image plane is essential. Do not use the digital zoom facility on a camera. Unlike a zoom lens, which actually magnifies the image using optical mechanics, a digital zoom crops into the captured image to give the illusion of zooming but the resultant file is a portion of the standard file the camera produces, leading to a reduction in image quality.

2 Image Capture Standards

2.1 File type

There are many different kinds of digital image file. Generically, they are called raster images because they are composed of a matrix of pixels. Most cameras produce a joint photographic experts group (JPEG), raw (RAW) or tagged image file format (TIFF) image file. Many cameras will produce a JPEG and RAW file at the same time. JPEG and TIFF are both open formats, which allows them to be opened and viewed by all computer operating systems through many types of imaging programs. Both also allow the embedding of EXIF and International Press and Television Council (IPTC) metadata (see below).

TIFF

The TIFF (version 6) is widely used and accepted as the standard file for archival purposes. A TIFF is described as lossless, ie it is uncompressed and stores all the information captured, hence its relatively large size in comparison with the other widely used open format, the JPEG (see below). TIFFs can be stored in 2-bit, 8-bit, 16-bit or 24-bit depth for each red, green and blue channel. The bit depth is the amount of colour information held within each pixel used to describe the colour of the light it has captured or is reproducing. One-bit images would only provide enough information to produce a black-and-white image. A 24-bit image will provide vast amounts of colour information about the subject, greater than the eye can perceive; even 8 bits per channel exceeds what the eye can see. The additional bit rates over and above 8 bits allows for greater tonal graduation and depth of colour. However, increasing the bit depth to 24 comes at the price of a greatly increased file size. Additionally, not everybody can open a 16- or 24-bit file, so for accessibility an 8-bit file has become the standard archive size. You should check with your intended archive for any specific requirements before submitting any files.

JPEG

The JPEG file is a format that compresses the image by discarding some bits of information, hence it is described as lossy, and grouping pixels together, to produce a smaller file. This is suitable when storage space is restricted or if the image is to be transmitted or viewed via electronic media such as the Internet or attached to an email. It is an excellent format for accessibility and, in spite of the loss of information caused by its compression, it provides a useful format for viewing, storing and exchanging images.

It is important that JPEG images are not over-compressed to make very small file sizes, as this degrades the quality of the image. It is equally important not to repeatedly compress JPEG images because more information is lost with each compression, resulting in a lower quality image. Merely opening and closing a JPEG image will not alter its quality in any way, it is only opening the image and saving it as a new JPEG file that will have the effect of further compressing it and degrading the quality of the image.

JPEG files are currently offered in two formats, JPEG and JPEG2000. The former is widely used by most camera manufacturers and imaging programs. The latter, which was developed in the year 2000 as an intended replacement for JPEG, has not been widely adopted in spite of it offering many advantages in terms of compression and metadata storage. Few, if any, cameras capture JPEG2000 files, and support among web browsers is limited. The use of this format as a storage medium is more common but at this time it is not recommended because of its limited support.

RAW

The other file format that demands attention is RAW. RAW files are widely used by photographers because of the flexibility offered by this format post-capture. A RAW file provides the data as captured by the camera, 'what the pixel saw', with minimal processing applied. This means the pixel data can be uploaded into a computer program for interpretation and processing. The RAW data can be manipulated in many ways to adjust colour, exposure and saturation, and even bring back detail not readily visible in shadow and highlight areas of an image. In addition, corrections can be made to compensate for defects in image quality brought about by imperfections in the lens. Many lenses for current and future cameras are/will be designed to make use of the capabilities of a computer program to correct distortions in the image produced during image capture. Like JPEGs and TIFFs, RAW files allow the embedding of EXIF and IPTC metadata.

The use of RAW images as archive files is an area of debate. Many believe that storing RAW data files is the best and most useful way to archive images because improvements in computer programs will enable more and better information to be extracted from them in the future. This view is not universal, however, because, unlike TIFFs and JPEGs, RAW files are not an open format: they can only be opened by camera-specific programs or by expensive imaging programs such as Adobe Photoshop, which will open most current RAW files but not all. Additionally, the camera manufacturers that own the RAW file format can change the way they write their RAW files over time, sometimes removing earlier RAW formats. It may not be possible to open a RAW file from 10 years ago in current RAW converter programs. This restriction is why TIFF is the file of choice for an archive.

Adobe has tried to standardise RAW file data by using a universal open file format known as digital negative (DNG). This file format contains all the data necessary (lossless) for interpretation and conversion to other file types such as TIFF or JPEG. Adobe also offers a free RAW file converter that will convert camera manufacturers' RAW file formats to the DNG format for interpretation via various computer programs. Unlike the TIFF, however, take up of DNG has not been universal.

