

Making the Transition from Film to Digital

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In the beginning

Photography became a reality in the 1840s. During this time, images were recorded on film that used particles of silver salts embedded in a physical substrate, such as acetate or gelatin. The grains of silver turned dark when exposed to light, and then a chemical fixer made that change more or less permanent. Cameras remained pretty much the same over the years with features such as a lens, a light-tight chamber to hold the film, and an aperture and shutter mechanism to control exposure.

But the early 1990s brought a dramatic change. Instead of using grains of silver embedded in gelatin, digital photography uses silicon to record images as numbers. Computers process the images, rather than optical enlargers and tanks of often toxic chemicals. Chemically-developed wet printing processes have given way to prints made with inkjet printers, which squirt microscopic droplets of ink onto paper to create photographs.



Snafellnesjokull Glacier Remnant. Iceland, June 2004

This image was taken with a Contax 645 camera with Kodak DCS Proback and Zeiss Sonnar 210mm F/4 lens. With appropriate processing, silicon imaging chips can capture even the extremes of tonality and shading.

While digital technology has revolutionized photography, the process of adopting these new technologies is an ongoing one. In these early years of the 21st century, both professionals and amateurs use traditional and digital photographic technologies. This coexistence of technologies is comfortable, yet contentious. Silicon is gradually replacing film, and many photographers are still uneasy with the transition. At the same time, there are passionate fine art photographers, as well as professional photographers, for whom traditional chemical-based photography is unfamiliar. Digital photography, digital image processing, and inkjet printing are the technologies they know, and no historical paradigms exist as points of reference.

But for many photographers who are versed in the ways of film, the transition is a work in process. Therefore, this article is intended for both professional as well as amateur photographers.

Making the transition

Photographers who learned their craft by using film-based cameras can make the transition to shooting digitally with ease. But to fully master this new medium, they must ascend some portion of the learning curve. For starters, photographers must understand how silicon differs from film. In some ways, silicon responds to light similarly to the way that transparency film does, but there are important differences. Likewise, the differences between so-called raw files and camera-generated JPGs and TIFFs need to be understood, as does the role of color balance settings.

The image quality equation, when seen as a function of chip size and pixel count, is complex. The size of print that can be made (and also the amount of cropping that can be done) depends on the number of pixels that an image contains. Yet smaller pixels (such as those found on digicams) are generally noisier than the larger pixels generated by Digital Single Lens Reflex (DSLR) cameras that use larger chips. This statement doesn't always hold true though, particularly when making moderate-sized (A4 or smaller) prints. Each photographer's level of critical acceptance also plays a role in deciding what's acceptable in terms of image quality.

Grain versus pixels

Individual pixels, or *photo sites*, are incredibly small. Depending on the particular chip, these pixels can be as small as 2 or 3 microns (thousandths of a millimeter) in size. A pixel this size is smaller than a single particle of silver on fine-grain film. And, unlike film grain or dye particles, which are spaced irregularly, pixels are organized in neat rows and columns.

As long as the pixels aren't too small, they can capture enough photons to produce extremely clean and noise-free images. The tiny pixels found in digicams begin to get noisy as the ISO setting increases. The signal-to-noise ratio (an image-forming signal and a nonimage forming noise) increases when the gain on the chip's analog output stage increases. Chips have an inherent sensitivity, usually its lowest published speed. You can achieve higher ISOs simply by increasing the ISO setting on your camera.

With film, you can achieve higher sensitivity and increased graininess by increasing the size of the grain particles, for example, by using a high-speed (or high ISO) film. Similarly, digital images printed from a camera that is set to a high ISO are noisier.

But, the photographer's ability to instantly change the camera's ISO setting provides digital imaging with one of its greatest advantages. A photographer can be shooting images at ISO 64 one moment and then increase the camera to ISO 400, or even higher for the next image. With film, the photographer would need two separate cameras, or at least would need to change film, to take pictures at a higher ISO.



This image was taken with a Canon 20D at ISO 1600.

Noise reduction was not applied to the image.

Current DSLR cameras are able to shoot very clean images at what used to be considered high ISO settings. Some DSLRs can shoot at ISO 800 and produce essentially noise-free images. Even ISO 1600 is very usable. For some photographers, especially those who use slower zoom lenses rather than fast primes, shooting at high ISO settings is a major advantage of DSLR cameras. On the other hand, digicams with their smaller photo sites are prone to fairly high noise at ISO settings above ISO 100. For this reason, digicams with fast zoom lenses are preferred over those with smaller, though slower, optics.

