

An Extension to  
PhotoCourse Digital Photography Textbooks

# Digital Photography Workflow



DENNIS P. CURTIN

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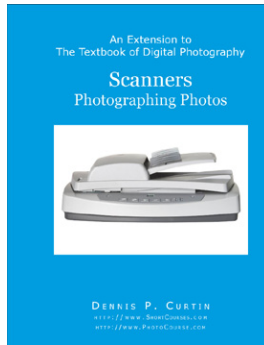
# Digital Workflow



*A snow fence lines up almost perfectly with the horizon at the Washington Monument in Washington, D.C.*

Capturing a digital photograph is just one step in a multi-step process called the *digital workflow*. Every photographer personalizes their workflow to some extent, but all include checking equipment before starting out, and the post-capture steps of transferring pictures from the camera; reviewing, organizing, and ranking the images; then adjusting, sharing and archiving them. Many of the steps in this workflow have traditionally been performed using a variety of applications including those that do image management, RAW image conversion, and photo-editing. However, truly innovative applications including Apple's Aperture and Adobe's Lightroom are reshaping the playing field. These programs integrate into a single application almost all of the steps in the digital workflow so post capture digital photography is easier, faster, and more efficient. These programs also make working with RAW files as easy as working with JPEGs so there's no reason not to use this high-quality image format. In this chapter we'll explore the steps in the digital workflow from getting ready through to organizing and editing images on your computer. The emphasis is on Adobe's Lightroom, mainly because it runs on both Macs and PCs. Apple's Aperture is a highly regarded program and shares many of the same goals and features.

## DIGITAL WORKFLOW—AN OVERVIEW



PDF

Click for a PDF extension on scanning images into a digital format.

### PHOTO-EDITING

There are now two kinds of photo editors:

- Pixel editing software adjusts images at the pixel level. In so doing it changes the original data and changes can't be undone later.
- Parametric image editing software does not alter pixels. Instead it records changes as sets of instructions or parameters. Software that adjusts images in this way such as Lightroom, Adobe Camera Raw (ACR), Aperture, Bibble, and Capture One—allow you to undo any and all changes at any point.



Many Web sites let you design your own photo book and have it printed and bound in portrait or landscape mode.

If you have ever performed the same task over and over again, the chances are that you developed a routine, a series of steps that eliminated variations and problems from the process. In digital photography we call this routine the *workflow*. Creativity is confined to the capture and editing steps in a routine that is otherwise highly structured. Although each photographer personalizes their workflow to meet their own needs, all include some variation of the following steps—each of which can be broken down farther into a number of substeps. The exciting thing about Aperture and Lightroom is that they handle all of these steps, providing an end-to-end workflow solution.

### STEP 1. CAPTURING PHOTOGRAPHS

When you pick up your camera at the start of a session, the first workflow-related steps include checking that the lens is clean, the battery is charged, the memory card is in the camera and has enough storage capacity for the number of photos you plan to shoot, and all settings are the way you want them.

### STEP 2. STORING & ORGANIZING PHOTOGRAPHS

After capturing images, you transfer them to a computer for more permanent storage. As you do so, you need to transfer and store them in an organized manner so you can quickly find images later. The latest image management programs provide a number of tools that make this easier such as the ability to rank images, add keywords, and sort images by a number of criteria.

### STEP 3. EDITING PHOTOGRAPHS

With photos in a digital format, you can edit and manipulate them with a photo-editing program. In some cases you improve an image by eliminating or reducing its flaws, adjusting its exposure, colors and sharpness. In other cases, you adjust an image for a specific purpose, perhaps to make it smaller for e-mailing or posting on a Web site. The latest programs such as Apple's Aperture and Adobe's Lightroom make improving your images much easier and all changes are *non-destructive* so they can be undone at any time.

### STEP 4. SHARING PHOTOGRAPHS

Once an image is the way you want it, you'll find that there are many ways to display and share it. These include printing it (on almost anything from fine art paper to coffee mugs), inserting it into a document, posting it on a photo sharing Web site or a blog, e-mailing it, including it in a printed book or a slide show that plays on a computer or TV, or displaying it in a digital photo frame.

### STEP 5. ARCHIVING AND BACKING UP PHOTOGRAPHS

When you have photos for which you have no immediate use but want to save, or important photos you don't want to lose, you can copy them to optical discs (CD/DVD/Blu-Ray) or even another hard disk. If you then delete the images from the hard disk on your main system the remaining files are referred to as *archive files*. If you also keep them on the main system the duplicates are called *back up copies*. When you back up files, make sure you store them so the same accident can't happen to both the original and backup. Some events to avoid are broken water pipes, fires, floods and earthquakes.

## IMAGE FORMATS

### Animation

*Click to explore the differences between JPEG and RAW formats.*

### STORAGE CAPACITY

The number of new images you can store at the current settings is usually displayed on the camera's monitor or control panel.

### RAW FORMATS

There are so many RAW file formats in the marketplace that it's becoming a major problem. Here are just some of the RAW filename extensions that indicate different and incompatible formats.

- Nikon—NEF
- Olympus—ORF
- Fuji—RAF
- Sony—SRF
- Canon—CR2
- Pentax—PEF
- Generic—DNG

One of the most important workflow related decisions you make when capturing images is which image file format to use. All cameras let you use the popular JPEG format but many also let you use a higher-quality RAW format. A very few cameras also offer alternate formats including DNG and TIFF.

### FORMATS

When offered a choice of image formats to use, here are some things that might help you select the best one for your needs.

- **JPEG** is the default format used by almost every digital camera ever made. Named after its developer, the Joint Photographic Experts Group (and pronounced “jay-peg”) this format often lets you specify both the image size (in pixels) and how much the image file is compressed. When you capture an image in this format a processing chip in your camera manipulates it based on the camera settings you used, and then compresses it to reduce its size. The changes made to the image cannot be undone later because it's the final, altered image that is saved in the image file. Some of the original image data is lost for good. Because you can't easily add pixels and retain image quality, or remove the effects of compression after the fact, it's usually best to use the largest available image size and the least compression available. If you have to reduce either, you can do so later using a photo-editing program. The only problem with this approach is a small one; higher quality images have larger file sizes.

- **RAW** is a format that's available on many high-end cameras including all SLRs. One of Ansel Adam's better known expressions, drawn from his early experiences as a concert pianist, was “The negative is the score, the print is the performance.” In digital photography, the image file is your score and the best possible score is a RAW image file. These files contain all of the image data captured by the camera's image sensor without it being processed or adjusted in any way by the camera. This lets you move the images to the computer and interpret this data the way you want to instead of having the camera do it for you. When you want total control over exposure, white balance, and other settings, this is the format to use because only four camera settings permanently affect a RAW image—the aperture, shutter speed, ISO, and focus. Other camera settings are saved as metadata and affect the appearance of the thumbnail or preview images but not the RAW image itself.

With many cameras you can capture RAW images by themselves or with a companion JPEG image that gives you an identical high quality RAW file and a smaller, more easily distributable JPEG file. Both images have the same names, but different extensions. The latest applications such as Lightroom have made working with RAW images so easy this is no longer really useful and the duplicate JPEG images just take up room. In case storage space is limited, some cameras offer more than one size for RAW images so you can retain the advantages of the RAW format while capturing smaller images that have smaller file sizes.

One thing to keep in mind is that RAW images are not always noticeably better. Where they shine is when you have exposure or white balance problems. Because RAW images have dramatically more information to work with, you can open up shadow areas, recover lost details in highlights, and make fine adjustments to colors.

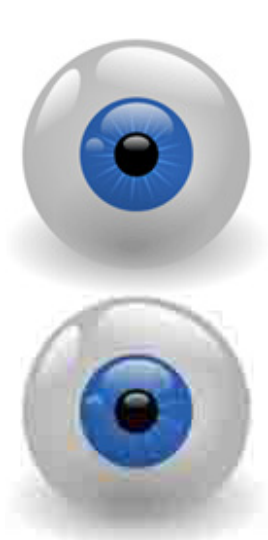


The DNG logo.

- **DNG** (Digital Negative). Camera companies have introduced many different, and frequently changing, raw file formats. By some estimates there are hundreds of such formats with more coming—some of them specific to a single camera model. On top of this, manufacturers are often pointlessly secretive about their specifications so there are almost always RAW files your software can't read—at least until someone reverse engineers the formats so they can support them. This lag time and inconvenience can be laid at the doorstep of the camera companies. These proprietary RAW files are at risk over time since companies come and go and their interest in maintaining a particular format waxes and wanes. One solution to this growing problem is an Adobe format called the *Digital Negative* (.DNG). This publicly defined and openly shared format for RAW files is an attempt to ensure that you will be able to access your image files in the future. If your camera doesn't capture images in this format, and very few of them do, you can convert them to DNG using a program such as Photoshop or Lightroom. When you do so, you can even choose to store the original RAW image inside its DNG file so you can extract it at some future date should you need it. The DNG format is supported by Photoshop and other Adobe products, some other software companies, and a few camera companies, but currently none of the major ones. As with all things in computing, only time will tell if the format becomes more widely accepted or gradually fades away.

## Animation

Click to see the effects of compression.



Here, two versions of the same image. The image on top is the original JPEG. The one on the bottom shows what happens after it's saved a few times at the lowest quality setting. Art courtesy of webweaver.nu.

- **TIFF** (tagged image file format) is a format that's often used to exchange files between applications and computer platforms. It's supported by virtually all image-editing and page-layout applications. Only a few cameras let you capture images in this format but when they do TIFF files tend to be larger than RAW images.