All RAW files require additional processing in a computer program to get the best results and make the images accessible to others, which can be time consuming. If photography is not your primary occupation, taking images as JPEGs and saving them as TIFFs is a time-saving image production work-flow. However, some loss of quality will result from this practice.

2.2 Colour space

As the name suggests, colour space is the space in which computers and cameras store the information that describes the colour of an image. There are three main choices of colour space that are widely used: Adobe RGB 1998, sRGB and CMYK. The size of these spaces and therefore the colour information that can be contained within them vary.

Adobe RGB 1998

This is a large space with the capability of describing millions of colours (wide gamut, range or spectrum). It is an additive colour system that is based on the different amounts of red, green and blue (RGB) light that need to be mixed together to produce any colour. Digital cameras and computer screens are RGB devices.

sRGB

This is a smaller colour space that also describes millions of colours, although fewer than Adobe RGB 1998. This smaller gamut is primarily designed for colour monitors, domestic colour printers and the Internet, hence widely used. As with Adobe RGB, it is an additive colour system. Many cameras will only offer the sRGB colour space for image capture.

CMYK

CYMK differs from RGB colour spaces because it is based on a subtractive colour system for colour-printing inks. Printed colour images are made up from cyan (C), magenta (M), yellow (Y) and black (K) (CYMK) inks. The CMYK colour space is the smallest of the three and is designed to accommodate the colours that can be reproduced on a printed page.

As both sRGB and CMYK limit the number of colours that can be described, it is desirable to capture images in the Adobe RGB 1998 colour space if it is available on your camera. If required, conversion to either of the other colour spaces can be carried out post-capture.

White colour balance

Most digital cameras will give a good colour rendition for a wide variety of lighting conditions when the white balance setting is set to auto. Using this setting in mixed light sources will often produce the most neutral results. However, there are times when setting the white balance within a camera to a colour temperature setting will produce a more accurate and more consistent colour rendition.

Colour Temperature

Light comes in different colours which is classified by using a system developed by William Thomson Kelvin—colour temperature and is expressed in degrees Kelvin. The light that we see ranges in colour temperature from about 1700 degrees Kelvin (candle light) up to 27000 degrees Kelvin (as reflected from a blue sky).

Digital cameras have the ability to be set for different colour temperatures of light and this is done using the white balance settings. As the name suggests this is a setting to reproduce white objects white/neutral when they illuminated by light sources of different colour temperatures.

Using any of the standard, daylight, cloudy, tungsten, etc., settings will keep the same colour temperature during a series of images. This will provide consistency in colour reproduction as long as the light falling on the subject does not change substantially during the exposure period.

Tungsten/Incandescent

The camera is expecting to receive light of a colour temperature of between 3200 degrees Kelvin and 3400 degrees Kelvin which is the colour temperature that photographic tungsten light bulbs are set to operate at. Domestic incandescent light bulbs usually run at a colour temperature of less than 3200 degrees Kelvin and consequently produce images on this white balance setting with a warm (red) cast.

Using the fluorescent and tungsten settings also helps achieve colour accuracy in the captured image. Fluorescent lights in particular have a green bias that is unseen by the eye but captured by the image sensor. Fluorescent light has an extra amount of green light (peak) which the eye and brain ignores but the cell will see and reproduce images with a green cast. Using this white balance setting will activate program to remove this extra green light from your image.

2.3 Digital file and storage standards

File type

Archive image files should be uncompressed 8-bit per channel TIFF version 6 files of not less than 25 megabytes (without interpolation). The files should be flattened (ie not contain image adjustment or other working layers introduced post-capture by some image-editing computer programs).

Sharpening

Archive Images should not be sharpened. Image sharpening is offered by many image manipulation programs. This works by increasing the contrast at the junction of each pixel giving the impression of sharper edges between them and greater overall contrast. For scanned images as opposed to camera images it is usually necessary to apply a degree of sharpening as some sharpness is lost during the scanning process. Sharpening is also applied at the taking stage of images produced in camera as part of the capture process. Care should be exercised on the application of any additional image sharpening. In general, sharpening should not be applied to any archive image as sharpening is dependent on the size that the image is going to be reproduced. The future reproduction size of any archive image cannot be known.

Output sharpening can, if necessary, be applied to a copy of the original when preparing the image for reproduction once the size of reproduction is determined.