Exposure considerations

Shooting with a digital camera is similar to shooting transparency film in regards to exposure because both are direct-positive processes. As with transparency film, photographers need to avoid overexposure. When a part of an image is overexposed on reversal (transparency) film, it becomes clear, but a clear piece of film contains no useful information. Similarly, when a digital image is completely overexposed, the numeric value becomes 255 (in 8-bit mode) and the exposure contains no image data. It's simply pure white.

Shadow areas are another matter. Shadows on slide film contain information to a certain point. Of course black is black, so if there's nothing on the slide film, there's nothing to be extracted. But it is often possible to pull useful information out of the shadow areas of film.

Finding useful information in the shadow areas is also possible with digital images, but to a lesser extent. Shadow areas contain less information than midtones and highlights, and less information means a lower signal-to-noise ratio. In other words, the shadow areas can be noisier than elsewhere in the image.

To understand this comparison better, and to gain some insight into how image data is recorded as numbers, we need to look at the issue of bit depth.

This won't hurt a bit

When photographers who are new to the concepts of digital image processing encounter the phrase “bit depth,” their eyes glaze over. They know that it has something to do with image quality, and that more bits are somehow better, but that’s about all they know. Let’s look at this relatively simple, but often misunderstood topic and see if we can make sense of it.

We should get some basics out of the way first. A bit is the smallest unit of data. It can be 1 or 0, black or white, and on or off. Eight bits make up a byte. A byte (or eight bits) can therefore represent 256 different states, or 2^8 .

Most of the digital world operates with 8-bit images. Inkjet printers and monitors typically use eight bits of information to create most images that you see.

8 bits or 24 bits; which is it?

At times, conversations become confusing when we speak of an 8-bit image because we’re usually talking about an image that consists of three colors, which is also referred to as a 24-bit image (3×8).

High-bit images

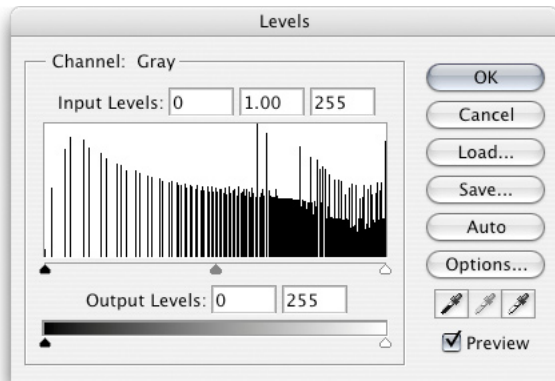
Instead of using just 8 bits to represent a single color, we can use 12 or 16 bits. A 16-bit image can handle 65,536 discrete levels of information, instead of the 256 levels that an 8-bit image can.

The increased degree of subtlety that these higher bits make available is dramatic. And, just as an 8-bit image is actually a 24-bit image when we’re dealing with color, a 16-bit image is actually called a 48-bit image (16×3) in terms of a three-color composite. A 48-bit image is capable of billions of colors.

All imaging chips in digital cameras are capable of producing 24-bit images (8×3). Some digital cameras can capture 36-bit images (12×3) capture, and some high-end scanners and cameras can even capture 48-bit images (16×3) images.

Why would you want to use a high-bit image?

The key advantage of using a high-bit image is that when you apply a Levels or Curves adjustment in Adobe® Photoshop® software, you adjust much more data than if you adjusted a low-bit image. If you change the tonal range of a high-bit file that has 65,536 levels (compared to a low-bit file with only 256 levels), by using Levels or Curves to compress or stretch the data, you have more data to work with. A low-bit image leaves gaps (the toothcomb effect), and these gaps lead to posterization. Posterization manifests itself as abrupt jumps in color or brightness level.



Histogram showing the toothcomb effect

Maximizing image information without blowing it

Assume that a digital image has a dynamic range of five stops. When you work in raw mode, which you should be, most cameras record a 12-bit image. (We say that the camera is in 16-bit mode, but the reality is that it's only recording 12 bits in a 16-bit space, which is better than 8 bits, but not as good as a real 16-bit image would be).