### FILE COMPRESSION

Image files are huge compared to many other types of computer files. For example, RAW files captured by a 21 Megapixel camera can range up to 30 or even more Megabytes. As resolutions continue to increase, so will file sizes. To make image files smaller and more manageable, digital cameras use a process called *compression*. During compression, data that is duplicated or that has little value is eliminated or saved in a shorter form to reduce a file's size. For example, if large areas of the sky are the same shade of blue, only the value for one pixel needs to be saved along with the locations of the other pixels with the same color. When the image is then opened and displayed by any application, the compression process is reversed more or less depending on which form of compression was used—*lossless* or *lossy*.

- **Lossless compression** compresses an image so when it is uncompressed, as it is when you open it, its image quality matches the original source—nothing is lost. Although lossless compression sounds ideal, it doesn't provide much compression so files remain quite large. For this reason, lossless compression is only used by the highest quality image formats—namely TIFF and RAW.

- **Lossy compression** (rhymes with “bossy”) can dramatically reduce file sizes. However, this process degrades images to some degree and the more they're compressed, the more degraded they become. In many situations, such as posting images on the Web or making small to medium sized prints, the image degradation isn't obvious. However, if you enlarge an image enough, it will show. The most common lossy file format is JPEG and many cameras let you specify how much images in this format are compressed. For example, many cameras let you choose Fine (1:4 so files are 1/4th their



## COLOR DEPTH

When discussing color depth, photographers refer just to the bits per color or the total number of bits, and both forms of reference mean the same thing. For example, if you say "8 bit images" or "24 bit images," people will know you are talking about JPEGs and not RAW images.

## Animation

Click to see how all colors can be formed from red, green and blue.

original size), Normal (1:8), and Basic (1:16) compression. This is a useful feature because there is a trade-off between compression and image quality. Less compression gives you better images so you can make larger prints, but you need more storage space for the larger files.

### COLOR DEPTH

When you look around a room or landscape you are able to distinguish millions of colors. A digital image can approximate this color realism, but how well it does so depends on your camera and the settings you choose. The number of colors in an image is referred to its *color depth* and is determined by the number of bits used to store each of a pixel's three colors—red, green, and blue. JPEG images use 8 bits per color. To calculate how many different colors can be captured or displayed, you raise the number 2 to the power of the number of bits used to store them. For example:

- For each color 8-bits captures 256 levels of brightness because  $2^8 = 256$ .
- For all three colors combined there are 24 bits (8 per color times 3), and the total number of colors is over 16 million ( $2^{24} = 16,777,216$ ).

RAW images have greater color depth and that gives smoother gradations of tones and more colors to work with as you make adjustments. How many more colors is astronomical. RAW images are initially captured by the sensor in an analog form and then an analog to digital converter converts them to 10, 12 or 14 bits per color.

- For each color 14-bits captures 65,536 levels of a brightness ( $2^{14} = 65,536$ ).
- For all three colors there are 42 bits (14 per color times 3), and the total number of colors is over 4 trillion ( $2^{42} = 4,398,046,511,104$ ).

These extra colors are not actually used by display screens, printers, or most other devices, but are there to give exceptionally fine gradations when editing and adjusting images into their final form.

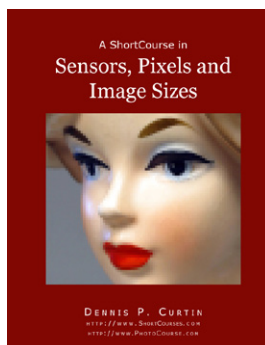
Here's a table that summarizes these color depth facts.

Name	Bits per color	Total bits	Formula of colors	Number of colors
JPEG	8	24	$2^{24}$	16,777,216
RAW	10	30	$2^{30}$	1,073,741,824
	12	36	$2^{36}$	68,719,476,736
	14	42	$2^{42}$	4,398,046,511,104

### CHOOSING A FORMAT

When choosing between JPEG and RAW formats, there some advantages to using RAW:

- Any compression used is lossless.
- Images in this format are as easy to process as JPEGs when you use the latest programs such as Aperture and Lightroom.
- RAW lets you decide on most camera settings after you've taken a picture, not before. For example, when you shoot a JPEG image under fluorescent lights, the camera adjusts the image to remove the yellow-green tint. Any changes you make later are on top of this initial change. If you shoot the image in RAW format, the camera just captures the image as is and you decide what white balance setting to use later. You can even create different versions



## PDF

Click for a PDF extension on pixels and read Part 4 on color depth and file sizes.



of an image, each with its own white balance.

- RAW images can be processed again at a later date when new and improved applications become available. Your original image isn't permanently altered by the current generation of photo-editing applications even if they don't support non-destructive editing.

- You can generate alternate versions of the same RAW image. For example, many photographers will adjust highlight and shadow areas and save these versions separately. Using a photo-editing program, they then combine the two images as layers and by selectively erasing parts of the top image layer let areas of the lower image layer show through so all areas have a perfect exposure. The latest versions of Photoshop have even automated this process.

Admittedly, there are drawbacks to using RAW images.

- RAW files are quite large. If you use this format a great deal you may need more memory cards or cards with more storage capacity, and computer processing times may be slightly longer.

- When shooting images, you may have to wait longer between shots, or shoot fewer images continuously, because the buffer gets filled more quickly and the camera is tied up longer processing the last image you took, and moving it from the buffer to the memory card.

- Since RAW images aren't processed in the camera, you have to process them on the computer and export them in a usable format when you want to e-mail them, post them on a Web site, print them, or import them into another program to create a slide show or publication. When you are done shooting for the day, there is still work to do.

- Since each camera company has defined its own proprietary RAW format, operating systems and even photo-editing programs are unable to recognize some of these files. For this reason camera manufacturers always supply a program to process RAW images along with their cameras. Whether you'll still be able to open these image files with the software available in 10, 20 or more years is an unanswered question.

*RAW images used to be hard to work with because they required some extra processing steps. The latest photo-editing programs such as Aperture and Lightroom make them as easy to work with as JPEG images.*



## IN-CAMERA IMAGE STORAGE DEVICES



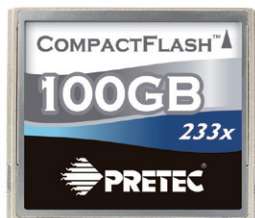
A few cameras, like this Nikon SLR, accept more than one card. Sometimes the card slots are for the same kind of card and sometimes for different kinds.

With traditional cameras, the film both records and stores the image. With digital cameras, separate devices perform these two functions. The image is captured by the image sensor, then transferred to an in-camera storage device designed for temporary storage. At some point you transfer the images to a computer, erase the device, and reuse it.

Almost all but the cheapest digital cameras use some form of removable storage device, almost always flash memory cards. The number of images that you can store during a shooting session depends on a variety of factors including:

- The number of storage devices you have and the capacity of each (expressed in Megabytes or Gigabytes—a Gigabyte is 1000 times larger than a Megabyte).
- The resolution or image file format used to capture images.
- The amount of compression used.

Once your storage devices are full you have to move image files to a computer, quit taking pictures, or erase some existing images to make room for new ones. How much storage capacity you need depends on the factors mentioned above and how prolific you are when photographing.



Pretec makes a 100 Gigabyte CompactFlash card with a speed of 233x.



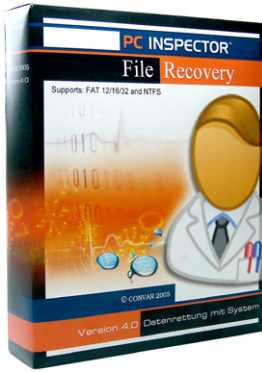
Not too long ago the very popular Sony Mavica stored images on a floppy disk.

Most cameras store images on a removable memory card that slides into a slot on the camera. Courtesy of Gepe ([www.gepe.com](http://www.gepe.com)).

Over the past few years a variety of flash memory cards and other in-camera storage devices have come and gone. At the moment there are two types in widespread use—Compact Flash (CF) and Secure Digital (SD). These cards store your image files on flash chips that are similar to the RAM chips used inside your computer but there is one important difference. Your photographs are retained indefinitely without any power to the card. These chips are packaged inside a case equipped with electrical connectors and it's this sealed unit that is called a *card*. Flash memory cards consume little power, take up little space, and are very rugged. They are also very convenient; you can carry a number of them and change them as needed. The only problem is that the various types aren't interchangeable. Once you have a sizable investment in memory cards, you are locked into using only cameras that support that format, or you are forced to buy a new set of cards. There are adapters for computers but not for cameras.

- **CompactFlash** (CF) cards are about the size of a matchbook and the most common card used in digital SLR cameras.
- **Secure Digital** (SD) cards are smaller and thinner than CompactFlash cards and are the most widely used cards—especially in smaller point-and-shoot cameras. SDHC cards support higher storage capacities and SDXC (eXtended Capacity) even more—up to 2 Terrabytes.
- **MultiMedia** (MMC) cards, falling out of favor, are used in a few pocket cameras. MMC Plus cards support higher storage capacities.





A very good freeware image recovery program is PC Inspector, available from [www.convar.com](http://www.convar.com)

#### TIP

When you buy new memory cards, be sure they are supported by your system. To achieve maximum transfer speeds the camera, cards, readers, and the computer system must support the technical standards being used. The latest standards are rarely supported by products that have already been produced. If any part of the chain predates the introduction of a new standard, you won't see maximum transfer speeds.



When you have more than one card, a case protects your spares. Courtesy of Gepe ([www.gepe.com](http://www.gepe.com)).

- **Memory Stick™** cards use a proprietary format from Sony Corporation and are used almost exclusively in Sony products.

