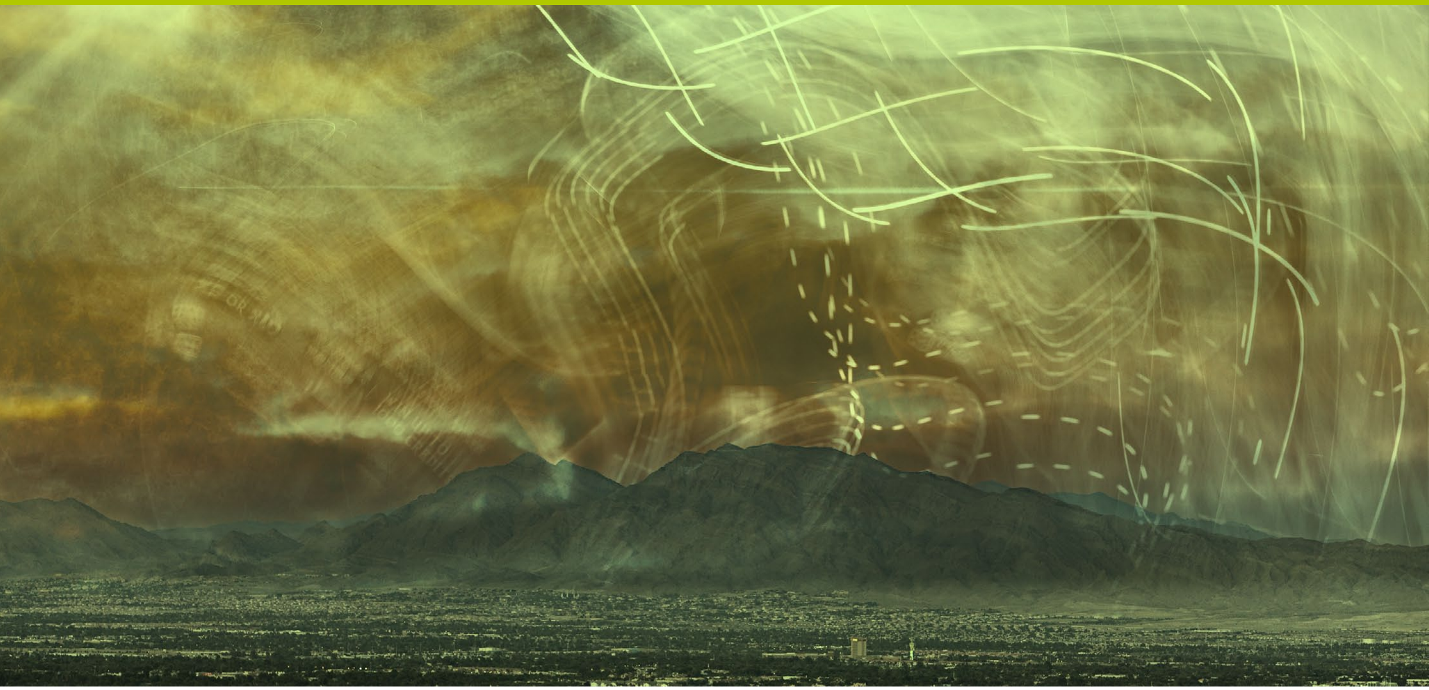


Digital Capture

A photographer I worked for once told me 'learn the tricks of the trade first, and art will find its course'. Photoshop is certainly a complex program to learn, but as you begin to understand it in depth, this acquired knowledge will give you the freedom to solve all sorts of technical challenges and the talent to express yourself photographically. This supplementary PDF is all about the process of capturing a digital image before it is brought into Photoshop and provides an updated account of the latest camera and scanning equipment. It is very relevant to whatever else you do in Photoshop, because everything begins with the creation of an image and how you capture that image matters greatly, especially from a technical standpoint. The better the image quality is to begin with, the easier it will be to manipulate later.

Digital imaging has been employed successfully by the printing industry for over twenty years now and if you are photographing anything that is destined to be printed, your images will at some stage be digitized. At what point in the production process that digitization takes place is up for grabs. Before, it was the sole responsibility of the scanner operator working for the printer or at a high-end bureau. The worldwide sales success of Photoshop tells us that the prepress scanning and image editing more commonly takes place at the desktop level and it is self-evident that the quality of your final output can only be as good as the quality of the original. Taking the digitization process out of the hands of the repro house and closer to the point of origination is quite a major task. Before, your responsibility ended with the supply of the film to the client. Issues such as image resolution and CMYK conversions were not your problem, whereas now they can be. To begin with let's look at the different ways you can scan film originals.

Scanners

A scanner reads in the analog information from an original, which can be a print, negative, transparency or artwork, and converts this into a digital format and saves it as an image file, ready for image editing. Scans can be made from all types of photographic images: transparencies, black and white negatives, color negatives or prints. Each of these media is primarily optimized for the photographic process and not for digital scanning. For example, the density range of a negative is very narrow compared to that of a transparency. This is because a negative's density range is optimized to match the sensitometric curve of printing papers. On the other hand, a negative emulsion is able to capture a wider subject brightness range. That is to say, a negative emulsion can record more subject detail in both the shadows and the highlights compared to a chrome transparency. Therefore the task of creating a standardized digital result from all these different types of sources is dependent on the quality of the scanning hardware and software used and the ability to translate different photographic media to a standard digital form. If one were to design an ideal film with CMYK print reproduction in mind, it would be a chrome transparency emulsion that had a slightly reduced density range and the ability to record natural color without oversaturating the blues and greens. In other words, what might look good on a light box is not necessarily the best type of image to use for print reproduction.

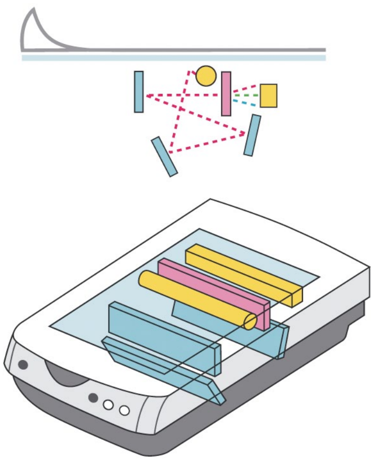


Figure 1 This diagram shows the inside of a flatbed scanner. An artificial light source illuminates the object to be scanned and the light reflected from the surface of the object bounces across a series of mirrors before arriving at the sensor.