A 12-bit image is capable of recording 4,096 (2^{12}) discrete tonal values. You would think that each F/Stop in the five-stop range would be able to record about 850 of these steps ($4096 / 5$), but this is not the case. The first (and brightest) stop's worth of data contains 2048 of these steps—half of the available amount. Each subsequent stop contains half again of the remainder because a digital camera's imaging chip is a linear device. And because each F/Stop records half the light of the previous amount, only one-half the remaining data space is available. The following table tells the tale.

A 12 BIT RAW FILE	
Within the first F/Stop, which contains the Brightest Tones	2048 levels available
Within the second F/Stop, which contains Bright Tones	1024 levels available
Within the third F/Stop, which contains Mid-Tones	512 levels available
Within the fourth F/Stop, which contains Dark Tones	256 levels available
Within the fifth F/Stop, which contains the Darkest Tones	128 levels available

AN 8 BIT JPG FILE	
Within the first F/Stop, which contains the Brightest Tones	69 levels available
Within the second F/Stop, which contains Bright Tones	50 levels available
Within the third F/Stop, which contains Mid-Tones	37 levels available
Within the fourth F/Stop, which contains Dark Tones	27 levels available
Within the fifth F/Stop, which contains the Darkest Tones	20 levels available

This realization carries with it a number of important lessons; the most important lesson being if you do not use the right fifth or so of the histogram for recording some of your image, you waste half of the available encoding levels of your camera. But, the worst choice when we perform digital imaging is to blow out, or overexpose, the highlights—just as when we shoot slide film. Once the highlights are blown (past the right edge of the histogram), that data is lost.

Therefore, when shooting digital, bias the exposure toward the right of the histogram, or in other words, risk overexposure, to the greatest extent possible without blowing the highlights. Assuming that you're working in raw mode, it's necessary during raw conversion to then adjust the exposure for a more pleasing image. The results show that you've used more of the data space available and consequently improved the image's quality.

About raw files

When a digital camera makes an exposure, the imaging chip (whether it's CCD or CMOS) records the amount of light that has hit each pixel or photo site. This amount is recorded as a voltage level. The camera's analog-to-digital circuitry changes this analog voltage signal into a digital representation. Depending on the camera's circuitry, either 12 or 14 bits of data are recorded.

After you've taken the photograph, the outcome depends on whether you have the camera set to save images to the memory card as raw files or JPGs.

If you've saved the file in raw mode, when you subsequently load the file into a raw conversion program and then save it as a TIFF or PSD format file, it can be exported in 16-bit mode. The 12 or 14 bits recorded by the camera are then spread over the full 16-bit workspace. If you've saved the file as a JPG, the camera's software converts it to 8-bit mode, and you will only have 256 brightness levels to work with. The rest of the data captured by the imaging chip is lost forever.

Saving the raw file

If you save raw files, the camera creates a header file that contains all of the camera settings, including sharpening level, contrast and saturation settings, color temperature/white balance, and so on. (The specific settings depend on the camera.) The image isn't changed by these settings, but they are tagged onto the raw image data.

This raw image data, the information recorded on the imaging chip and the metadata (the camera settings and other technical information), is now saved to the card. Some cameras compress these files, other cameras don't. If a camera compresses a file, the compression is done losslessly so there is no deterioration of the file due to compression artifacts.

Saving the JPG file

If you choose to have the camera save the file as a JPG, there are several important points to keep in mind:

- By itself, no sensor can record color. All imaging chips, except those from Foveon (which use three separate layers of silicon: one for each primary color), use either a *Bayer Matrix* or a *Color Filter Array* to record color. These processes place red, blue, and green filters over each pixel. Half of the pixels are filtered green, and the remainder are filtered either red or blue. (The Sony F828 uses a four-color array pattern with emerald green as the fourth color.) Through a very complex algorithm, the values recorded by each pixel are compared with its neighbors, and the full color information is derived.
- Imaging chips are linear devices. This means that when twice as much light hits one pixel then another, it produces twice the voltage. But F/Stops and brightness values are rendered logarithmically. This means that an uncorrected image appears very dark, and requires that you apply a tone curve to the data to recreate a natural looking scene.
- Digital images that have not had sharpening applied to them look flat, have low contrast, and therefore appear unsharp. Photographers want their out-of-camera JPGs to look good, so the camera applies unsharp masking (USM) to the file. USM finds the edges between light and dark areas and enhances the contrast. By enhancing the contrast, halos are produced around the edges. If sharpening is set too high, these halos are visible in a final print. If they are set too low, then sharpening may be insufficient. Cameras usually have between one and three different sharpening settings that you can choose from.
- Contrast can be set on some cameras.
- Color saturation can be set on some cameras with usually two or three setting levels.
- The camera converts the file from 12- or 14-bit mode to 8-bit mode. In other words, the 4,096 to 16,384 brightness levels recorded by each pixel are reduced to 256 brightness levels.
- Compression is the final setting for a JPG file. JPG, by definition, is a lossy format. To make smaller file sizes (which is the whole point of the JPG format), some data is thrown away. If compression is set to a low level (say 2:1), then little information is lost, and it is almost impossible to see any data loss. High compression increasingly causes artifacts to become visible. Most cameras offer at least two or three compression levels.