- **xD Picture cards** are small and used by Olympus and Fuji, the companies that developed the format.

All of these cards have multiple versions and there is no reason to think that will change as capacities and speeds increase.

Over the past few years the capacity and speed of these cards has jumped dramatically, and cameras have adapted as best they can, but usually more slowly. The result is that some newer cards won't work on some cameras or card readers. It takes a while for the hardware to catch up. When you buy large capacity or very fast cards, be sure they are compatible with your system.

One thing to consider when buying a card is its speed, often specified as an "X" number. Cards with higher X-speed ratings are designed to perform faster but X-speed ratings vary among manufacturers. Some refer to the X-speed as the read speed while others refer to the write speed or data transfer speed. In digital photography the write speed, which tends to be slower than the reading speed, is most important because it determines how long it takes to store an image on the card.

Using the X-speed rating you can also calculate the transfer rate, the speed at which files are transferred to or from the card. A 1x card can transfer data at 150 Kilobytes per second, so you multiply this number times the speed rating to calculate the transfer rate. For example, a 266x card will transfer 39,900 Kilobytes per second ( $266 \times 150 \text{ Kilobytes} = 39,900$ ). Divide the result by 1000 to determine the transfer rate in Megabytes/per second ( $39,900/1000 = 39.9$ ). If the manufacturer gives only the transfer speed, you can calculate the X-speed rating by dividing it by 150 Kilobytes per second.

Manufacturers charge a premium for the largest capacity and fastest cards. Unless you are missing shots while shooting continuously or dropping frames in movies because your camera can't move images from the buffer fast enough, you may be better off investing elsewhere in your system, especially since any bottleneck may be in your camera, card reader or computer and not the card.

Every camera that accepts memory cards has a *Format* command listed somewhere in its menus. Formatting a card the first time you use it in a camera ensures the card will be accurately written to and read in that specific camera. You may also find that formatting fixes a card that has developed problems. Some cameras let you perform a *low level format* that restores the basic architecture of data storage on the memory card. Normally you use this setting when the speed of the card has dropped. Signs that this has happened include a slower continuous shooting speed, dropped movie frames during recording or playback, or longer image storage or playback problems.

Just be aware that the *Format* command erases all of the images stored on a card. Should you ever do this by mistake, there is digital image recovery software available but it won't work on a disk you have low level formatted. To find this software, Google "digital photo recovery."



## TRANSFERRING IMAGES



Card readers are often connected to a computer's USB port, or may even be built in. Cards inserted into a slot are treated just as if they were removable hard disk drives. Cards vary in size and have different connections so many readers now have a variety of slots. Photo courtesy of PQI at [pq1st.com](http://pq1st.com).



If a card is smaller than a slot, or if your notebook has an ExpressCard Slot you can usually find an adapter that mates your card to the slot. Here is Delkin's adapter that lets you read CF cards in an Expresscard slot. Some adapters accept a variety of cards. Courtesy of Delkin.

### Animation

Click for an animation on dragging and dropping files.

Some home printers, print kiosks in public locations, and even TV sets have slots that accept cards directly from your camera so you can view or print images without a computer. Courtesy of Kodak.

Storage in the camera is only meant to be temporary. When you want to use or edit the images, or make room for new ones, you transfer the images on the card to the computer.

Almost all digital cameras come with software that will transfer your images for you as do newer photo-editing and image management programs. As useful as these tools are, you should also know how to use your operating system's tools. Here are some reasons why:

- **Availability.** Operating system tools are on every computer of the same type, anywhere in the world.
- **Change.** If you change applications, what you have learned about operating system tools remains useful. What you have learned about the old application may not.
- **Control.** Many programs have a mind of their own and rename and store files in a manner you may not choose were you given the choice. Operating system tools let you use your own file management system.

Regardless of how you transfer the files, you have to choose whether to move or copy them.

- **If you move files** from the camera's card, they are first copied to the computer and then deleted from the storage device. If anything goes wrong during the transfer you may lose image files.
- **If you copy files**, they are not automatically deleted from the card. You either have to do that using your computer or one of the camera's commands. Although deleting the images after the transfer is an extra step, this procedure is safer than moving files because if anything goes wrong you still have the original images on the card.

To transfer files you have to connect the camera or memory card to the computer or other device and there are a variety of ways to do this.

### CARD READERS AND SLOTS

One of the most common ways to transfer images to a computer is using a card reader or card slot that accepts your card with or without an adapter. Card slots are increasingly being built into computers, printers, and even TV sets. If your system doesn't have one, there are inexpensive card readers that will plug into a USB or ExpressCard port.





## CABLE CONNECTIONS

Another popular way to transfer photos is by way of cables. The most popular connections at the moment are USB 2.0 and the newer USB 3.0 that's 10 times faster.

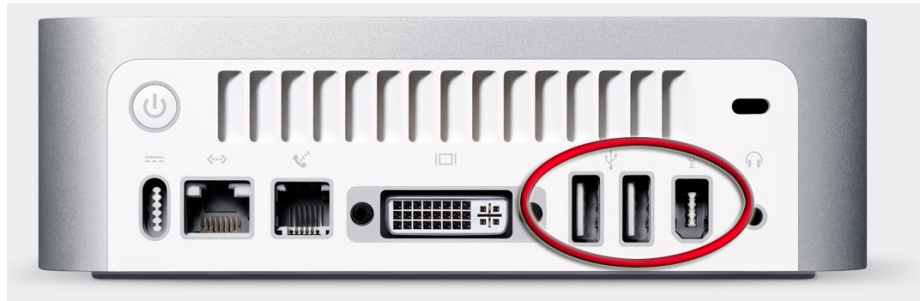
*Almost all cameras come with a USB cable that connects it to a computer or printer. Courtesy of Canon at [www.powershot.com](http://www.powershot.com).*



## FIREWIRE—RIP

Apple, the biggest supporter of Firewire, has left it off some of its latest notebooks signaling its demise as a way to transfer files. It's been replaced by USB.

*Cable connections on the back of Apple's Mac Mini with two USB and one Firewire (IEEE 1394) connector circled in red. Courtesy of Apple at [www.apple.com](http://www.apple.com).*



*SanDisk makes an SD card that folds to reveal a USB connector so it can be used without a card slot or card reader.*

*A dock lets you easily connect a camera to a printer or computer and even charge the camera's batteries. Unfortunately, docks are camera-model specific so if you buy another camera you'll need another way to make your connections. Courtesy of Kodak at [www.kodak.com](http://www.kodak.com).*



USB cables have a standard plug at the computer end but those on the other end vary. To make connections you can use an adapter kit like this one from Phillips.



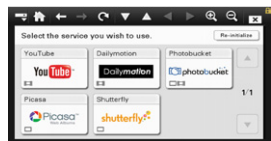
A newer high-speed connection is Intel's Light Peak that uses light instead of electricity to transfer files.



Eye-Fi makes an SD card that not only stores photos but also includes WiFi so you can send them wirelessly.



Logo found on products approved by the Digital Living Network Alliance (DLNA).



Sony and others make WiFi enabled digital cameras so you can upload photos and videos to Web sites through any public hot spot.



## WIRELESS CONNECTIONS

One of the latest trends is using wireless connections between your camera and your computer or printers, and between your camera and a network so you can immediately share your photos using e-mail, photo sharing sites, or photo blogs. There are a variety of approaches:

- **WiFi** connects cameras to WiFi networks in homes and public hot spots. It is built into a few cameras and can be purchased separately for others. It's reasonable to assume we will see this become increasingly common. When shooting within range of your home network or a public hot spot, you can upload photos to your system or a photo sharing Web site directly from the camera.

Camera phones often send photos over the operator's network but you are at their mercy when it comes to pricing. Luckily, some camera phones also let you connect to WiFi networks so you can cut your transfer costs.

One group trying to ensure network devices work together is the Digital Living Network Alliance (DLNA). Hardware adopting their standards, including entertainment devices, can communicate with each other over a home WiFi network.

- **Bluetooth**, although much slower than WiFi, works well as a way to replace some of the cables hanging off your desktop, Bluetooth is finding a home in photography mainly in camera phones and the occasional digital camera. Photo kiosks are often equipped with Bluetooth so you can beam your photos to the printer. There are also adapter cards and USB adapters that let you add Bluetooth capability to a computer that doesn't already have it.

- **Infrared** connects line-of-sight devices where the infrared beam isn't blocked. This has made periodic and brief appearances in digital photography but has never become widespread.

- **TransferJet**, developed by Sony and supported by all of the major digital camera companies, quickly transfers very large files just by touching the transmitting device with the receiving device. For example, simply touching a computer or TV with a digital camera displays the camera's images or movies on the larger screen. TransferJet may replace the connectors currently used to exchange files among a wide variety of consumer electronics devices.

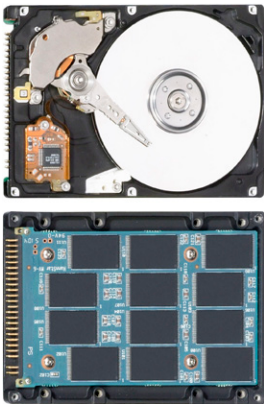
## STORING IMAGES—ON YOUR SYSTEM



Small portable drives that plug into a USB port are great at home and on the road. Courtesy of Toshiba.



External enclosures are available that hold up to four drives. Here one from Drobo.com is shown open (left) and closed (right). If you group the drives together into a RAID configuration (Random Array of Inexpensive Devices) they not only store information but automatically back it up. If one drive fails, it can be replaced and the damaged files are then automatically reconstructed from the remaining drives. Courtesy of Drobo.com.