Drum scanners

Many professionals prefer to use high-end drum scanners. The optical recording sensors and mechanics are superior, as is the software, and you should also be paying for a skilled operator who will be able to adjust the settings to get the finest digital results from your original. Smaller, desktop drum scanners are available as well and at a much more affordable price.

With a drum scanner, the image is placed around the surface of a transparent drum and to avoid Newton rings, the film original is oil mounted. A very thin layer of a specially formulated oil ensures good, even contact with the drum surface. Fastening the film originals in place is quite a delicate procedure and demands skillful handling of the film materials. For this reason, high-end drum scanners are often sited in an air-controlled room to minimize the amount of dust that might contaminate the process. The image on the drum is then rotated at high speed and a light source aligned with a photomultiplier probe travels the length of the film. This records the image color densities in very fine detail. Drum scanners offer mechanical precision and advanced features such as the ability to make allowance for microscopic undulations in the shape of the drum and thereby guarantee perfectly even focusing. Drum scanners generally use a bright point light source, so that the photomultiplier is able to record shadow detail in the densest of transparencies (this is where inferior scanners are usually lacking). Drum scanners often have a separate photomultiplier (PMT) head to record tonal values in advance of the recording RGB heads and intelligently calculate the degree of sharpening required for any given area (of pixels).

Flatbed scanners

Flatbed scanners (Figure 1) work a bit like a photocopying machine. There are professional ranges of flatbeds that are gaining popularity in bureaux due to the true repro quality output which can now be obtained and the ease of placing images flat on the platen (compared to the messiness of oil mounting on a drum). The better models are able to record all the color densities in a single pass and have a transparency hood for chrome and negative scanning. Heidelberg have a good reputation – they manufacture a broad range of flatbeds and even the cheapest model in their Linoscan range has an integrated transparency hood. Other top of the range flatbeds include: Agfa, Fuji, Microtek and Umax. Another reason why high-end flatbeds have now become more popular is largely due to the quality of the professional scanning software now bundled such as Linotype and Binuscan.

Most flatbed scanners fall into the cheap and cheerful class of equipment and although not necessarily designed for repro work, a great many photographers are finding they can nevertheless attain quite acceptable scans within the limiting confines of a cheap flatbed device. To get the best optical scanning quality from your flatbed scanner, you should position the original around the center of the platen, which is known as the 'sweet spot'.

CCD scanners

CCD (Charge Coupled Device) slide scanners are designed to scan film emulsions at high resolutions (Figure 2). Microtek, Polaroid, Nikon and Canon make good scanners that are specifically designed for scanning from 35 mm and 120 formats. It is also worth investigating the Imacon Flextight range of CCD scanners. These CCD scanners offer high optical scanning resolution and a good dynamic range. To my mind the Flextight scanners such as the Flextight 343 (35 mm and 120 films only), Flextight 646 and Flextight 848 (which I have used in my office) are the best quality CCD scanners you can buy for small and medium format professional scanning and they offer excellent value compared to a desktop drum scanner.

CCD scanners and dust removal

CCD scanners tend not to emphasize dust and scratches as much as some other scanners. The reason for this is that the light source is much softer in a CCD scanner and it is a bit like comparing a condenser with a diffuser printing enlarger. The latter has a softer light source and therefore doesn't show up quite so many marks. To combat the problem of dusty originals, the Nikon LS 2000 was the first 35 mm CCD scanner to employ Digital ICE (Image Correction and Enhancement) image processing. This is a clever filtering treatment that involves the use of the infrared portion of the data to mask out surface imperfections. The ICE processing can automatically remove dust and scratches with very little softening to the image.

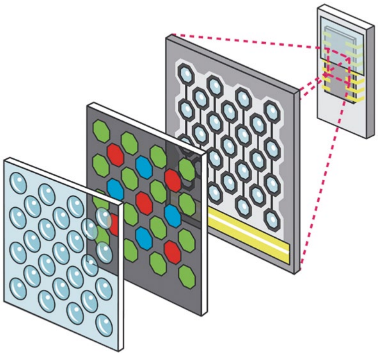


Figure 2 A diagram of a CCD sensor.

What to look for in a scanner

A flatbed is certainly the cheapest option and if you get one with a transparency hood you will be able to scan prints, negatives and transparencies. If your main goal is to scan small format films, then you will probably be better off purchasing a basic 35 mm CCD scanner. If you want to scan 120 films as well and get professional repro quality consider looking at any of the products in the aforementioned Imacon Flextight range.

The manufacturer's technical specifications can guide you to a certain extent when deciding which to buy. What follows is a guide to what those figures actually mean.

Resolution

The resolution should be specified as pixels per inch, this indicates how precisely the scanner can resolve an image. If a film scanner has a scanning resolution of 4000 ppi. This means you can scan a full-frame 35 mm image and get a 60 MB 24-bit file. Remember that it is the optical resolution that counts and not the interpolated figures. Some manufacturers claim scanning resolutions of up to 9600 ppi, when in fact the maximum optical resolution is only 600 ppi. This is a bit like claiming you possess a movie clip of your car breaking the sound barrier and you prove it by playing the movie back at fast speed.

The low-end flatbed machines begin with resolutions of 1200 × 2400 ppi, rising to 3200 × 6400 ppi for the high-end models. Flatbed resolutions are expressed by the horizontal resolution: the number of linear scanner recording sensors, and vertical resolution: the mechanical accuracy of the scanner. My advice when using a flatbed is to set the scanning resolution no higher than the 'optical' resolution and interpolate up if necessary in Photoshop. There is also a good case to be made for scanning at the maximum optical resolution and reducing the file size in Photoshop, as this can help average out and reduce some of the scanner noise pixels that are typically generated by the cheaper flatbed scanners.

DPI or PPI?

You will quite often see the resolution of a scanner expressed using DPI which stands for dots per inch. Just about every Photoshop instructor you meet will agree that this is an incorrect way to describe the resolution of a pixel generating device such as a scanner. The correct way to describe the resolution of a scanner is to use PPI, which stands for pixels per inch.

Dynamic range

A critical benchmark of scanner quality is the dynamic range, which is the range of tones that can be captured by the sensor from the maximum to the minimum intensity. Not every manufacturer will want to tell you about the dynamic range of their scanner (especially if it is not very good). A good, repro quality scanner should be able to attain a dynamic range of 3.8, but note that the dynamic range specified by some manufacturers may be a little optimistic and the quoted values could actually be influenced by scanner shadow noise.