Pros and cons

A raw file is essentially the data that the camera's chip recorded with some additional tagged information. A JPG file is a file that has had the camera apply linear conversion, matrix conversion, white balance, contrast, and saturation, and finally, some level of potentially destructive compression. A JPG file directly from the camera can, in many cases, produce very high quality prints.

Reasons to shoot JPG

There are, in fact, numerous valid reasons why a photographer would want to shoot JPG files:

- JPG files are smaller and, therefore, more of them fit on a card.
- For many programs, the image quality (for pictures of family snapshots and news images) is more than sufficient.
- Small files are more easily transmitted wirelessly and online. This ease of transmission is important to newspaper photographers.
- Many photographers don't have the time or inclination to post-process their files.
- Many cameras (especially digicams) can't quickly shoot when working in raw mode. Some lower-end models can't record raw files at all.

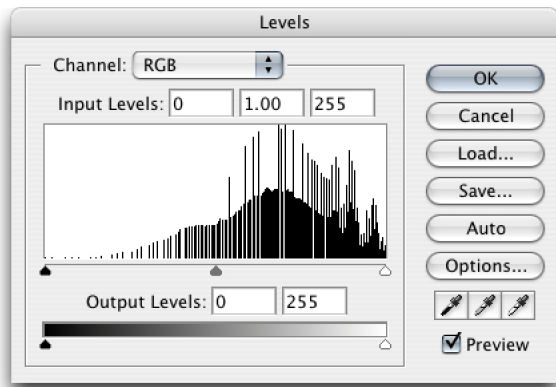
Reasons to shoot raw

There are also numerous reasons why a photographer would want to shoot raw files:

- A raw file is comparable to the latent image contained in an exposed, but undeveloped, piece of film. It holds exactly what the imaging chip recorded—nothing more, nothing less. The photographer is able to extract the maximum possible image quality at any time. A modest analogy in the traditional world of film is that you have the opportunity to use a different type of developer or development time that you think might do a better job of processing the image, if one comes along at any point in the future.
- Raw files have not had white balance set. They are tagged with the camera's setting, (either that which was manually set or changed by means of the automatic white balance), but the actual data has not been changed. This lack of white balance lets photographers set any color temperature and white balance they wish after the image is taken with no image degradation. After photographers convert the file from the linear space and they've applied a gamma curve (such as in a JPG), they can no longer properly adjust the white balance.
- File linearization and color filter array conversion is done on a computer with a fast and powerful microprocessor. Using a computer lets photographers use more sophisticated algorithms than those used in cameras that have slower and less powerful processors and less space for complex conversion programs.
- The raw file is tagged with the contrast and saturation information that the photographer set for the camera, but the actual image data has not been changed. The photographer is free to change these settings based on a per-image evaluation rather than use one or two generalized settings for all of the images taken.
- Possibly the biggest advantage of shooting raw is that photographers have 16-bit images (post raw conversion) to work with. A 16-bit file has 65,536 levels to work with compared to a JPG file's 8-bit space with just 256 brightness levels. These increases are important when editing an image, particularly if a photographer is trying to open up shadows, adjust color, or alter brightness in any significant way.

The following images show why these increases are important. Assuming for this example a five-stop dynamic range, you can see how much data is found in each of the brightness levels in the image. In other words, with a 12-bit file, the two darkest levels of the file combined have about 384 brightness levels to work with.