A hard disk drive (top) uses a spinning platter and a moving read/write head to store images. A solid-state drive (bottom) uses flash memory chips and has no moving parts. Courtesy of Intel.

When you transfer images to your computer where they can be organized, edited and shared, it's usually to a hard drive. From there you may then copy or move them to other hard drives or optical discs so you have both an original and backup copies.

### HARD DRIVES

Hard drives have become so inexpensive, and their storage capacity so great, that you can have an almost endless supply of hard disk space on which to store images. Currently, affordable drives have capacities up to 1.5 Terabytes—enough room to hold more than 99 thousand 15 Megabyte images. If these were film images at 50-cents a picture, you've have a small box of images worth almost \$50-thousand dollars! One way to think of this amazing capacity is by how long it would take you to fill a drive. If you shot a hundred 15 Megabyte photos a day, you could shoot for 22 months before filling a 1 Terabyte drive. And forget backing up these drives to optical discs. It would take 20 dual layer Blu-Ray, 212 DVDs, and over 1400 CD discs. Even tape backups have fallen far behind. The only affordable backup for entire libraries of photos is another hard drive—either an internal drive or an external drive that plugs into a computer's USB port. Although still much more expensive, an up and coming drive is the solid state drive (SSD) that stores data on flash cards instead of a rotating disk. These drives are light, durable, and very fast and prices will decrease and capacities increase as the technology improves.

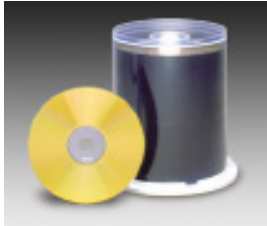
### OPTICAL DISCS

Other than hard drives, the only other widely available storage device is the optical drive that *writes* (stores) and reads one of four kinds of optical discs—CD, DVD+, DVD- or Blu-Ray. These discs are frequently used to backup important images to protect them, share them with others, and even to store slide shows that can be played back on a computer or TV set. (When an optical disc device is attached to the TV it's called a *player* or *recorder*. When attached to a computer it's called a *drive* or *writer*.) The main types of optical discs are summarized in the following table:

Type	Sides/Layers	Capacity	Formats
CD	Single side, single layer	700MB	CD-R (recordable) and CD RW (reusable)
DVD+	Single side, single layer	4.7GB	DVD+R (recordable) and DVD+RW (rewriteable)
	Double-side	8.75GB	
	Double layer	8.5GB	
DVD-	Double side	8.75GB	DVD-R (recordable and DVD-RW rewriteable)
	Double layer	8.5GB	
Blu-Ray	Single layer	25GB	BD-R (recordable) and BD-RE rewriteable)
	Double layer	50GB	

- Optical drives come in both internal versions that are mounted inside a computer and external versions that are plugged into a USB port.





Optical discs are less expensive when you buy them in bulk and use envelopes to store them in drawers.



An external optical drive. Courtesy of LaCie.



There are many notebook computers that have built-in optical disc drives.

- All optical discs are available in single-sided versions and some in double-layer or double-sided versions.
- All discs are available in recordable (one-time) and rewriteable versions that can be reused. Discs that can't be erased and rewritten are ideal for archival storage because the information on them can't be deleted or overwritten.
- Optical discs are relatively new forms of storage. How long they will last before data is lost through deterioration isn't yet known with any certainty. Most tests use accelerated aging that may or may not accurately reflect the future or your storage conditions. The consensus seems to be that they will last a few decades if manufactured and stored properly. Given the uncertainty, the best thing you can do is buy only name brands and store them in acid-free envelopes in a cool dark place such as a drawer or album. Discs that use a gold, rather than a silver recording layer, are generally considered to last longer. One company ran a light fastness test that showed that gold discs could withstand sunlight for only 100 continuous hours without damage. Discs with the widely used cyanine dye began to deteriorate after only 20 hours and failed at 65 hours.
- Initially you could select DVD+ (plus) or DVD- (dash) formats. Since the formats are incompatible, the industry solved the problem by having you pay for both in the form of a multiformat or dual DVD drive.
- Writing speeds, which are determined by the drive, are specified in X-speeds just as memory cards are. The value of 1X depends on the type of drive.

- CD 1x is 150 Kilobytes per second (0.15 Megabytes)
- DVD 1x is 1,352 Kilobytes per second (1.35 Megabytes)
- Blu-Ray 1x is 4,500 Kilobytes per second (4.5 Megabytes)

In some cases, the manufacturer of an optical drive will provide three X-speeds on the box or in the specifications. A sequence such as 32x10x40x indicates the write, rewrite and read speeds of the drive.

## DISK VS DISC

Hard disks are spelled with a "k" and optical discs with a "c."



Discs with a gold recording layer outlast those with silver or aluminum. Courtesy of Delkin.com.

## BURNING SOFTWARE

To copy files to an optical disc, you need *authoring* or *burning* software. This software is readily available—for example, the latest Windows and Mac operating systems let you burn a CD or DVD directly from the operating system. In addition, there are programs from Nero, Roxio and others designed specifically for this task. The ability to burn optical discs is often integrated into other applications. For examples, Apple's iPhoto and Aperture and Adobe's Lightroom all let you select images and burn them to a CD or DVD, and maybe a Blu-Ray disc by the time you read this, without leaving the application. Many applications also let you create a slide show of your images and burn the show to a disc in a format that can be played on the computer or displayed on a TV.

## LABELING OPTICAL DISCS

When you burn a disc, you or your software can add a title that will be displayed by your computer when you access the disc in a drive on your system. The title will also be used by image management software to keep track of your images. For example, when using an image management program, if you double-click the thumbnail of an image that isn't currently on-line, the name





When copying images between devices, USB flash drives come in very handy. You plug one into a computer's USB port and copy files to it. You then plug it into any other computer and copy the files from it. Here are some whimsical Star War figure drives from Mimoco.com.



Neato makes an applicator that centers a label on a disc so the label goes on right the first time. Courtesy of neato.com.



Drives using Lightscribe technology can label Lightscribe discs as they are burned. Courtesy of Lightscribe.com.



The Epson Discproducer that burns and prints labels on optical discs.

you assigned the disc on which it is stored may be displayed and you may be prompted to insert that disc.

You can add your own descriptive title such as *Florida Trip Disc*, or let the program automatically assign one based on the current date and time. For example, the number *100412\_0849* indicates the disc was burned in the year 2010 (10) on May (04) 12 (12) at 8:49 AM.

Even when a disc is labeled when burned, you still need to physically label it. Generally, the information should be on the disc itself, not on an envelope or insert. It's too easy for these to get separated from the disc. One way to label a disc is with a permanent marker pen that writes on the non-recording side of the disc with ink that won't rub off with use. For longevity reasons, the best choice is a pen that uses water-based inks. Some marker pens use solvent-based inks and should be avoided. You can easily identify the pens not to use by their solvent odor. These solvents can attack the protective covering of the disc, even when you write just on the label side. Over a long period of time, possibly measured in decades, this can affect the data.

For a more professional look, you can buy press-on labels that you print with an ink jet printer and stick onto the surface of the disc. One major problem is alignment because once the label sticks, it's stuck. Unlike life, there are no second chances. To help you get it right the first time there are alignment gadgets that center the label as you press it onto the disc. When using these labels, apply them after recording the disc. If you apply one first and it's slightly off-center, it may affect the recording process.

Most optical disc burning applications include software you use to lay out and print labels and even jewel case inserts. This software usually includes a number of backgrounds from which to choose (or lets you use your own photos as backgrounds), and text boxes into which you type your text. You don't have to be technically proficient or very artistic to get a decent design.

Should you ever decide to ramp up your distribution efforts, the next step is a label printer. These printers print on special discs that have a water permeable coating on one side. If a disc doesn't have this special layer, the ink beads up on the surface of the disc and flakes off when dry. Ink jet printable discs are produced by several major companies and are available from office supply and on-line retailers. A number of photo printers from Epson and others have added optical disc trays so you can print labels directly onto these printable discs. When you insert a disc into the printer's disc tray it's carried through the printer's straight-through paper path. There are also printers designed for the sole task of printing labels on discs and there are even robots available that will insert one disc after another into the printer so you can print a quantity of discs unattended.

If you ever need large quantities of a single disc, you may want to have them professionally duplicated and the labels silk-screened. You can also give your own discs a professional and personal appearance. Just have a supply of blank discs silk screened with professional graphics, leaving a space to write in specific information such as the discs's name or title.

## STORING IMAGES—ON THE ROAD



Some iPods can both store and display photos.

Storing images at home is easy. It's on the road that problems arise. With traditional cameras, you just stuff the bag with film and shoot till it runs out. Then you go buy some more. With a digital camera you'll eventually reach the point where your memory cards are all full and you have to move images to another storage device and erase your cards so you can reuse them. This is especially true when you capture high-resolution images or use file formats such as RAW or TIFF that give you the best image quality but create huge files—30 Megabytes, or more in some cases. Here are your alternatives on an extended photo shoot or expedition:

- **Find a place to burn optical discs for you.** This will now be done by most photo stores but they are often clueless so double-check that everything has been copied correctly.



Netbook computers are smaller lighter and easier to carry than notebooks. They have fairly large hard drives you can use for image storage on trips and you can also connect additional hard or optical disc drives to a USB port to dramatically increase storage.

- **Buy more or larger memory cards.** This is a common solution but it can be expensive if your trip is long or you are a prolific shooter. Also, putting a large number of photos on one card increases the risk of losing images.

