digital cameras

essential skills

• Understand the differences between various types of digital cameras.
• Compare specifications and isolate features important to your personal workflow.
• Appreciate the limitations of various systems and their impact on image capture and quality.
Introduction

I first encountered a DSLR when I was working in London in 1993. It was the Kodak DCS100 - the first totally portable Digital Camera System (DCS) that had been released in 1991. It had a 1.3-megapixel sensor mounted in a largely unmodified Nikon F3 SLR body that had a restricted viewfinder, no memory card (just a hard drive that used to get hot) and the image had to be downloaded via an umbilical cord to a separate digital storage unit (DSU) that had a 4-inch black and white monitor. The DSU was about the size and weight of a large camera bag that could be mounted on your belt. Having said all that I was hooked on the very first image that I captured with this beast. I shot a press image with the camera and after glancing at the monitor I realized I had the image in the bag (so to speak) with the very first shot. It felt very, very strange walking away without shooting the other 35 frames and winding off the film. Although I had seen the future - it remained just that for many years. The camera was a bit of a Frankenstein's monster (Kodak digital technology bolted into a Nikon film camera), cost the same as a new family car and the low pixel count made it easy not to invest any personal money into digital capture at that point in time.

The development of the digital SLR camera

In 1999 Nikon announced its digital independence day (independence from Kodak's branding) with the launch of its landmark camera the D1. Looking at the spec sheet of this camera in 2006 (with just 2.7 megapixels) it is hard to see what all the fuss was about. It was, however, the first digital camera that did not look or feel like a 'bitsa' (bits of this and bits of that) using an all-new camera design rather than the Nikon F4 or F5 film body. The price of the Kodak/Nikon hybrids had been enough to frighten many pro-photographers but the Nikon D1 came in at a price that made many pro-photographers start to take notice. A few pro-photographers took the plunge but unless you were shooting for newspapers, catalogs or real estate magazines the pixel count was still a major issue. The year 2000 (a new millennium), however, saw the capabilities of the D1 expanded just 8 months after its original release. The D1x now sported a sensor capable of recording nearly 6 megapixels and many photographers who could do their maths saw the significance of the D1x to their own workflow. Single page illustrations in magazines were now an affordable reality for the pro-photographer.
The hardware was still significantly more expensive than the film equivalent but when the savings on film were factored into the equation the DSLR made economic sense for many photographers. The year 2000 also saw Canon realize their independence from Kodak with the release of their built-from-the-ground-up 3-megapixel D30 using a CMOS sensor instead of the CCD technology favored by Nikon. The most notable feature about this camera was not its megapixel count, or its quality (which was pretty impressive) but its comparatively low price (US$2800 - half that of the D1x) and its user-friendly interface – a sign of things to come. Nikon and Canon - the traditional suppliers of 35mm SLRs to pro-photographers - it seemed, were set to do battle in the digital arena, just as they had in the film arena that preceded it.

The D2x would be four years in the making but during this period Canon were making some significant advances in DSLR technology that started their rise to market supremacy. In 2001 the incredibly fast EOS 1D outgunned Nikon’s D1H (more pixels and faster). In 2002 they released the very impressive 11-megapixel EOS 1Ds that set a new quality benchmark for all the other DSLR manufacturers would have to aspire to. This camera could shoot in low light at high ISO settings with minimal noise.
Choosing a digital camera

Choosing a digital camera that will meet your imaging needs (and not blow a hole in your budget) can seem as difficult and confusing as choosing a new mobile phone plan or setting your neighbor’s DVD recorder to record their favorite TV show in two days’ time. If we focus on the key differences between the digital cameras currently available the choice can be somewhat clarified, and the range of models that will fulfil your requirements can be narrowed considerably. If you need to go shopping it can be a useful exercise to create a ‘must have’ list after considering the implications of the various features that digital cameras do, or do not, offer. As the numbers of makes and models of digital cameras are immense this chapter focuses its attention on a few significant cameras (significant in their respective genres) to enable direct comparisons.

Megapixels

Top of most people’s ‘things to consider’ list is usually ‘megapixels’ - how many do I want, how many do I need? 12 or 14 megapixels is great if you like cropping your images a lot or have a constant need to cover double-page spreads in magazines at a commercial resolution or create large exhibition prints.

Many high quality 10-megapixel cameras can, however, create digital files that can be grown to meet these requirements if the need arises. If the ISO is kept low digital files from many cameras can be ‘grown’ with minimal quality loss. Try choosing the ‘Bicubic Smoother’ interpolation method in the ‘Image Size’ dialog box when increasing the pixel dimensions of an image to ensure maximum quality is achieved.
A 39-megapixel medium-format capture may sound like something everyone would want to aspire to or own (and for some commercial photographers it is the only option) but you have to weigh up the implications of capturing such large files. A 39-megapixel file will place an increased burden on the hardware and software - slowing systems considerably if they do not have the performance to cope with the heavy traffic that multiple 39-megapixel files can impose. Many photographers in this period of transition from analog to digital make the mistake of replacing like with what they perceive to be like, e.g. an analog medium-format camera such as a Hasselblad or Mamiya 645 or RZ67 with what they believe to be the equivalent digital medium-format camera. It is worth noting, however, that the quality that can be achieved with a high-end digital SLR, such as the Canon 1Ds Mark III or Nikon D3, can match the image quality of a medium-format analog camera using a fine-grain film. A digital medium-format camera, one could safely assume, is knocking on the quality door of 5 x 4 film and surpasses the quality that is available from medium-format film. The price differential between a Hasselblad medium-format digital camera and the Canon 1Ds Mark III is considerable and for many photographers the DSLR would outperform the Hasselblad in terms of speed and ease of handling.