An 8-bit JPG file, on the other hand, has considerably less. Both the sRGB and Adobe® RGB color spaces use a Gamma 2.2 encoding. Gamma encoding reallocates encoding levels from the upper F/stops into the lower F/stops to compensate for the human eye's greater sensitivity to absolute changes in the darker tone range. Therefore an 8-bit JPG file has 47 brightness levels available in the bottom two stops. (The remaining levels out of 256 are for the F/stops beyond the five in this example).



The toothcomb effect occurs when too little data is stretched over too large an area in image processing.

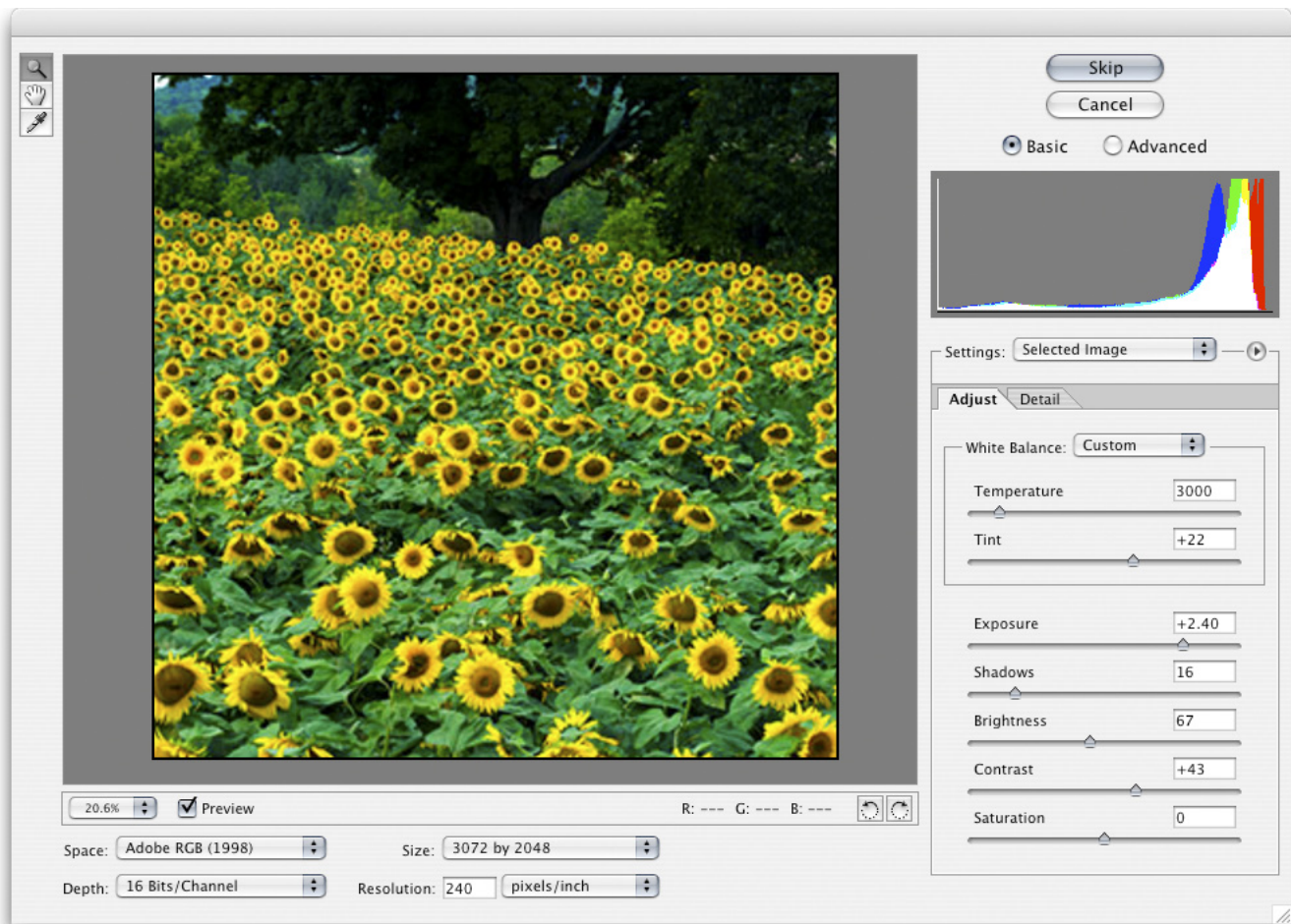
Imagine that you want to make a modest adjustment to the file in Adobe® Photoshop® software or any other image-editing application. Which would you rather have to work with: 47 levels or 384 levels? Clearly, the 8-bit file will show posterization, which is the effect that you would see. Instead of smooth transitions between brightness levels, you would see abrupt jumps.