Dynamic range

Exposure should aim to produce good highlight and shadow detail. This can be difficult at many buildings and archaeological sites because the levels of light in the highlight and shadow areas of a scene can be brighter or darker than the sensor can record. The eye is able to adapt to take in these extremes but the sensor disregards excess brightness, making everything beyond its sensitivity white. At the other end of its sensitivity range, the sensor fails to register any detail in the darkest areas, making everything black. Known as the dynamic range, these extremes of luminance level can be reduced and brought within the range that the sensor can capture with the introduction of additional lighting (most practically an electronic flash or sometimes a large reflector) to illuminate the shadow areas. Highlight luminance levels can be reduced by reducing the level of light falling on the subject using a diffuser. Large and very dark or bright areas that are impractical to light can be tackled using the technique known as high dynamic range (HDR) photography. The basics of this are that the camera is placed on a tripod or other stable platform and several exposures of the scene are made using a range of shutter speeds to increase or decrease the exposure delivered to the image sensor. Changing the shutter speed is better than altering the aperture because of the effect this will have on the depth of field in the image. This series of exposures should be calculated to produce detail at both ends of the range of luminance within the scene. This series of identically composed but differently exposed images can then be imported into a computer program to combine them, thereby including information from a very wide range of luminance captured in both the highlight and shadow areas. However, the use of extreme HDR techniques can lead to very unusual looking images; these may be eye catching but are not truthful reproductions of the subject matter.

Artefacts

Files should be cleaned of all sensor dust marks visible at 100% view, ie visible on screen.

Metadata

The metadata included with a file should contain information under the following field headings.

EXIF

This provides the camera data and date and time information.

XMP and IPTC metadata

Extensible metadata platform (XMP) is the technology originally created by Adobe and later adopted as an ISO standard for the creation, processing and interchange of standard and customised information for images and other digital resources. The XMP file contains information set out in a standardised format devised by the International Press and Telecommunications Council (IPTC) within which additional information as well as the EXIF data can be added to the metadata file embedded in the image. The minimum additional data that should be added comes under the following headings:

Description: what it is; where it is (county, district, parish); who it is; why it was taken.

Author: the photographer's name.

Copyright: who owns the image and where to apply for permission to use it if copyright restrictions are to be applied.

GPS: where possible, this information should be included at the time of image capture or added post-capture. If captured by the camera, it is worth remembering that the GPS records the position of the camera not the position of the image subject. This is significant if a building is distant from the viewpoint.

Keywords: the addition of keywords will assist searches for the subject matter. Provide a list of at least three keywords that describe the subject matter captured within the image. Thesauri of controlled vocabularies are available from Historic England (see table below).

Origin: the 'Transmission Reference' box should contain the job or order number if there is one.

If your project:	Use this Historic England (HE) thesaurus:	Available from this web address:
includes specific monument types	Monument types	http://thesaurus.historicengland.org.uk/thesaurus.asp?thes_no=1&thes_name=FISH%20Thesaurus%20of%20Monument%20Types
includes specific types of evidence	Evidence	http://thesaurus.historicengland.org.uk/thesaurus.asp?thes_no=92&thes_name=FISH%20Evidence%20Thesaurus2
recovered marine evidence	Maritime craft types	http://thesaurus.historicengland.org.uk/thesaurus.asp?thes_no=143&thes_name=FISH%20Maritime%20Craft%20Types%20Thesaurus
includes a particular event or process	Event types	http://thesaurus.historicengland.org.uk/thesaurus.asp?thes_no=566&thes_name=FISH%20Event%20Types%20Thesaurus

Thesauri of controlled vocabularies available from Historic England.

The 'Instructions' box should contain additional information about the image, in particular any restrictions on image use.

General

Images should be free of any technical imperfections such as camera shake, lens flare and over- or under-exposure. All architectural images should be vertically true (achieved at the point of capture using perspective control or post-capture using computer programs) unless deliberately untrue for dramatic or artistic purposes.

Lens Flare

Lens flare can either be a reduction in the contrast and saturation of an image due to unwanted light (non image forming) hitting the lens and causing a haze across the image or alternatively a manifestation of reflections from within lens mechanism displaying as a bright line or several bright circles at far and near points within the image. These circles may sometimes reveal themselves as polygonal reflecting the shape of the iris (aperture) within the lens barrel.