- **Carry a notebook or even smaller netbook computer.** Not only may you already have one of these, but its large screen and ability to run your choice of applications provides you with a mobile version of the typical desktop system. If you attach a portable hard drive to the notebook's USB port, you can just plug it into any other system's USB port when you return home. You can then transfer the files or edit the images right on the portable drive. However, a notebook computer isn't always the ideal portable device because of its size, weight, short battery life, and long start-up time. On a car trip it's perfect, especially with a *voltage inverter* so you can power it from the car's battery. On hiking or canoe trips it's difficult or impossible. On trips across national borders you may need voltage adapters or converters.



The Epson P-7000 is a portable storage and viewing device with a 160 Gigabyte hard drive and a 4 inch screen.

- **Buy a portable storage device** based on a hard or optical drive. Some of these devices have card slots or connect directly to the camera. When you get back to the computer you use for storing, editing, printing, and distributing images, you copy or move the images from the portable storage device to that system. Many portable storage devices, including some models of Apple's iPod, also let you use them as a hard drive. This is separate from their function of displaying images on the device's LCD monitor or on a connected TV. Some devices also let you print directly to a printer without using a computer and combine digital photos, digital videos, and MP3 music. With a device such as this you'll be able to create slide shows with special transitions, pans, and accompanying music and play them back anywhere. If you consider one of these devices, be sure it can handle the image formats you use. RAW and other non-JPEG formats are often not supported.

- **Use file transfer.** You can upload your images to an on-line photo service, but be sure they store the original image, not just a reduced and manipulated version. A service named GoToMyPC is widely used by people to access and operate their home or office computer from other computers anywhere in the world, even those in libraries and cyber-cafes. If you subscribe to this service you can also transfer files and folders between PCs, or an attached memory card or camera, simply by dragging and dropping between screens. There are also other peer-to-peer file transfer systems available.

## HOW PHOTOS ARE STORED IN YOUR CAMERA AND COMPUTER

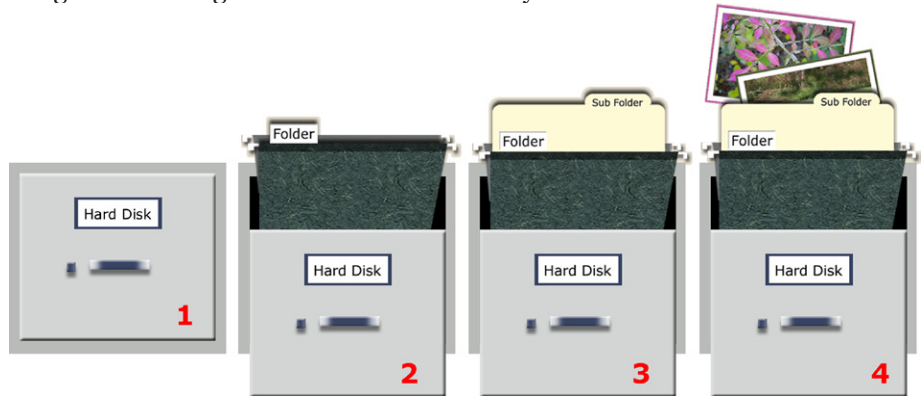
### DCF

DCF (Design Rule for Camera File System) defines the entire file system of digital cameras including the naming and organization of folders, file naming methods, characters allowed in filenames, and file formats.

The photos you take are stored as files on your camera's storage device following rules spelled out in a variety of standards adopted by camera companies. These standards assure that files and storage devices can be moved among cameras and other digital imaging hardware and software. Since file storage and organization are so important you should understand how drives, folders, and files relate to one another. When someone takes up digital photography without having mastered these few simple concepts, they may not be able to locate the photos they want to use, or know how to organize their images so working with them is fast and easy.

### FOLDERS

You may encounter the interchangeable terms *directory* and *folder*. When computers were used primarily by professionals, the term *directory* was used. As computers became more widespread, the more user-friendly *folder* was introduced. In photo sharing you'll also find the names *albums* and *galleries* used for the same things.



A new hard disk drive (1), like an empty file drawer, has no files nor organization. Dividing a hard disk into folders (2) is like dividing a file drawer with hanging folders. Nesting subfolders inside folders (3) is like putting manila file folders into the hanging folders. Files, including images, can be stored in any of the folders or subfolders (4)—or even in the drawer outside of the folders, called the drive's root directory.

### DRIVES

Almost all computers have more than one drive. To tell them apart, they are assigned letters or names such as *Macintosh HD*, and icons are used to identify their type. For example, the now defunct floppy disk drive was assigned both drive A and B and those drive letters now go unused. The hard drive that the computer looks to for the operating system when you turn it on is drive C. Additional drives vary from computer to computer but often include other hard drives, or optical drives. When you attach your camera, a card reader, or even a digital picture frame to the computer, these too become drives. Many devices are recognized automatically when you plug them in, but a few require you to install small programs called *drivers* so the computer knows they are there.



Apple's Macintosh Hard drive icon.

### FOLDERS

Folders are used to organize files on a drive. Imagine working in a photo stock agency where you're told to find photos of "Yosemite" only to discover that all of the photos the agency ever acquired are stored in unorganized boxes. You have to pick through everything to gather together what you want. Contrast this with an agency that uses a well-organized file cabinet with labeled hanging folders grouping related images together. For example, there might be a hanging folder labeled *California National Parks*. If a further breakdown is needed, labeled manila folders are inserted into any

## Movie

Click for a group of movies on folders.

of the hanging folders—basically, folders within folders. There might be one labelled *Yosemite* containing images of the park. With everything labelled and organized, it's easy to locate the images you need. The same is true of your memory cards and drives on your computer system. Both are equivalent to the empty file cabinet—plenty of storage space but no organization. The organization you need to find things on the camera's memory device (which we discuss here) is created by the camera, but on your computer, you have to create it yourself (as you will see later).

If you use operating system tools or applications to look at a storage device in the camera or card reader, you will find it is listed like the other drives on your system. If it contains more than one folder, the one photographers care about is named *DCIM* (for *Digital Camera IMages*). If you delete this folder, the camera will recreate it (but not any images it contained). The purpose of this folder, called the *image root directory*, is to keep together all of the images you capture with the camera. If you use the same card with other devices, there may also be other folders on the same card holding MP3 music or other files.

As you take pictures, your camera automatically creates and names subfolders within the *DCIM* folder to hold them (like placing manila folders in a hanging folder). The first three characters in a folder's name, called the *directory number*, are numbers between 100 and 999. The next five characters are known as *free characters* and can be any uppercase alphanumeric characters chosen by the camera manufacturer. When a new folder is created, as one is when the current folder is full, it is given a number one digit higher than the previous folder. Some cameras allow you to create and name your own folders, or select among folders the camera creates. This lets you route new images into a specific folder and also play back images from just selected folders rather than the entire card.



Image files have an 8-character name followed by a period and a 3-character extension.

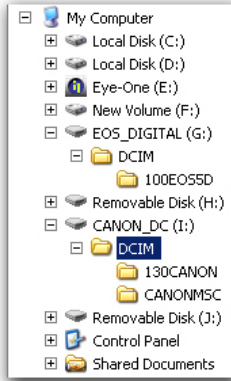
### FILENAMES

When an image is saved, the camera assigns it a filename and stores it in the current folder. Filenames have two parts, an 8-character filename and a 3-character extension. Think of them as first and last names. The name is unique to each file, and the extension, separated from the name by a period, identifies the file's format. For example, a JPG extension means it's a JPEG image file, TIF means it's a TIFF image file, CR2 means it's a Canon RAW file and NEF means it's a Nikon RAW file.

Extensions play another important role. An extension can be associated with a program on your system so if you double-click a file, the associated program opens and then it in turn opens the file you clicked. Also, when you use an application program's *File > Open* command it often lists only those files having extensions that it can open. (You can list other file types but it usually requires an additional step or two.) If you change the extension, your system may no longer know what to do with the file.

The first four characters in an image file's name, called *free characters*, can only be uppercase letters A–Z or an underscore. The last four characters are digits between 0001 and 9999 and are called the *file number*. Canon uses the first four free characters *IMG\_* followed by the file number, Nikon uses *DSC\_*, and Sony uses *DSC0*. Once transferred to your computer, or sometimes while transferring them, you can rename images with more descriptive names.





A tree displayed by Windows Explorer indicates drives and folders with icons and labels. The - and + signs indicate if a drive or folder is expanded (-) to show subfolders, or collapsed (+) to hide them.

## TREES

One way to illustrate the organization of folders on a drive is to display them as a tree. In this view, all folders that branch off from the drive are listed. If any of these folders contain subfolders, those subfolders are shown indented under the folder that contains them. When using a tree, you can expand and collapse the entire tree or any branch. This allows you to alternate between a summary of the computer's contents, and details of each drive or folder.