- Because a raw file has not been processed in any way, if new and improved methods of linearizing files, applying color filter array decoding, or other image processing advances are made, photographers can return to their archived raw files and work on them afresh. A JPG file, on the other hand, can't be improved.

Raw converters

No two manufacturers encode their raw files in the same way. Indeed many camera makers change their raw format between camera models. Every manufacturer provides software for decoding and processing their camera's raw files. In most cases, this software is free and provided with the camera purchase. In other cases, the software program must be purchased separately.

One program that has great appeal, both because of its capabilities as well as the fact that it supports virtually every raw format from every manufacturer currently available, is the Camera Raw converter that is built into Adobe Photoshop CS. Adobe offers updates for the converter as new camera models are released.



The Adobe Camera Raw plug-in dialog in Basic mode.

Every digital camera is always shooting in raw mode. But, if you choose to save the file as a JPG, you are committing to the raw conversion program that is built into the camera. If you let the file be saved in raw format though, you have the opportunity to do the conversion with a more sophisticated program, and you'll have the opportunity to perform the conversion again and again if there are any improvements in future. The decision is—do you want to perform the raw file conversion in the camera, or later on your computer?

With a JPG file, you are largely committing yourself at the time of exposure to several of the most important aspects of image quality, namely white balance, overall contrast, and color saturation. With a raw file, you are free to make decisions about these settings at your leisure.

Because JPG files require little or no additional processing when you make adjustments in post-processing, you must keep these adjustments within a limited range, or else you will see processing artifacts. For some photographers the ease and speed of use is a benefit, for others not. Anyone looking for the best-possible image quality will want to shoot in raw mode whenever possible.

Some cameras can simultaneously save both raw and JPG files, and for many photographers, this is an ideal solution. This way, the camera provides a ready-to-use image for most applications, and a raw file for more comprehensive processing. The only downside to this double format is the extra space that it requires on memory cards.

Some photographers complain that raw files are too large, and that they take up too much space. With memory card, hard disk, and DVD-R disks at all-time low prices, the cost for storage is relatively small. Keeping track of all your files, on the other hand, requires good backup and archiving procedures, and record keeping, but these are subjects for another article.

One exciting development is Adobe's introduction of a new open standard called *Digital Negative* (DNG). DNG will let all camera manufacturers, as well as publishers of raw conversion software, to (hopefully) adopt this format and permit photographers to have unfettered access to the data within their raw files, both now and far into the future.

Reading histograms

Possibly the most useful tool available in digital photography is the histogram, which is also the least understood. Virtually every digital camera, from the simplest point-and-shoot camera to the most sophisticated DSLR, can display a histogram directly, or more typically, can superimpose a histogram upon the image just taken. On most cameras though, the histogram display takes place on the rear LCD (Liquid Crystal Display) screen. Photographers can program most cameras to display a histogram both on the image that is displayed immediately after a shot is taken or later when they are reviewing the frames.



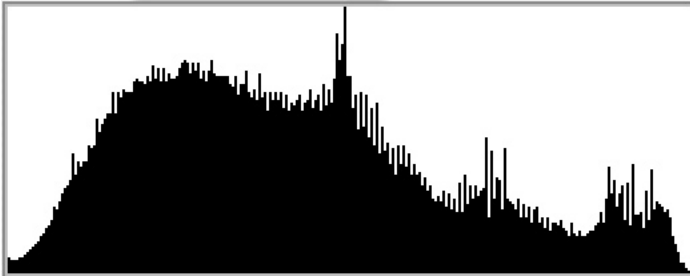
In Bloom. Costa Rica, February 2003

The 21st century light meter

A light meter reading tells you the exposure that will render a standard 18% gray reference card as a midtone. This reading may have been made because the camera read a variety of areas in the scene and averaged them out, or because you read the highlights, the shadows, and some other areas of the scene, and then you decided that a particular setting would yield the best compromise exposure for that scene.

This setting, like every other setting that you or your automated camera makes, is a compromise. In most real world situations, there is no such thing as an ideal or perfect exposure. There is simply one exposure that places the tonal values found in the scene most appropriately within the capability range of the camera's imaging chip. And "most appropriately" means that the mid-tones found in the image fall roughly halfway between the darkest and the brightest values.