A wide dynamic range usually means that the scanner can record detail from the brightest highlights to the darkest shadow areas. When it comes to scanning transparencies the ludicrous density ranges of modern E-6 emulsions can prove a really tough scanning challenge (Ektachrome transparencies have a typical dynamic range of 2.85–3.6). Some film photographers used to deliberately overexpose a chrome transparency film like Velvia and underprocess it. This produced weaker shadows in the chrome transparency, which was a good thing, because it meant they were easier to scan.

Scanning software

The scanner will be supplied with a software driver that controls the scanner (see Figure 3). The scanner driver may be in the form of a stand-alone application which imports the image and saves as a TIFF file ready to open in Photoshop, or it may come in the form of a plug-in or TWAIN driver designed to be accessed from within Photoshop. The installer will automatically place the necessary bits in the Plug-ins folder and the scanner will then be accessed by choosing File ⇨ Import ⇨ *name of scanner device*.

A well-designed driver should provide a clear scan preview that will help you make adjustments prior to capturing a full resolution scan. The ideal situation is one where the scanning device faithfully captures the original image with minimal tweaking required in Photoshop to achieve an accurate representation in the master file.

Multipass scanning

Some CCD scanners feature multipass modes. Since a CCD will tend to generate random noise, especially in the shadow areas, scanning the original more than once can help average out the CCD noise and produce a cleaner result, although the scanning process will take much longer.

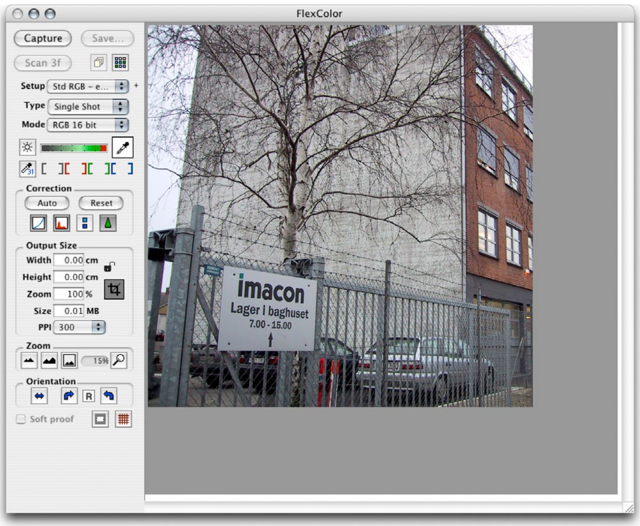


Figure 3 The Imacon FlexColor interface. Like other camera and scanner software, FlexColor allows you to configure the scanner/capture settings. Most professionals prefer to keep the image processing options neutral, leaving all the tonal correction and sharpening to be done in Photoshop.

Modern scanner software should be using ICC-based color management to take care of interpreting the color from the scan stage to when it is opened in Photoshop. Even the ‘canned’ scanner ICC profiles that might be supplied with your scanner should get you into the right ball park. For really accurate color management you may want to investigate having customized profiles created for you.

Scanning speed

If it takes a long time for the scanner to make a preview plus carry out the final scan, this could really stall your workflow. The manufacturer’s quoted scan times may be a bit on the optimistic side, so check the latest magazine reviews or the Web for comparative performance times. Do also take into account the time it takes to set up and remove the original and the additional time it might take to scan at higher resolutions or work in a multi-pass scanning mode. I have used a drum scanner in the past and am very aware of the length of time it takes to mount each transparency, peel these off the drum and then have to clean everything afterwards.

Purchasing bureau scans

Low-end scanners are fine for basic image-grabbing work such as preparing scans for a website, but professional photographers should really investigate the purchase of a repro quality scanner and if you cannot afford to do that, get a bureau to do the scanning for you. The cost may seem prohibitive, but you should be getting the best that modern digital imaging technology can offer. It amazes me that people are prepared to spend good money on professional cameras and lenses, yet use the equivalent of a cheap enlarging lens to scan their finest pictures.

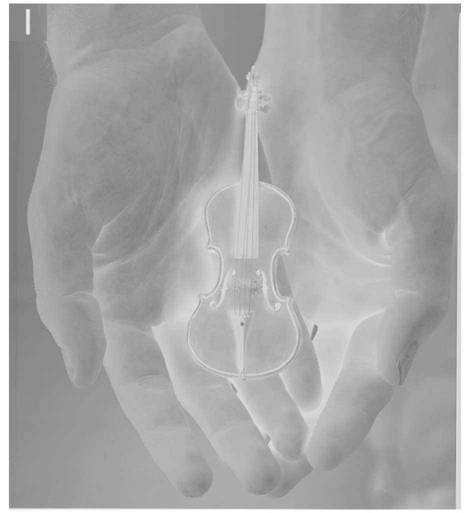
When buying bureau scans, you need to know what to ask for. Firstly, all scanners scan in RGB color, period. The person you deal with at the bureau may say 'our scanners scan in CMYK'. When what they really mean is, the scanner software automatically converts the RGB scan data to CMYK color. A bureau may normally supply scans to go direct to press, and these are converted on-the-fly to CMYK color and pre-sharpened. If you want to do any serious retouching before preparing the file to go to press you are always better off with an RGB scan that can be sharpened and converted to CMYK later. You can of course edit and composite in CMYK, so long as you don't mind not being able to access many of the plug-in filters. The pre-sharpening can be a real killer though. Make sure you ask the bureau to always turn off any sharpening. Also, insist on the scans being done in 16 bits per channel and supplied with an embedded profile. If they don't understand these basic needs you should probably shop around to find a bureau that is more used to the requirements of photographers.

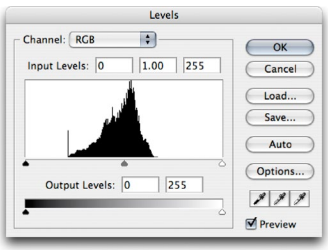
Visual assessment

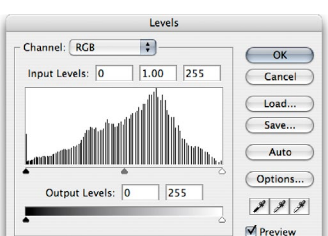
All scanners are RGB devices. CCD chips are striped with three or four colored sensors, usually with one red, two green and one blue sensor (the extra green is there to match the sensitivity of the CCD to that of the human eye). When evaluating the quality of a scan, check each individual channel but pay special attention to the blue channel because this is usually the weakest. Look for excess noise and streaking. The noise will not always be noticeable with every subject scanned, but if you had lots of underwater pictures or sky photos to process, this would soon become apparent.