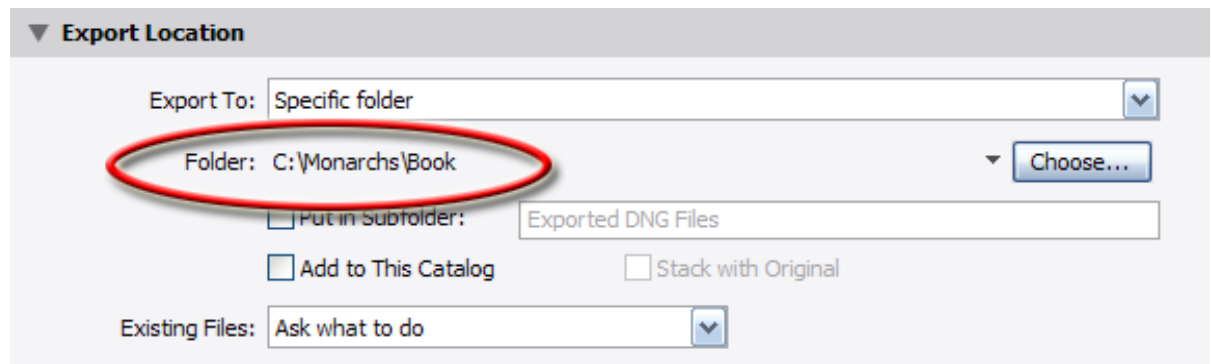
## PATHS

With files stored in folders on a disk, you specify a *path* to get to them. For example, if a file named *IMG\_4692.JPG* is in a subfolder named *146CANON* that's in a folder named *DCIM* on drive H, the path to that file is *H:\DCIM\146CANON\IMG\_4692.JPG*. The key elements of a path—the drive, folder, subfolder, and filename—are separated by backslashes (\). You might be more familiar with paths from your Web browser that uses a similar approach using slashes. For example, the URL...

<http://www.shortcourses.com/index.html>

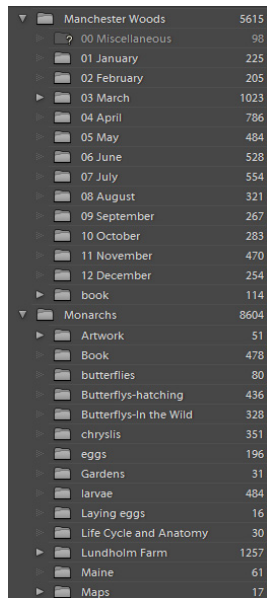
... is a path to a specific page on the Web. Normally you don't type in paths, you click drives or folders to open them. However, many programs display paths on the screen as a navigational aide and so it's easy to confirm the actual location of the file on your system.

Here is the path to the file *IMG\_4692.JPG* in subfolder *146CANON* that's in the *DCIM* folder on drive H. The drive, folder, subfolder, and filename are separated by backslashes.



Here is the path to an image as displayed in Lightroom when exporting an image.

## ORGANIZING YOUR PHOTO FILES



Manchester Woods	5615
00 Miscellaneous	98
01 January	225
02 February	205
03 March	1023
04 April	786
05 May	484
06 June	528
07 July	554
08 August	321
09 September	267
10 October	283
11 November	470
12 December	254
book	114
Monarchs	8604
Artwork	51
Book	478
butterflies	80
Butterflies-hatching	436
Butterflies-In the Wild	328
chryslis	351
eggs	196
Gardens	31
larvae	484
Laying eggs	16
Life Cycle and Anatomy	30
Lundholm Farm	1257
Maine	61
Maps	17

Here is a tree from the Lightroom Library that shows two projects—one on Manchester-Essex Woods and one on Monarch Butterflies.

### DATE FORMATS

Shorthand ways of ordering and separating days, months, and years vary from country to country. However, sorting on the computer works best when dates are in the format yyyy-mm-dd.

When you move your images from your camera to your computer and then to an optical disc, you need to do so in an organized way. It doesn't take long to be overrun with images; and all of them with meaningless names to boot. Luckily, with some planning, and the right tools and knowledge, you can work with thousands of images without getting lost.

Before transferring images from your camera to your computer, you should develop a system that lets you quickly find them later. Folders are the heart of any image management system. The best way to organize images on your computer is to create one or more folders for images and then subfolders that meaningfully identify the images stored in them. The thing to keep in mind is that your organization is not about storing images, but about finding them. Ask yourself, where you'd most likely look for pictures of interest a year from now, long after you've forgotten where you stored them.

There are a variety of ways to organize and name folders depending on what kind of photos you take or how you use them.

- **A chronological organization** uses folders named with dates in the format *yyyy-mm-dd*. For example, a folder named *2010-02-10* would contain photos taken or downloaded on February 10, 2010. When using dates, be sure to add zeros to single digit months and days or the folders won't sort into a perfect chronological order. You can use hyphens or underscores between elements, and although they are allowable, some people avoid using spaces.

- **A subject organization** uses folders named after subjects, events, projects, or experiences. For example, a folder named *Christmas 2010* would contain images of that day. *Emilys Birthday 2010* would contain images of the birthday party.

These two approaches aren't mutually exclusive. For example, if you organize images chronologically, you can add a comment after the date that indicates the subject or project. Although duplicating images should be avoided as much as possible, you can also create a chronological system, and then copy selected images to separate subject or project folders. The chronological folders act as an archive of original images, and the subject or project folders become the versions you edit, print, or distribute. This system has the advantage that you never actually edit your original photos. The drawback is that you can have different versions of the same image in more than one folder. As you'll soon see, the latest image management programs give you the same advantages using collections or albums (based on the same concept as iTunes playlists). When combined with non-destructive editing you never need more than one master copy of any photo on your system, because each master can have many variations.

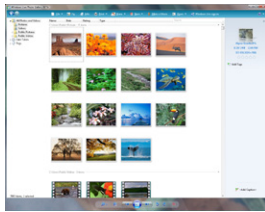
Once you have developed an organizational system that works for you, you need to decide what folders and files should be copied or moved to optical discs or a hard drive for backup or long term archival storage.

The tools you use to create folders, and view, transfer, and manage images include those that come with your computer as part of the operating system. However, image management applications are better because they store thumbnails, descriptions, rankings and keywords in a database so you can even locate images that are stored on optical discs in a drawer. We'll explore these tools in the sections that follow.

## IMAGE MANAGERS

### TIP

A thumbnail image is actually created at the time you take a picture. In a JPEG image it is stored in the image file as metadata and goes anywhere it goes.



Windows Live Photo Gallery is a free program that lets you manage your digital photos on Windows PCs.



Apple Macs have the iLife suite of applications installed including iPhoto and iMovie.

Lightroom creates a record for each of the images in its database called the Library. You then use Lightroom to view this data, including thumbnails and Exif information, in a variety of ways.

If you've set up your folders systematically, it's not hard to locate images taken on a certain date or during a certain period. However, you need to see the actual images to choose the specific ones that interest you. You can do so with any program that displays your images as small thumbnails. Viewing thumbnails is so important this feature has been integrated into operating systems and almost every digital camera and photography program. However, thumbnails are only one resource offered by programs designed specifically to manage large collections of images. These *image management applications* not only let you view thumbnail images and information about the images, they permanently store this information in a *database*, often called a *library* or *catalog*. What is a database? In one respect it's just a rigidly organized collection of facts. You interact with databases every day without even knowing it. For example, when you use Google to search for the phrase "*digital cameras*," you are searching Google's database for Web pages in which that phrase appears. Another familiar database is iTunes' Library where songs and information about them are stored.

Although you never see that actual database it is a table, much like a spreadsheet, with one row or *record* for each image in the catalog. Each record contains a number of columns or *fields* that contain specific facts about the image. Typical fields might be the date the picture was taken, the camera used to take it, the size of the image in pixels, and the name of the file. The record for each image has the same fields, and this is what makes the database so powerful. You can sort the table based on the contents of any field. For example, you can sort it by the date pictures were taken, by their size, or format. You can also search the database by specifying what field to search in and what data, called a *criteria*, to find. For example you can search the date fields for pictures taken or modified on a certain date. Any images that contain the specified data in the specified fields are listed. Databases also let you view the information in different ways. You can have it display just thumbnails; or thumbnails, filenames, and image sizes. Another view might include the Exif information so you can see what shutter speeds or lens focal lengths were used for each image.



In an image database there is a record (red row) for each image and a number of fields (blue column).

File Name	File Size	File Color Space	Color Depth	Shutter	Aperture	Flash
IMG_1000.JPG	13 MB	SRGB	24 Bits	1/200	f/8.0	On
IMG_1001.JPG	11 MB	SRGB	25 Bits	1/800	f/11.0	On
IMG_1002.JPG	12 MB	SRGB	26 Bits	1/500	f/5.6	Off
IMG_1003.JPG	15 MB	SRGB	27 Bits	1/600	f/11.0	Off
IMG_1004.JPG	10 MB	SRGB	28 Bits	1/125	f/16	Off
IMG_1005.JPG	11 MB	SRGB	24 Bits	1/500	f/2.8	Off

## Movie

Click for a movie on Portfolio, an asset manager from Extensis.

Many image management applications also catalog other kinds of files such as movies, sounds, and the like. For this reason, these programs are called by the more inclusive name *asset managers*—each file on your system from a Word document to a digital image being an asset.

Database-backed image managers are used to manage small and large collections of images. Their features only grow in importance as the number of photos on your system increases. Here are some of their most important features.

### CATALOGS

The database in which image information is stored is often called a *catalog*. Once a photo has been added to the catalog, all of the image management and editing tools can be used on it. Some early applications forced you to copy the original image files into the catalog so the catalog could never be larger than the drive it was stored on, and as the catalog got larger it got slower. Newer applications let you copy or move photos into their catalogs if you want, but also let you reference photos anywhere on your system and even those stored off-line. For example, you can take an optical disc or external hard drive out of a drawer, add its contents to your catalog, and return it to the drawer. You can then view thumbnails and even larger previews of the images even though they are no longer on the system—called *off-line*. This is because you are actually viewing thumbnails and previews stored in the database when the images were added to the catalog. Each thumbnail or preview in the catalog is linked to its full-size image or points to it. If you double-click a thumbnail or preview of an image that's still on the system, the image opens full-size. If you double-click a thumbnail or preview of an image that is on an optical disc or backup hard disk drive that's in a drawer, some programs give you the name of the disc on which it's stored and prompt you to insert the disc or connect the drive.