**Enough is enough**

Now that most of the more recent prosumer fixed lens and DSLR cameras sport at least 10 megapixels the need for more is a timely question. A 10-megapixel file will easily cover a full page in your average magazine at commercial resolution. If you need more then you also need to consider whether the need for speed is greater than the need for size. Having both can be a costly venture.
Sensors

Size and aspect ratio

Does size really matter? When it comes to digital imaging it has to be said that bigger really is better. Apart from a few exceptions, the quality that can be achieved with fixed-lens prosumer digicams is limited by the size of sensor that they use. As the individual sensor sites are spread over a larger surface area the pixels tend to suffer less from noise (small white or colored speckles - see camera Raw). Sensors in the prosumer cameras tend to be small, whilst in DSLR cameras the sensor size is comparatively much larger (more than double the dimensions and quadruple the surface area). The use of small sensors in prosumer digicams usually leads to increased levels of noise when compared to the images captured with a DSLR camera at the same ISO - especially when comparisons are made at higher ISO settings. Larger sensor sites typically lead to less problems with noise. Images captured with 35mm full-frame sensors found in DSLRs such as the Canon EOS 1Ds Mark III and Nikon D3 exhibit lower noise levels than budget DSLRs that use slightly smaller sensors (such as the popular four-thirds or DX format sensors). The larger 645 sensors found in medium-format digital cameras such as the Hasselblad D2H or D3H capture images that are pretty much noise free.

Most prosumer digicams and some DSLRs currently available (Olympus and Panasonic) use sensors that have a 4:3 format or ‘aspect ratio’. A 4:3 aspect ratio means that for every unit of height, the width is one and a third times wider. This format is the same as a standard computer screen, e.g. 1024 x 769 pixels. All of the DSLRs made by Canon, Nikon and Sony have image sensors with a 3:2 aspect ratio that matches 35mm film. This is a slightly wider format than 4:3 but not as wide as a widescreen television that has a 16:9 aspect ratio. Some prosumer digicams now offer 3:2 as an alternative aspect ratio (usually cropped from the 4:3 format in camera) whilst some digicams use a CCD image sensor with a 16:9 format. Care needs to be taken when framing images for editorial work. The photographer has to be prepared to lose some of the visible image in the viewfinder if an editor wants to produce either a full-page or double-page spread from an image captured in a different aspect ratio.
Large sensors in small cameras
A couple of fixed-lens cameras have started incorporating a larger sensor to provide image quality that has typically been associated with DSLR cameras. The Sony R1 introduced the concept of using a larger sensor a few years ago and the Sigma DP1 has proved that DSLR image quality can now be achieved using a pocket sized camera.

Dynamic range
Another advantage that cameras with larger sensors enjoy over cameras with smaller sensors is the fact that larger sensors are able to record a broader dynamic range, i.e. the ability of the sensor to record information in a high contrast scene. Add a white dress, a black suit and a little sunshine and most digicams have met their match as the scene easily exceeds the subject brightness range that most digicams can handle.

The S5 Pro DSLR uses the SuperCCD SR sensor that uses two photodiodes located at each photosite. The ‘S’ pixel has normal sensitivity whilst the ‘R’ pixel is smaller and captures information beyond the highlight range of the ‘S’ pixel. The camera’s processor combines the information from the two photodiodes to create an image file with an extended dynamic range.

Using a DSLR to record the same high contrast scene has typically only been an advantage when capturing in the Raw format and the photographer extracts the additional detail using the Recovery slider in Lightroom or the Adobe Camera Raw interface (Fuji S5 excepted as it uses a specialized ‘SR’ sensor). Some manufacturers such as Sony are admirably handling the issue of high subject contrast by implementing an automatic dynamic range optimizer (D-Range Optimizer) that ensures the information from very bright highlights is preserved in an attempt to pass on the advantages of the broader dynamic range of a larger sensor to the JPEG file.
Full-frame or reduced-frame sensors for DSLR cameras