Optimizing a 16-bit scanned negative

1 A scanned black and white negative will contain a lot of subtle tonal information. It is important that the scanner you use is able to accurately record these small differences in tone. A histogram display of the inverted, but otherwise unadjusted negative confirms that you will need to expand the shadow and highlight points in order to produce a full tonal range image in print.

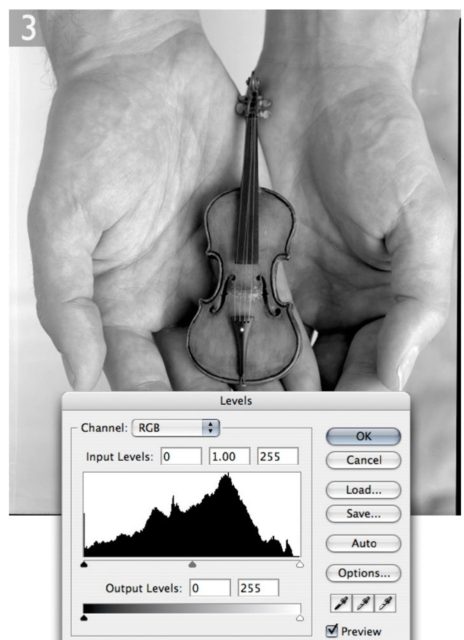






2 If you were to scan in the standard 24-bit RGB, 8 bits per channel mode and expand the shadow and highlight points, you will see how ragged the Levels histogram appears after inverting the image and adjusting the levels.

Photograph: Eric Richmond.



3 If instead you were to scan in high-bit (anything greater than 8 bits per channel scanning mode) the image will always open in 16 bits per channel in Photoshop. The histogram after adjusting the Levels will look smooth as shown here, which means we have minimized the amount of tonal information that was lost.

Digital cameras

Silver film has been with us for over 150 years. However, improvements in digital capture technology over the last 15 years mean that digital cameras have now superseded film completely.

Early digital camera systems

Eight or ten years ago the professional-level digital options were rather limited and hideously expensive. Some of the early digital cameras looked more like CCTV security cameras: a brick with a lens stuck on the front. These cameras had no viewfinder and you were forced to preview directly off the screen (this was about as useful as replacing a car's steering wheel with a mouse). Manufacturers such as Leaf, Phase One and Dicomed were among the first companies to produce digital backs that could easily fit on the back of conventional professional camera systems.

Comparing chips

With most consumer-level digital cameras you should be able to make decent inkjet prints and that is all that most users really want. The performance of some of the low-end consumer cameras is actually quite exceptional for the price you are paying, although you can't really compare the file output megapixel for megapixel with the more advanced SLR digital cameras. The spectral response in consumer cameras can be uneven, the chips may be noisy and the optics not that great, but nevertheless the results will be as good as, if not better than the mini lab prints you were used to getting from a compact film camera. Plus once you have bought the camera there is no more film and processing to pay for and all you will need is a computer to download the images to and somewhere to store them.

A number of digital cameras still use CCD sensors, which stands for Charge Coupled Device. These have been around a long time. The downside of CCDs are that they draw quite a lot of electric power. As a result of this, a CCD chip will get warm when it is in use and its charged nature can also attract dust particles. They are also prone to suffering from shadow noise, especially in the blue channel. Many professional digital camera backs use CCDs, but they also employ various strategies to keep the chip cool at all times. One of the most effective methods is the Peltier chip which is attached directly to the sensor chip and uses electronic cooling to dissipate the heat by transference and thereby significantly reduces the amount of noise generated. This is one of the reasons why the professional digital backs are so much bulkier compared to the digital SLR cameras. In the last decade or so, CMOS (complementary metal oxide semiconductor) technology has been used in still digital cameras (though not in medium format cameras). CMOS chips are cheaper to make, and more significantly, they draw about a quarter the amount of power of a CCD chip and therefore don’t suffer from the same types of noise problems. I think nearly all digital SLR cameras use CMOS chips now and some have full-frame sized sensors that correspond to the area of a conventional 35 mm film frame.

There are some other subtle variants of camera chip. The Sigma SD15 features the unique Foveon X3 CMOS chip which, unlike any of the other CCD or CMOS chips, reads full color information from every pixel sensor (or Photodetector, as Foveon prefer to call it). The camera sensor is advertised as having 14 megapixels, which is true, although it would be more accurate to say that it has 4.81 million pixel sensors per layer.

Counting the megapixels

The most important component in any digital camera system is the pixel sensor and the first thing most people look for is the megapixel size, which represents the number of pixels the chip can capture. For example, a 3000 × 2000 pixel chip can capture 6 million pixels (more commonly referred to as 6 megapixels). Be aware that very often not all of these pixels are actually used to capture an image and the megapixel size that is quoted should more precisely describe the effective number of pixels that the camera uses. Although the megapixel size can help you determine how big the image will be, it doesn’t really tell the whole story, because not all sensor chips are the same.

Digital image structure

Figure 5 illustrates how a typical single shot CCD or CMOS sensor will generate pixel color values by averaging out the color pixel readings from one red, one blue and two green pixel sensors in a 2 × 2 mosaic structure. When you take a picture with a single-shot camera, the camera software has to guess the color values for 75% of the red pixels, 75% of the blue pixels and 50% of the green pixels. This is why you sometimes get to see moiré patterns or ugly color fringing artifacts when you shoot finely detailed subjects, although this is something that's seen very rarely with the large megapixel sensors in use these days.

A 6 megapixel size RGB capture file has sufficient enough pixels to fill a magazine page. However, because of the way the sensor captures the one-shot image using a striped chip, there will be a limit as to how much you will be able to crop a picture and still enlarge it to fill the page. The Foveon X3 sensor features triple layers of red, green and blue sensors (Figure 6) where red, green and blue color information is simultaneously recorded in each single sensor position. Although the Foveon X3 sensor contains a relatively small number of pixel locations, each location actually contains three pixels, one on top of the other. The clean image quality attained using the Foveon X3 sensor is comparable with that of the advanced multishot digital camera backs. But for all that, the low pixel size capture does limit its versatility.