But with a histogram, the guesswork is essentially over. The histogram shows a graph of the distribution of tonal values in the photograph you took. Bright areas are to the right of the graph, and dark areas are to the left. The height of the bars in the graph shows the relative amounts of each brightness value found in the image.



Histogram of the Costa Rica picture, shown previously.

This histogram of the previous photograph taken in Costa Rica with a Canon 1Ds shows an almost perfect distribution of tones covering an estimated four-stop dynamic range—from deep shadows on the left to just short of bright highlights on the right. This distribution fits comfortably within the approximately five-stop dynamic range capability of most digital imaging chips.

Inherently, there's no such thing as a good or a bad histogram. For example, if the graph is bunched on the left of the scale, then the image appears very dark (low key), and if the majority of the graph is on the right, then the image appears very light (high key). Either of these appearances may be the effect that the photographer wants. If not, the histogram provides almost instant feedback, which the photographer can use to adjust the exposure accordingly. Histograms greatly decrease the need for bracketing exposures.

Proper interpretation can lead to technically better photographs. This fact is most apparent when it comes to avoiding overexposure. By ensuring that the histogram does not show any (or at least very little) of the graph against the right side, you can avoid an inadvertent overexposure.

About color balance

Film-based color photographers know that they need to purchase and use film with the correct color balance, depending on the lighting conditions they encounter. When shooting under tungsten light, for example, photographers need special film so that images don't turn out too warm. And similarly, if such film is used accidentally outdoors, images appear very blue.

Exacting photographers are used to carrying a range of color correcting (CC) filters, and even a color temperature meter, so that they can make the color balance of their photographs highly accurate. After an image is recorded on the wrong type of film, or with a color balance that is too far from what the film was designed for, it is extremely difficult to correct the image, if at all.

But, using filters and meters isn't necessary when shooting with a digital camera. All digital cameras include a range of color balance settings as well as an automatic setting. If photographers shoot JPGs, then it is important that they set the correct white balance for a particular scene, or that they use the automatic setting. As with film, if the actual color temperature is too far off from the setting, poor color quality results.

But, as discussed earlier, when photographers record images in raw mode, the color balance setting isn't permanently locked into the files; it is only metadata that is associated with the file. When photographers load their files into a raw conversion program, such as Adobe Camera Raw, color balance settings are assigned to the images, but photographers can change the settings to whatever they want without any negative effect on the files. For this reason, most photographers leave their cameras set to automatic white balance when shooting in raw mode.

Noise reduction

Digital files shot at any given camera's native ISO (usually its lowest speed) are typically noise free. Indeed this benefit is one of the great attractions of digital compared to film. But all digi-cams, and most DSLR cameras, when pushed to higher ISO ratings tend to get noisy. Photographers can deal with this noise in a couple of ways. One of the easiest ways to deal with noise is to use the Luminance Smoothing and Color Noise Reduction sliders found in Camera Raw.

These settings do a fine job on modest amounts of color noise. But to really do the job, and for when the noise is quite noticeable, photographers may need a dedicated noise reduction program. There are several good choices available, but one that is both powerful and easy to use is Noise Ninja from PictureCode, which is available for both Windows-based computers and Macs®. Noise Ninja analyzes a wide range of colors and tones within the image that is being processed, and does a very fine job of reducing noise. Photographers can also use this program to create a series of profiles for any camera at any ISO setting, and then apply these profiles to any given image for a quicker workflow.

Sharpening

The terms sharpening and unsharp masking are unfortunate historical holdovers because the process of digital sharpening has nothing to do with sharpness, but rather with acutance, or edge differentiation. Acutance isn't about resolving detail or resolution; it's about the transition between edges, or in other words, an edge changing from one brightness level to another. Acutance is what sharpening is all about in digital parlance. Scanning, as well as digital capture, softens acutance, and so photographers apply the unsharp masking process to increase edge sharpness to the level it should be.

Unsharp masking does the job, but it is a bit of a blunt tool. Over the past couple of years, some specialized programs have been developed that have dramatically improved the art of sharpening. One such program is Photokit Sharpener from Pixel Genius. This program lets photographers apply sharpening with great finesse and in the most appropriate manner for each particular image's eventual final use.