If your catalog ever gets too large or too slow you can create more than one catalog—perhaps one for professional work and another for personal. However, you can't work on both catalogs at the same time so this approach has limits.



In Lightroom you can mark images with keep or reject flags, stars, and color labels and then display only those images having the rankings you assigned.

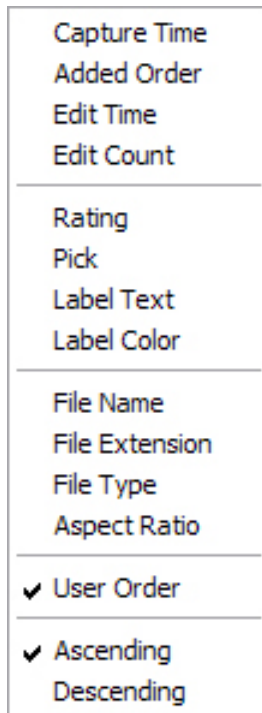
### TRACKING

Photographers often like to move photos around, rename them, and delete them. If you do this from within the image manager the program keeps track of the images of and accurately reflects the changes.

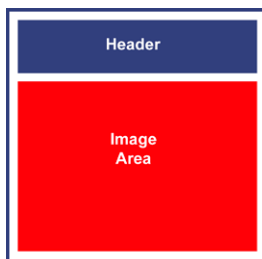
### WATCHED FOLDERS

You can specify that certain folders be watched so when you copy or move files into these folders without using the image manager to do so, they are automatically added to the catalog. The contents of the folder and the catalog are synchronized.





The Sort menu choices in Adobe's Lightroom.



The header is an area of the file separated from the image data.

## SORTING

You can sort your images in a number of ways including by the date they were taken, their filenames or extensions, and the date they were imported into the database. Sorts can be in ascending or descending order.

## RANKING

Most of the photos we take turn out to be disappointing so we usually focus on just a few photos. For this reason programs let you assign a ranking to images. The best might get a 5-star ranking while the next best 4-stars and so on. Variations of this are to mark images with pick or reject flags or with color labels to which you can attach meanings. Once ranked in one of these ways, you can display only those photos that match the specified criteria.

## KEYWORDING

You can assign keywords to images or groups of images to make it easier to find them later. Keywords can refer to such things as the location, subject, people, and so on. If you are consistent with keywording, you will be able to easily search for and display all of the photos of "Emily" that you took in "Santa Barbara" over the years.

## FILTERS

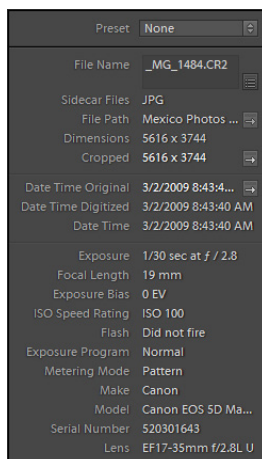
When you have a large number of photos in your catalog, you may only want to work with a small subset. To determine which images are displayed, you can use filters. For example, you can tell the program to only display pictures taken this week, this month, or on any given day. You can also display just those that have a five star rank or all photos that have been assigned any rank up to a certain level. Filters vary from program to program but all serve the same function—filtering out photos that don't interest you so you can zero in on the ones that do.

## METADATA

When you take a picture, the camera stores information about it along with the image data. You can also add additional information using some cameras and photo-editing or image management applications. The more information you have to work with, the easier it will be to find an image later.

- **Exif** (Exchangeable Image File Format) is a specification that spells out how information about a JPEG image is stored in the same file as the image. This information, including a thumbnail image, describes the camera settings at the time the picture was taken, and even the image's location if the camera supports GPS (Global Positioning System). Digital cameras record this information as *metadata* in an area of the image file called the *header*. This information isn't just for managing images, it can also be used by some printers to give you better results. Basically, any camera control set to auto at the time the image was taken can be manipulated by the printer or other device to improve results. Those set to one of the camera's manual choices is considered to be a deliberate choice and is not manipulated.

Metadata can sometimes be lost if a file is opened and then saved in another file format. (Or even lost when using the camera's own rotate, crop, or other commands that write to the disk.) However, most applications now preserve this information, although camera companies sometimes store secret metadata that can be lost.



Exif metadata is displayed for a selected file in Lightroom.

**METADATA?**

Metadata is data about data. In digital photography it's information inserted into the header of an image file that describes the contents of the file, where it came from, and what to do with it. You are already familiar with two examples, an image file's name and the date it was created. Other metadata includes the Exif data created by most digital cameras that records such data as what camera was used, what the exposure was, and whether a flash was used.

• **IPTC.** Using an image management application, you can often attach information to an image such as keywords, a copyright notice, or a caption. The problem is that when you send the image to someone else, that information is usually not sent along because it's stored on your computer in the database and is not part of the image file as Exif information is. (As you will see shortly, one solution to this problem is the xmp file.) To solve this problem, the International Press Telecommunications Council (IPTC) defines a format for exchanging such information. Programs that support this standard let you add, edit, and view information about an image and it's embedded in the file just as Exif information is.

**PREVIEWS**

When reviewing your images in detail, you'll generally find thumbnail images too small and full-sized images too slow to open and edit. For this reason image management programs will normally generate full-screen preview images that are then stored in the database. These need only be as large as the screen to be useful. In fact, on some applications you are normally viewing and editing a preview image. You only see the original image when you enlarge the preview past the size where it fills the screen. Since the preview is so much smaller than the original image this increases the application's response time.

**COLLECTIONS**

One rule of all databases is that an image should only be stored once. When you need the same image to appear in a number of projects, you don't create duplicates. Instead, you create *collections*, sometimes called *albums* or *projects*, of related images. The same image can appear in any number of such collections even though there is only one copy of the image on the system. (If you are familiar with the iPod, this is exactly how playlists work.) When you assign an image to a collection, the program just copies its thumbnail and information about it and adds a link to the full-size image. For example, if you have an image that you want to use in both a book and a calendar, you would create collections for each of these projects and add the image to both.

**STACKS**

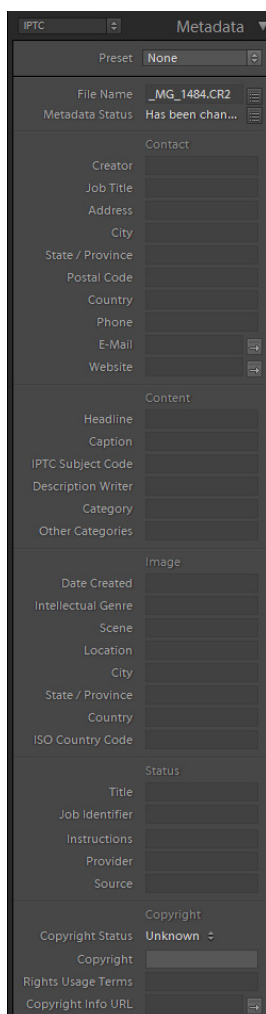
Stacks are sets of related photos such as a series captured in continuous mode or using autoexposure bracketing. You can collapse a stack so only the image you specify as representative of the stack is displayed, or expand the stack when you want to view and compare all of its images. Stacks reduce the clutter on your screen because you don't have to scroll through all of the stacked images unless you choose to. Although you can manually stack selected images some applications use metadata, such as how close together photos were taken, to automatically organize some images into stacks.

**LIGHT TABLE**

When working on a project such as a slide show, Web site, or publication, there comes a point when you'd like to see the photos you've taken arranged more like they will appear in the finished work. Film photographers did this by arranging slides on a light table so they could experiment with combinations that would create a particular visual effect. In an image management program an area of the screen provides the digital equivalent; a freeform digital canvas on which you can place, align, resize and group images in an unconstrained way.

**NON-DESTRUCTIVE EDITING**

*Non-destructive editing* means that at any point you can undo any changes you have made to an image.



*IPTC metadata is displayed for a selected file in Lightroom.*

## EXPORTING

With RAW images or non-destructive editing the original file is never changed. Your edits are applied to a copy of the image when you export it in another format, to a different folder or disk, or to a file with a different filename. When you do so you can also resize the image, attach a color space, specify a file format and the amount of compression.

## XMP

Applications using *non-destructive editing* store your edits in the database and reapply them to an image whenever you reopen its file. When you send one of your edited images to someone, or copy/move it to another system, the edits are left behind in the database. If you want to share the edits along with the image, programs such as Lightroom use Adobe's Extensible Metadata Platform (XMP) to embed editing metadata into the image file itself or in a separate "*sidecar*" file with the same filename as the image but the extension *xmp*. The metadata can include the list of editing changes you have made to the image as well as Exif and IPTC metadata. Other applications that support XMP can access and use the metadata so you can see the editing changes on other systems. However, if you share the image file without its accompanying XMP file, the recipient can't see your edits.

## ARCHIVING

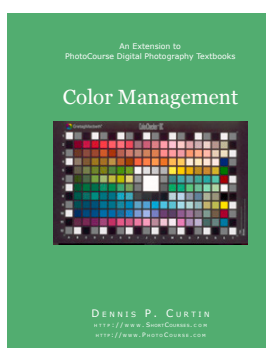
When you are finished with photos but want to save them, you should be able to archive them along with their metadata. Ideally you can easily select the images and burn them to an optical disc or copy them to a backup hard drive, and they remain listed in the catalog so you can see their thumbnails, previews and metadata. If you select an image that's off-line you may be prompted to insert the disc on which it's stored.