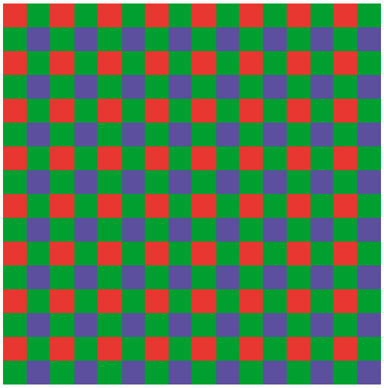


Figure 5 The sensor chip in most one shot CCD and CMOS cameras consists of a mosaic of red green and blue sensors. The RGB sensor elements use what is known as the Bayer pattern. This is a 2 × 2 matrix with one red, one blue and two green sensors. The green sensors match closest to the region of the visual spectrum that our eyes are most sensitive to.

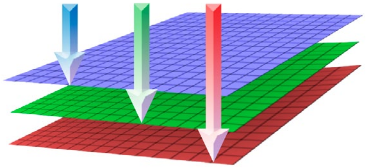


Figure 6 The Foveon X3 chip features a revolutionary new design whereby the RGB CMOS photodetectors overlap each other. Light can pass straight through the upper blue-sensitive layer of photodetectors to record information on the green and red-sensitive layers below. The result is a one shot CMOS chip less prone to moiré and edge artifacting which is able to capture image detail with a smoothness to rival the multishot mode camera backs.

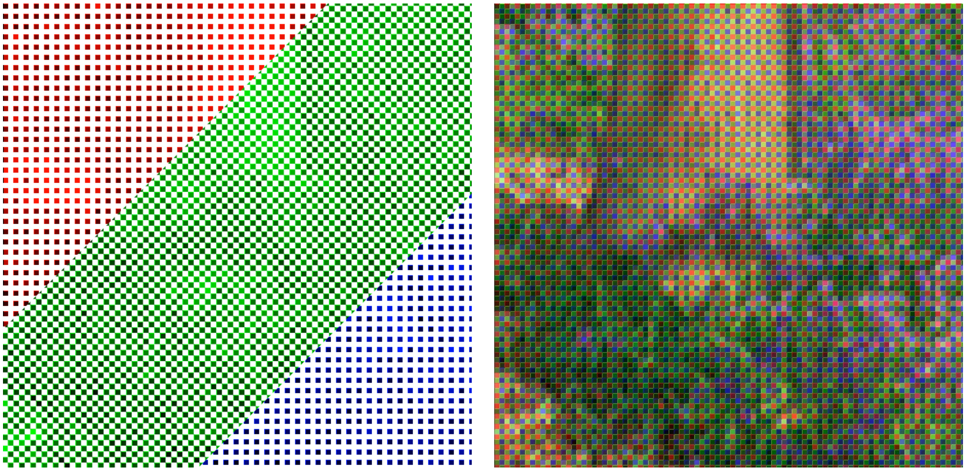


Figure 7 Let's now analyze more closely the way a one shot camera captures and interprets color using the Bayer pattern arrangement with most CCD and CMOS sensors. The sensor is simultaneously able to capture red, green and blue color. But there is only one red sensor element for every four pixel sensors. Likewise, there is only one blue sensor and there are two green sensors. The right hand picture gives some indication in close-up of how a CCD/CMOS chip captures the RGB data using this pattern of colored pixel sensors. The capture data must next be interpreted in order to produce a smoother looking result. Since only one in four pixel sensors is recording red or blue information, the values for the other three pixels (75%) has to be guessed. Although in the case of the green information, only 50% has to be guessed. Once the raw image has been processed, the underlying pattern is not seen. However, you should be aware that in the case of most one shot cameras, two thirds of the color information is guesswork. The weakness of one-shot cameras can sometimes be seen in a capture of a subject containing lots of sharp detail. Sometimes you get to see Christmas tree type artifacts, which is a result of the pixel guesswork having to fill in the gaps.

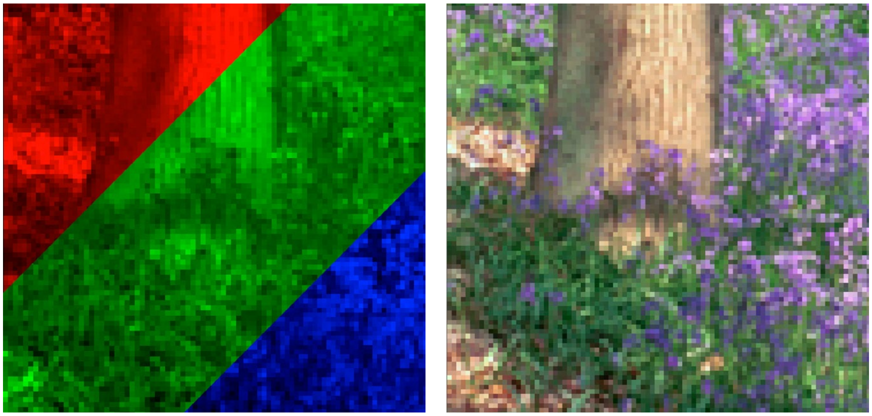


Figure 8 Multishot cameras capture sequential exposures of red, green and blue. Therefore, each resulting pixel is based on 100% color information, with no pixel guesswork. The raw data is able to produce a much smoother and cleaner image. Multishot mode is only suitable for still-life photography, although many of the professional digital camera backs are able to shoot in one-shot and multishot modes.

The sensor size

As well as the number of the pixels, you will want to consider the physical size of the camera chip. Among the cameras in the 35 mm digital SLR category, these typically vary in size from 13.8 × 20.7 mm on the Sigma SD15 to a 24 × 36 mm full-frame sensor on the high-end Canon and Nikon digital SLRs. These are said to have a lens magnification factor of ×1, meaning that the relative focal length of any system lens will be the same as when shooting with an equivalent 35 mm film camera. If the sensor is smaller than 24 × 36 mm in size, then the magnification factor will increase. Therefore, a 28 mm wide angle lens that is normally used on a 35 mm film camera will effectively behave more like a 35 mm wide angle when used on a digital SLR that has a lens magnification factor of ×1.3. Most of the cheaper, non-interchangeable lens cameras typically have a maximum wide angle that is equivalent to a 35 mm lens. But you can sometimes buy a specially designed wide angle lens adaptor to place over the camera lens to increase the wide angle view.

It is interesting to note that some of the sensors used in medium format digital camera backs are not that much larger than a full-frame 35 mm camera. Many range between 33 × 44 mm and 36 × 56 mm in size. As a consequence of this, your options are more limited for ultra wide angle photography. Hasselblad manufacture a 28 mm non-distorting lens, as do Phase One, which is fairly wide. However, if you use the Phase One 28 mm focal length lens combined with the P65 back (which features a full-frame 6 x 4.5 cm sensor) this is roughly equivalent to shooting with a 18 mm lens on a 35 mm SLR camera system.