It's in the cards

The thought of never having to buy a roll of film again, never having to pay the expense of processing it, or never having to experience the hassles of running to and from the photo lab are a few of the welcome advantages of shooting digitally. But images need to be recorded on some type of medium. Another aspect of working with the digital medium is that photographers must buy the correct memory cards.

There are several different physical sizes and formats that memory cards come in. Most professional-grade cameras take CompactFlash (CF) cards, and some cameras also take the newer XD format cards. CF cards are available as both solid-state memory and as miniature hard disks called *Microdrives* by Hitachi, which purchased IBM's hard disk business a couple of years ago.

Microdrives are surprisingly robust and reasonably fast. Solid-state cards can be faster and are somewhat more rugged, but unless you're in the habit of mistreating your camera and cards, either technology does the job. Solid-state cards come with different speed ratings and come in a wide variety of sizes, though multi-gigabyte cards can be quite expensive.

XD cards are quite a bit smaller. Some professional-level cameras use XD cards as a secondary storage medium, though several high-end, consumer-level cameras use them as well. There are also other card sizes, but most advanced digital cameras use CF or XD cards. In the end, you must choose a card based on the format that your particular camera uses. Because cards are a long-term investment (they are erased and reused once the images have been transferred to a computer), it makes sense to buy the biggest and fastest cards that you need and can afford. Having enough cards on hand to cover a full day's shooting is also a good idea because it means not having to bring a laptop computer or another backup device.

A matter of black and white

Though shooting in color dominates photography, many professional photographers, fine art photographers, and amateurs value the look of black and white images. But, black and white digital cameras do not exist, even though, ironically, digital imaging chips are monochromatic devices and require the use of special filter arrays over each pixel to create the illusion of color.

But rather than being an impediment to working in black and white, the fact that digital cameras shoot in color can be seen as a benefit. In post processing, photographers can convert the image to monochrome with almost any balance they want between the black and white tones. By using the Channel Mixer tool in Photoshop CS, photographers can convert images to monochrome by using any combination of the red, green, or blue channels. Photographers can effectively produce images that are the equivalent of those that were shot through any type of standard filter. The only difference is that photographers perform this conversion on a desktop computer rather than on location. So, for example, if an orange or red filter would have been useful to darken the sky or a green filter to lighten foliage, photographers can make this conversion on-screen at any time after the image is taken. Additionally, the raw file can be revisited to change the desired effect at any time.

Conclusion

Digital photography isn't the future any more. Rather, it is the current status of photography, encompassing the needs of snapshotters, ardent amateurs, and professionals alike. Digital photography has better image quality than film, convenience is certainly greater, and after the higher initial capital cost is digested, photography becomes a much less expensive hobby or profession than it ever was in the past.

Digital photography has also freed photographers from the dark and sometimes toxic confines of the chemical darkroom. Anyone with a computer and an inkjet printer can now produce very high-quality prints from their desktop computer. The Internet has made the distribution and sharing of photographs ubiquitous, from proud parents sharing their family photographs with grandparents to professionals working on location sending in images to their editors by modem. Shooting digitally has sped up all of these processes. Families no longer wait from one Christmas to another to get their film processed, and Olympic performances are on layout editors' desks minutes after they're taken. And for the fine art and creative photographer, image quality is now better than ever.

The days of film's dominance are now coming to an end. But though our means have changed, in the end, photography itself is more about photographers and their gift for seeing and recording the world than the tools that they happen to use. But better tools only advance the craft side of photography, and you can be sure to look forward to further improvements.



Michael Reichmann

Michael Reichmann has been passionately involved with photography as a working professional, as well as a fine-art photographer, for nearly 40 years. He began his career as a photojournalist and also worked as a still photographer in the motion picture and television industry. Experience in photographic retailing, as well as several years as a product manager for a major equipment manufacturer, has provided a broad industry background. His fine-art photography is in collections worldwide and is featured in frequent gallery exhibitions.

In 1997, Michael founded *The Luminous Landscape* (www.luminous-landscape.com), a website devoted to photographic education. Michael is also publisher of *The Luminous Landscape Video Journal*, a quarterly DVD-video based magazine devoted to the art and technique of photography.

Michael is a Contributing Editor to *Photo Techniques* magazine and also conducts regular field workshops and seminars in countries around the world.

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Printed in the USA. 10/04