A few of the more expensive DSLR cameras are described as ‘full frame’ as the size of sensor is the same as a frame from a 35mm film camera (the rest of the DSLR cameras on the market use smaller sensors). The use of a larger sensor has a few advantages and disadvantages for potential buyers of these cameras. As the sensor of a full-frame DSLR is larger it has the potential to offer higher quality images. This is, however, dependent on the lens that is used in conjunction with this larger sensor. These full-frame DSLRs cannot use lenses designed for the DSLR cameras that use smaller sensors without issues or problems arising, e.g. the owner of a DSLR with a smaller sensor who wants to purchase a full-frame camera by the same manufacturer may not be able to use the lenses they already own on this model unless the lenses they have purchased were designed for full-frame sensors or 35mm film. Nikon owners may be able to place a Nikkor DX lens designed for a Nikon D300 on the full-frame Nikon D3 but will have to capture images at 5 megapixels instead of 12 megapixels. This is because lenses designed for reduced-frame sensors do not create an image big enough to cover the larger full-frame sensors. The full-frame lenses are more expensive to build than lenses of similar quality designed for reduced-frame sensors. If a photographer aspires to owning a professional quality DSLR that uses a full-frame sensor they need to purchase wisely.

Magnification factor

The size of the sensor has an impact on the magnification factor that a photographer will experience with the lenses they are using, e.g. a 200mm lens on a Nikon D300 magnifies the image 50% more than if the photographer uses the same lens on a full-frame Nikon D3 (a magnification factor of x1.5). Manufacturers often quote these magnification factors for assessing the equivalent focal length of lenses when used in conjunction with a camera with a reduced-frame sensor. Nikon DX is x1.5 while Olympus quote x2 for their cameras using the four-thirds system sensors. A wide-angle 24mm lens is a wide-angle 24mm lens on a camera with a full-frame sensor but becomes a not-so-wide 36mm when attached to a smaller DX sensor. This may have been a big selling point for a photographer who had not yet made the jump from film who owned a more traditional range of lenses but purchasing one of the popular ultra wide zooms designed for reduced-frame sensors gives back the angle of view that the photographer may have lost. The advantage for the owners of DSLRs with smaller sensors is that their telephoto lenses suddenly bring everything a lot closer than if they were using the same lens on a full-frame sensor.
CMOS or CCD
The type of sensor (CMOS or CCD) found in a DSLR camera has a bearing on the levels of noise present in the image. The CMOS sensor has gained a reputation for delivering images with less noise at high ISO settings (400 ISO and higher) than a CCD sensor of a comparable size. The Canon CMOS sensors found in all of their digital SLRs raised the bar in terms of acceptably high ISO speeds that can be used before the level of noise becomes intrusive and the image loses its commercial viability. A high quality CCD sensor, however, can often deliver superior performance when capturing at a low ISO setting when compared to a CMOS sensor. The presence of noise at low ISO settings, however, tends to be less obtrusive and these differences are not usually seen in standard sized prints and screen presentations.

CMOS for high ISO performance
Canon has always used CMOS sensor technology in their DSLRs while the other manufacturers have favored the CCD for their consumer DSLRs. New models by Sony and Nikon, however, are now using the CMOS sensor for increased performance at high ISO settings. Although most modern sensors are excellent, each has its own characteristics that are evident when the ISO is adjusted. Typically noise levels get worse as the ISO of the sensor is increased or during extended exposure times. The ISO of good quality CCD sensors can often be raised to 400 or 800 ISO before excessive image noise rears its ugly head. The CCD sensor, however, is no match for the performance of modern CMOS sensors at higher ISO speeds. Photographers using cameras sporting these modern CMOS sensors can often find themselves shooting at speeds of 1600 and 3200 ISO before noise becomes problematic. This high ISO performance allows the photographer to shoot color images, hand-held and in low light, without resorting to flash (something that was only recommended with fast black and white film in the days of analog photography). This can be a liberating experience for professionals used to shooting at low ISO and having to resort to fast lenses (those with maximum apertures of f/2.8 or wider) and tripods. The wide aperture pro lenses are considerably more expensive than the consumer zooms. The ability to now work in low light with an f/4 zoom lens instead of a wide aperture fixed focal length lens opens up all sorts of creative and financial possibilities in this new digital era.
**Noise - low ISO**

Although CMOS sensors are very good news at high ISO the cleanest files at 100 and 200 ISO are usually captured with cameras using a CCD sensor. The difference, however, is usually only noticeable when large prints are being made from these files or where the photographer has been making the deep shadow information lighter using a Curves or Levels adjustment. When post-production editing requires the shadows to be opened to reveal more detail, the files created by a DSLR using a high quality CCD sensor at low ISO are usually able to deliver the goods.

In comparison the deep shadows found in files captured by cameras using CMOS sensors are best left as just that - deep shadows. With such great performance at high ISO, it is somewhat disappointing to see noise still evident at just 100 or 200 ISO in the image files captured by DSLRs with CMOS sensors (even though it would take large print sizes and lightened shadow detail to reveal these differences).

**Note** > When deep shadows are lightened excessively in digital files the photographer may notice 'tonal posterization' (a visible banding of tones) is often evident - even when the files are clear of luminance noise. This weakness in shadow detail is due to the linear nature of the sensor and is a result of the decreased number of levels dedicated to the shadow tones. The only solution to this problem is to increase the exposure so that more levels are dedicated to these darker tones.