The quest for the ideal digital camera is somewhat hampered by the goal of trying to make digital sensors fit within conventional film camera system designs. This has often been done for practical reasons, mainly because it can be more economical to adapt conventional 35 mm camera bodies to digital than to reinvent an SLR system to suit the constraints of digital capture technology. For

Megapixel limits

The first thing most people look for is a large megapixel size, which represents the number of pixels the chip can capture (see sidebar on page 16). Be aware that very often not all of these pixels are actually used to capture an image and the megapixel size that is quoted should more precisely describe the effective number of pixels that the camera uses. Although the megapixel size can help you determine how big the image will be, it doesn't really tell the whole story, because not all sensor chips are the same.

People have wondered if the megapixel sizes will keep getting bigger and bigger. At one time it was though unlikely we would see a digital SLR exceed the 14 megapixel barrier. now we see cameras that can capture 18 or 22 megapixels. More recently, Nikon announced the D800 and D800E with 38.3 megapixel, full-frame sensors. The critica issue here is how good are such sensors at capturing low light levels (very good it seems). More importantly, you will need to make sure you are using the best lens optics at the optimum lens aperture settings in order to fully appreciate the quality these extra megapixels can give you.

example, the Sigma SD15 sticks the small Foveon X3 chip inside a camera system body that was originally designed to accommodate 35 mm film. Where manufacturers have in the past tried to employ a full frame 35 mm size sensor in a 35 mm camera body this has sometimes forced the light to hit the surface of the CCD at acute angles and led to light fall-off towards the edges of the sensor. This has been due to some CCD designs having a layer of micro lenses on the chip surface. Olympus were the first to work on an answer to such problems, namely the four thirds system, which was originally based on the 4/3 aspect ratio Kodak CCD, that was smaller in size than the 35 mm frame area. By designing a new type of digital SLR with an interchangeable lens system from the ground up, Olympus were able to avoid such technical limitations and establish a new digital format which made its first appearance in the form of the Olympus E-1 camera. In recent years we have seen the emergence of many other types of 'compact digital SLR' cameras where the camera body size and custom lens systems have been specifically designed for a smaller bodied camera format.

Making every pixel count

When a film original is scanned, the scanner records the density of all the minute grain clusters that make up the photograph. As a consequence of this, the grain structure can cause the scanner to record sharp variations in pixel values from one pixel to the next. This is especially noticeable when you examine an area of pure color. Even on a low resolution scan, the pixel fluctuation caused by the grain can still be visible and with a high resolution scan you may actually see the grain clusters themselves. If you increase the size of such a file through image interpolation, the pixel fluctuations will become even more magnified. With a capture image shot on a professional digital camera capture, there is no fluctuation so it is therefore possible to interpolate a file upwards in size without generating unpleasant image artifacts. Such high-end equipment is not cheap of course, but the purity of the pixel image

Comparing film with digital

The optimum ratio of an image's pixel resolution to the printer's line screen is close to ×1.5. If you were to make an RGB scan, to fill an A4 magazine page using a 133 lpi screen, you would need a raw RGB image that measured A4 and with a pixel resolution of 200 ppi. This would then be converted to produce a CMYK file of 15.5 MB. If you allow a little extra for the bleed, you therefore need at least a 12 MB RGB file to produce an A4 output. All the professional cameras mentioned in this chapter are able to capture at least 36 MB of RGB 8 bit per channel data, which is more than enough for an A 4 output. These cameras are by no means limited to producing A4 output. The file capture is so smooth that you can realistically interpolate the files up to reproduce at bigger sizes and without incurring any perceivable loss of image quality as you would if you were to interpolate up a scanned image.

obtained from a professional digital camera sets it apart from anything else, including the best drum scans made from film. For example, the CCD chips used in the early 6 megapixel CCD camera backs would yield something like a 2,450 × 2,450 square format pixel image and the RGB composite image could therefore be anything up to 18 MB in size for a 24-bit output image. Of course, once cropped the image would have even fewer pixels. That might not sound particularly impressive by today's standards, but with high-end digital cameras we have always had to think differently about the meaning of megabyte sizes or more specifically pixel dimensions and the relationship this has with print output size. Images that have been captured with a digital camera are pure digital input, while a high-end scanned image recorded from an intermediate film image is not. If a small scanned image is blown up, the scanning artifacts will be magnified. If a good quality digital capture image is relatively free of artifacts, it is possible to enlarge the digital data by 200% or more and match the quality of a similar sized drum scan.

It's hard to take on board at first, I know. It came as a shock to me too when I was first shown a digital portrait photograph which was an A3 print blowup from a 4 MB grayscale file! These days medium format camera backs will most likely have at least 22 megapixels, so size is no longer likely to be an issue. If anything, the problem with some medium format backs is that the files they generate are so huge they cause storage problems when you can end up with so much data at the end of a busy shoot.

Chip performance

Apart from the physical size and the number of megapixels, it is important to give equal consideration to the bit depth and the dynamic range the sensor is able to record. Both these topics were covered earlier in the scanner section. It is even more important when capturing a scene digitally that the camera you use is capable of recording more than 8-bits per channel information. A higher bit depth means that more detailed tonal information is captured.

Multishot exposures

The very first multi-capture backs used grayscale CCDs to capture three sequential exposures through a rotating wheel of red, green and blue filters. As the new generation of mosaic CCD arrays were being designed it was realized that moving the CCD in one pixel increments gave similarly good results. The CCD chip is moved between three or four exposures by a piezo crystal that can be made to expand or contract in exact increments whenever a small voltage is applied. The piezo crystals shift the single grayscale chip, repositioning it by fractional amounts. In multishot mode such cameras are only suitable for shooting still-life subjects. Some multishot backs are also able to capture a single shot image keeping the chip still to create the single exposure.

The dynamic range is sometimes expressed in f-stop values and this refers to the sensor's ability to record image detail across a broad subject brightness range. So a camera with a large dynamic range will simultaneously be able to see and record detail in the darkest shadows and the brightest highlights. In light of the recent high dynamic range support now in Photoshop CS2 onwards, I have heard predictions that we may soon see cameras capable of capturing with even wider dynamic ranges.