2.4 Storing digital image files

As soon as possible after capturing digital images it is advisable to download the files from the camera memory card onto two or more computer hard drives. Using a card reader for this is safer than connecting the camera directly to the computer, as a direct connection to the camera requires dual functionality of the camera to read and transfer the files at the same time. Hard disk drives are susceptible to failure and valuable data should be stored on more than one drive and preferably in more than one location in case of some disaster occurring in the location where the data are normally kept. The storage drives themselves need to be regularly backed up so that any changes made to files on one drive are reflected on the other drives. Losing a day or a week of post-capture work is worth avoiding. There are some computer programs that offer the facility to download and backup at the same time, for example Adobe Lightroom and Capture One from Phase One; these save time and alleviate the need to copy the files manually.

Backup can be simplified with the use of programs purchased or downloaded free from the Internet that compare the drive being backed up with the drive or drives being backed up to, and only transfer the files that have changed.

The downloaded files should be placed into folders named by site and date. Metadata as outlined above should be added to the files.

Naming files

Digital cameras give a unique number to each image taken but this can be reset by accident and there may also be a limit after which the numbers will be reset to the first numbers used, thus risking duplication. It is good practice to apply non-camera-assigned numbers to images to avoid more than one image having the same number. Files can be renamed at the time of download or after post-capture work when the finished archive file is created.

There are many conventions for naming files. They can be named purely by number, for example 0000567, or they can be named by site and number, for example The Grange Netherhampton 0024, or perhaps with something signifying the photographer's name, for example Jones 000551. The important thing is that each image should have a unique identifier so that it can be referenced and found again when needed.

Storage of the finished and uniquely numbered files should occur on several drives and in different locations until they are deposited in an archive.

The cloud: off-site data storage

A secure, effective and expandable method of storing your image files, or any file, is to use the services of a cloud storage company. The cloud is a generic term for data storage on servers that can be accessed from a computer or other web-enabled device from anywhere in the world provided there is an Internet connection. There are many different companies to choose from, some allowing limited storage for free and others charging for the amount of storage space used. Many offer other refinements, such as computer programs to back up your files regularly or encryption to make sure your files are secure. Cloud storage can also mean you can share your data with selected parties via a secure link, although the sharing of an archive file needs careful consideration because of the possibility of loss or unwanted changes to the file. It is better to allow this kind of access to copies of files rather than originals. Other than running your own backup servers, having securely stored files in the cloud is perhaps the best way of ensuring their survival.

The disadvantages of any cloud storage is that the transmission of large quantities of data to the servers of the storage company can be time consuming if the connection to the Internet has limited bandwidth, and it can be expensive if you have a limited data contract with your Internet service provider. In addition you are handing your data to another party who may lose it or deny you access to it should a dispute arise. There are also potential copyright issues with some cloud service providers, and it is worth noting that currently government agencies and semi-public administrative bodies are not permitted to use cloud storage or cloud processing that involves servers outside the European Union (EU), which limits the services available.

How and wherever your images are stored, it is important that their accessibility is kept up to date by ensuring that the hardware, software and file types used for storage do not become redundant. This can be achieved by transferring/transforming the data during transition periods. Major changes to technology or preferences for storing files are unlikely to happen overnight; the means of updating usually exists during the transition period but becomes harder to source thereafter.

3 Where to Get Advice

For more information on the IPTC photo metadata standard, see http://www.iptc.org/cms/site/index.html?channel=CH0099

For more information on JPEG2000, see http://www.jpeg.org/jpeg2000/

For guidance on good practice regarding raster images, see the Archaeological Data Service (ADS) http://guides.archaeologydataservice.ac.uk/g2gp/RasterImg_Toc

For further explanation regarding bit depth, see http://photo.tutsplus.com/articles/post-processing-articles/bit-depth-explained-in-depth/

For imaging essentials, see http://help.adobe.com/en_US/photoshop/cs/using/WSfd1234e1c4b69f30ea53e41001031ab64-7949a.html

More information on digital technologies in education and research (UK), see http://www.jisc.ac.uk

For the use of the RAW file format in photography, see the following:

Andrews, P 2007 *The Complete Raw Workflow Guide: How to Get the Most from your RAW Images in Adobe Camera Raw, Lightroom, Photoshop, and Elements.* Focas Press , Abingdon, Oxfordshire

Evening, M 2007 *Adobe Photoshop Series for Photographers.* Focal Press, http://www.focalpress.com

Verhoeven, G J J 2010 'It's all about the format: unleashing the power of RAW aerial photography'. *International Journal of Remote Sensing* 31(8), 2009–42,

Wheatley, D 2011 'High dynamic range imaging for archaeological recording'. *Journal of Archaeological Method and Theory* 18, 256–71, http://eprints.soton.ac.uk/162413/

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