Leaf, Sinar, Phase One, Kodak and Imacon all make single and multishot backs. At this level the photographer can expect quite superb image quality, exceeding that of film. These backs produce sharper images and offer more precise color control over a greater dynamic range which will typically be up to 10–12.5 f-stops between the shadows and highlights. To give you some idea of how impressive this is, transparency chrome film has a typical dynamic exposure range of around 4–5 f-stops and negative film about 7–8 f-stops. So, if you take into account the benefits of shooting with a high-end digital system, such as the grain-free smoothness, the absence of noise and the incredible amount of tonal information that can be captured digitally compared to film, you can see why many pros prefer to shoot digital all the time now. In nearly all these cameras, special attention has been paid to reduce the electronic noise through special cooling mechanisms. In some cases the electronics are put to sleep, awakening milliseconds before the exposure is made and then go back to sleep again.

Looking after the chip

As you might expect, the chip sensor is extremely delicate and is also the single most expensive component in a digital camera. If it becomes damaged in any way there may be no alternative but to have it replaced. Pay special attention to using the manufacturers' correct cleaning methods and take every precaution when removing dust from the sensor surface. Insurance policies against accidental damage are also available for the more expensive digital cameras – a wise step to take considering how fragile the sensor is.

SpheroCamHDR camera

So far there is only one high dynamic range camera I am aware of that is able to capture a high dynamic range subject and that is the SpheroCamHDR camera. This is admittedly a specialist camera used for capturing 360º panoramas with a single scan pass. But it does have a remarkable dynamic range of up to 26 f-stops! For more information visit the Spheron VR website: www.spheron.de.

Memory cards

Another essential consideration is the speed with which you can get your photographs from the camera to the computer. At the high end, you can expect most if not all camera backs and cameras to have FireWire or USB 2 connectivity, including nearly all the digital SLRs. Most digital cameras can store the captured images on an internal memory card such as Compact Flash, so you can transfer the data directly off the camera via a USB 2 or FireWire card reader. The memory cards supplied with consumer cameras will usually offer limited storage capacity, so it is worth buying extra cards. I recommend that the card should be able to contain up to at least 100 captures. So if the average size of raw file is, say, 20 MB, a 2 GB card should be the minimum card size to use. These days I prefer to work with larger cards and be able to store more files on a single card, but it is still better to use multiple cards to capture extra shots as this reduces your reliance on a single card, plus the very largest cards are proportionally more expensive to buy.

There are several types of cards that are in common use today. The most common are the flash memory type I and type II cards. These contain non-volatile memory that, unlike RAM memory, is able to store and hold digital data in the memory cells when not connected to a power source. Flash memory cards do wear out with use, but nevertheless they are still very durable.

Secure Digital (SD) cards are incredibly compact and have gained popularity for use in many digital SLR cameras. There is also Memory Stick, a memory storage medium for Sony devices and lastly, SmartMedia, that can be used with Fuji and Olympus cameras, which is in the process of being superseded by the new XD card standard – also for Fuji and Olympus.

Avoiding card failure

To reduce the risk of card failure or file error, don't use up the card's capacity beyond 90% each time you shoot with it and always reformat the card in the camera before you start

Choosing a memory card

It is worth doing a little research to find the right type of card for your camera. Memory cards have different read/write speed specifications. This will be specified on the card but does not necessarily provide a truly accurate indication of the actual performance. The read/write speeds are due to factors such as the speed of the device used to transfer the data to the computer and the speed the camera can write the data to the card. I highly recommend that you visit Rob Galbraith's website and check out his ongoing data sheet reports into compact flash card performance with the latest cameras: www.robgalbraith.com. You will notice that the speed test results of individual cards can be surprisingly varied from camera to camera.

shooting a new batch of pictures. Even so, flash memory cards are surprisingly robust. 'Digital Camera Shopper' magazine found that 'five memory card formats survived being boiled, trampled, washed and dunked in coffee or cola, and given to a six-year-old boy to destroy'! Even when the cards were nailed to a tree, 'data experts Ontrack Data Recovery were able to retrieve photos from the XD and Smartmedia cards'.

Camera response times

A major drawback with the lower-end cameras is the time it takes for the camera to respond after you press the shutter. You compose your shot, you press the shutter release and by the time the shutter actually fires your subject has disappeared out of the frame. This annoying delay is not something you will experience with high-end cameras, but even these can suffer from being able to capture only a limited number of shots within a given time frame. If you compare cameras carefully, you will notice that none of the high-end digital backs can really match the fast performance of the digital SLRs. News and sports photographers will probably prefer to use the Canon 1DX or Nikon D4 cameras, since priority has been given here to making these the fastest digital cameras on the market. Medium format camera backs are generally very slow. For example the latest Hasselblad H4D-60 is able to shoot at a rate of 1.4 seconds per capture. This is nowhere near as fast as a digital SLR, but still quite impressive considering the size of the capture files.

Comparing sharpness

As CCD and CMOS sensors have got to the point where they are now capturing a much greater number of pixels, there is less need for anti-aliasing filters. There was always a trade-off to be taken into account. You could remove the anti-aliasing filter and get sharper captures, or leave it in and have fewer problems with moiré. Note that the Camera Raw plug-in is able to automatically resolve some potential moiré as you import the files.

Dust removal

Camera chips generate a static charge, which attracts dust like a magnet. The chips used in compact digital cameras are completely sealed so they are not at risk. But if you use anything else, such as a digital SLR, the chip can be exposed to dust particles every time the mirror flips up. There is no getting around the fact that you have to keep a regular check on the camera chip and have to keep it clean. Instead of using an aerosol spray, use a blower brush instead to remove dust. Don't try blowing with your mouth as the air you blow will contain moisture and leave more marks on the sensor. An even safer method is to use a statically-charged nylon brush, which is the method adopted by 'Visible Dust' Sensor cleaners. You can also safely clean the sensor thoroughly using special sensor swabs and cleaning fluid. Photographic Solutions inc. make sensor swabs designed for all sizes of digital sensors, including the full-frame SLRs. A few careful swipes with a fresh swab should keep the sensor spotless. More recently, we have seen camera such as the Olympus system, and now Canon, introduce a built-in sensor cleaning mechanism, where the sensor is vibrated slightly to shake off any dust.

If you want to compare the output sharpness of different cameras, you should be aware that many cameras carry out some on-board image processing that artificially sharpens the captured image to make it look better (this applies to JPEG capture results). Some cameras can even interpolate the captured data to enlarge the central area and call this a 'digital zoom', or 'digital marketing con' as it's otherwise known. You can more easily crop the image and enlarge it in Photoshop and get better results.

Scanning backs

These are really out of use these days. Anyway, scanning backs though record a scene similar to the way a flatbed scanner reads an image placed on the glass platen. A row of light sensitive elements travel in precise steps across the image plane, recording a digital image. The digital backs are designed to work with large format 5 × 4 cameras, although the scanning area is slightly smaller than the 5 × 4 format area. Because of their design, daylight or a continuous light source must be used. HMI lighting is recommended in the studio because this produces the necessary daylight balanced output and lighting power. Some flash equipment manufacturers, like the Swiss firm Broncolor, have made HMI lighting units that are identical in design to the standard flash heads and accept all the usual Broncolor lighting adaptors and accessories. Many photographers are actually able to use standard quartz tungsten lighting, providing the camera software is able to overcome the problem of light flicker. However, the lower light levels may require a higher ISO capture setting and this can lead to increased blue shadow noise. Sometimes bright highlights and metallic surfaces will leave bright green streaks as the CCD head moves across the scan area. This is known as blooming and looks just like the effect you often saw in the early days of color television. It might have appeared cool in a TV recording of a seventies glam rock band, but it is really tricky to have to retouch out in a stills photograph. Some scanning back systems contain anti-blooming circuitry in the equipment hardware to counteract this.

Hot mirror filters

The spectral sensitivity of many CCDs matches neither the human eye nor color film and extends awkwardly into the infrared wavelengths. This is partly inherent in their design and partly due to their original development for military uses. To overcome the extreme response to the red end of the spectrum a hot mirror filter is used to reduce the infrared wavelengths reaching the CCD. In most cameras this is part of the CCD design. But some cameras have a removable filter which will allow you to shoot with the camera in infrared grayscale mode.

The exposure time depends on the size of final image output. It can take anything from under a minute for a preview scan to almost 10 minutes to record a 100 MB+ image. The latest Betterlight scanning back can scan a high-resolution image in just a few minutes, but everything has to remain perfectly still during the exposure. This limits the types of subject matter which can be photographed. You can use a scanning back on location, but sometimes you get unusual effects similar to the distortions achieved with high-speed focal plane shutters, such as in the Stephen Johnson image shown in Figure 9.

Figure 9 Photograph by Stephen Johnson. Copyright © 1994 by Stephen Johnson. All rights reserved worldwide: www.sjphoto.com. Notice the shape of the plumes of steam in this photograph are a result of this exposure being made via a scanning back system.

When digital photography was in its infancy, scanning backs were considered to be technologically superior to most of the CCD camera backs. This was mainly because they were the only devices that enabled you to capture such big file sizes. These days, you can capture a 384 MB 16-bit RGB file using a top of the range professional CCD camera back. To my mind, CCD technology now offers better technical quality and larger file sizes. Some scanning backs are still in use today, so I continue to mention them here.

Stephen Johnson

One of the first photographers to adopt digital capture was Stephen Johnson, who shoots fine-art landscape photographs, using a Betterlight scanning back attached to a 5 × 4 plate camera which he takes on location. When Stephen Johnson began testing a prototype Betterlight scanning system in January 1994, he simultaneously shot a sheet of 5 × 4 film and made a digital capture of a view overlooking San Francisco using the Betterlight. He made a high resolution scan of the film and compared it with the digital capture. He was blown away by what he saw. The detail captured by the scanning back was incredibly sharp when compared side by side with the film scan. This was the moment when Stephen Johnson declared 'Film died for me on that day in 1994.' Since then, everything he has photographed has been captured digitally (you can visit his gallery website at: www.sjphoto.com). It wasn't just the sharpness and resolution of the images that appealed. The Betterlight scanning back system is able to discern a much greater range of tonal information between light and shade than normal film ever can. The digital sensors are able to see deep into the darkest shadows and retain all the highlight detail. The color information can also be made to more accurately record the scene as it really appeared at that time of the day.

Pros and cons of going digital

A really important benefit of digital shooting is increased productivity. When a client commissions a photographer to shoot digitally, they have an opportunity to see the finished results straight away and approve the screen image after seeing corrections. The picture can be transmitted by FTP to the printer (or wherever) and the whole shoot 'signed off' the same day. Because of the capital outlay involved in the purchase and update of a digital camera system, it is not unreasonable for a photographer to charge a digital premium, in the same way as the cost of studio hire is normally charged as an expense item. Digital capture is all too often being promoted as an easy solution and unfortunately there are end clients who view the advantages of digital photography purely on the basis of cost savings: increased productivity, fast turnaround and never mind the creativity. Some clients will look for the material savings to be passed on to them regardless, but I find that all of the clients I work with are willing to accept a digital capture fee being charged on top of the day rate. The way I see it, clients are still be able to save themselves time and money on the film and processing plus further scanning costs. As more and more photographers are getting involved in the repro process at the point of origination, there is no reason why you should not consider selling and providing an extra menu of services associated with digital capture, like CMYK conversions, print proofing and image archiving.

Digital photography has become firmly established as the way of the future. But making the transformation from analog to digital can be a scary process. The photographer is rightly anxious to keep their customers happy and often compelled to invest in digital camera equipment because they fear they will otherwise lose that client. Meanwhile clients want to see better, faster and cheaper results, but they also wish to avoid the disasters brought about through digital ignorance. For photographers this is like a replay of the DTP revolution that saw a massive shake-up in the way pages were published. For newcomers, there is a steep learning curve ahead, while for experienced digital pros there is absolutely no going back.

Backup storage

If you are inclined to get carried away shooting lots of photographs, how are you going to save all the images that you capture, and archive them? I typically use hard drive media as the prime means for backing up my data. In addition to this I also use DVD media to archive my capture files. DVD disks can store around 4.2 GB of data per disc. It is possible to devise a workflow where everything that has been shot in a day can be copied across to a single DVD disk. This task is something that can be done in the background at a suitable time and does not necessitate hanging around the computer swapping a pile of DVD disks in and out of the machine. Ultimately I aim to have one copy of the raw files stored on an external backup hard drive system and further copies made on DVD backup discs.

Adobe™ Photoshop™ CS6 for Photographers

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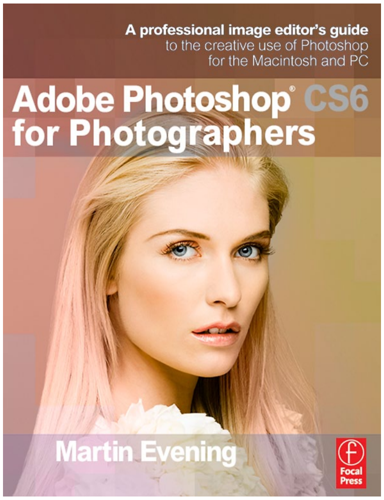

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