If you want offsite backup, so the same accident can't affect your originals and your backups, backup Web sites may be the answer. Once you subscribe to one of these services when you change or add files, they are backed up in the background while you work on other projects. The only problem with this form of backup is that it can be very slow even with a fast Internet connection. However, after the initial backup of all important files, only new or changed files are backed up so it goes much faster.

## USING ALL OF THE FEATURES—THE WORKFLOW

When a photographer returns from a shoot, his or her goal is to process images as quickly as possible. Here are some of the workflow steps many photographers might follow in a program such as Lightroom.

1. Add the photos to the catalog.
2. Select all of the images and add a copyright notice to each.
3. Select all of the images and add keywords.
4. Scroll through the images and rank them using stars, colors, or pick/reject flags. Delete the rejects
5. Edit images, export them in the desired format and share them.



*Click for a PDF extension on color management so you know why your screen should be adjusted for best results.*



## EVALUATING YOUR IMAGES—BASICS

### CHANGES

Without you even being aware of it, your camera is making changes to your JPEG images that cannot be undone. These include such things as sharpness, white balance, and contrast. If you want to adjust these yourself, use the camera's RAW format if it has one.

When you open an image on the computer, you really get to see it for the first time. The display on the camera's monitor is so small, captured images are hard to evaluate. So what do you look for when deciding if the image you are looking at can be improved? In this section we'll get you started. As you learn to identify characteristics that can be improved, you'll also discover there is frequently more than one way to adjust them. Many people start with a photo-editing program's automatic adjustments because they are so easy to use. However, it won't be long before you find yourself migrating to more powerful tools that take more practice, but which give results that make the extra effort worthwhile.

To properly evaluate images your system should be color managed, as we discuss later. At times you should also enlarge images to 100% (sometimes called 1:1 or Actual Size) or use a digital loupe to zoom in to examine details.

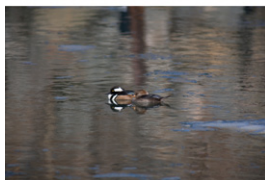
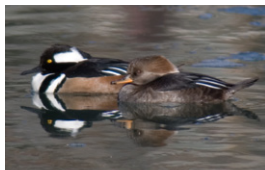
As you examine your images, here are some things to look for.

### EVALUATING IMAGE SIZE AND ORIENTATION

The initial size and orientation of an image is determined by what the camera captured. There are situations in which you may want to change these characteristics.

### PDF

Click for a PDF extension on pixels and read Part 5 on changing image sizes.



*Cropping (top) is one way to emphasize the key parts of an image or make it fit a format, perhaps in a magazine layout.*

### Movie

Click for a movie on adjusting tonal ranges.

- **Resizing** can be done in two ways. The first is done by changing the number of pixels in the image, called its *pixel dimensions*, through a procedure called *resampling*. This process adds or removes pixels to make the image larger or smaller. You might want to do this to reduce the size of images you will be sending by e-mail or posting on the Web. You might also want to increase the size of the image when making large prints. However, increasing the number of pixels in an image doesn't always make the image better. In fact it usually has the opposite effect. You can also change the size of the image without changing the number of pixels it contains, called its *document size* by specifying the pixels per inch. You normally do this when making a print or exporting an image to another application.

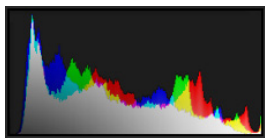
- **Cropping** removes distracting or unimportant parts of an image. You might also want to crop if the image has to fit into a specific design such as a newsletter or greeting card.

- **Rotating** an image may be necessary if you turned the camera vertically to capture a picture, or if the horizon line is tilted.

### EVALUATING THE TONAL RANGE

Dynamic range in music is the range between the faintest and loudest sounds that can be reproduced without distortion. In photography the dynamic range, called the *tonal range* or *contrast*, indicates the range of brightness in an image between pure white and pure black. There are two ways to evaluate the tonal range of an image—visually and using a histogram (discussed in the next section). You should use both approaches because they are not mutually exclusive. For example, you can analyze an image visually and then learn why it's the way it is by checking its histogram.

Visually, images that use the full tonal range look rich and crisp, with vibrant colors and smooth transitions in tones. Those that don't use the full range



One way to evaluate the tonal range is with a histogram that charts the various levels of brightness in the image.

lack contrast, often looking flat and dull. Details may be missing in highlight and shadow areas or the image may be too dark or light. In these cases you may want to adjust or expand the image's tonal range.

### EVALUATING COLORS

The human eye perceives color in terms of three characteristics—hue, saturation and brightness and there is even a color model based on these characteristics, called HSB. The color monitor uses a different color model called RGB because images are displayed using varying amounts of red, green, and blue light. When evaluating images, you can think in terms of these two models—one to evaluate colors and the other to look for color casts.

To evaluate colors in an image, think of them in terms of hue, saturation, and brightness because these three aspects can be adjusted.



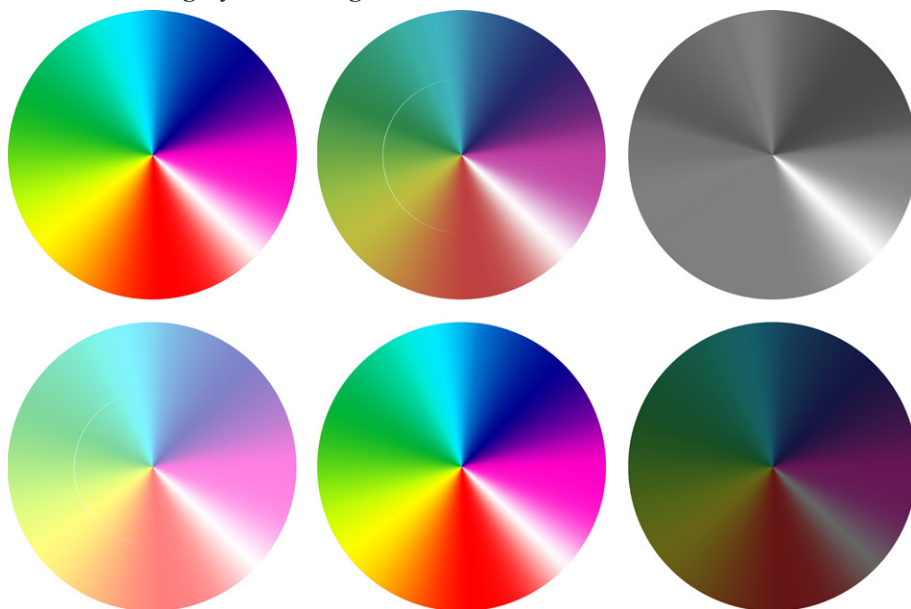
Hues can be arranged on a color circle or wheel.

- **Hue** is unique in one respect, it is the actual color, as measured by its wavelength, while the other two characteristics (saturation and lightness) modify the hue in some way. The hue can be red-orange, yellow-green, blue-purple; or any intermediate color between those pairs.

- **Saturation**, sometimes called *chroma*, is the strength or purity of the color. If you adjust saturation through its entire range, colors go from rich and vibrant to dark gray.

- **Lightness**, also called *luminance* or *brightness*, is the relative lightness or darkness of the color. Brightness is reduced by adding black to the color mix and increased by adding white. If you adjust brightness through its entire range, colors go from white to black. This is the only one of the three color attributes that gray scale images have.

As you decrease saturation (top), colors become muddier and finally gray. As you decrease lightness (bottom), colors become darker and eventually black.



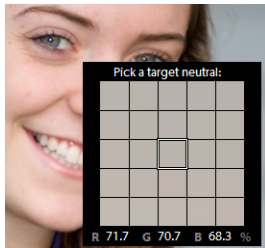
### Movie

Click for a movie on adjusting hue, saturation and brightness.

### NEUTRALS

A neutral color has equal amounts of red, green, and blue and appears as a shade of gray.

A color cast is usually caused when one or more of the three color components (red, green or blue) are too high or low over the entire image. This can be caused by not setting white balance correctly, by photographing a scene illuminated by more than one type of light source, or even photographing a subject picking up reflections from a colored surface. Color casts are very noticeable when shooting during sunrises and sunsets—but there we usually like the effects. It's easiest to identify a color cast by looking at areas that should be neutral white or gray. If these areas have any colors mixed in, the



As you point Lightroom's white balance selector tool at a pixel in an image, the pixel's color mix is displayed. If you click that pixel, it and all like it will become neutral.

image has a color cast that you should remove. Pure white areas should have R, G, and B settings of 255. Gray areas should have R, G, and B settings that are equal; for example, 128, 128, and 128 for middle gray. Pure black areas should have R, G, and B settings of 0. Regardless of which neutral tone you are examining, if one or more of the RGB values is higher or lower than the others, these tones won't be neutral and will have a color cast.

#### EVALUATING DETAILS

When examining an image, look for small imperfections that can be re-touched. The camera's image sensor may have dust on its surface that shows up on the image as dark spots. A portrait subject might have a small blemish that will be very noticeable when you enlarge the image. There may be reflections, or even telephone wires you want to remove. Small areas may benefit by being made a little lighter or darker than their surroundings. Portrait subjects taken with flash may have red-eye that needs to be removed.

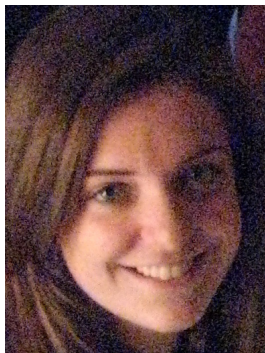
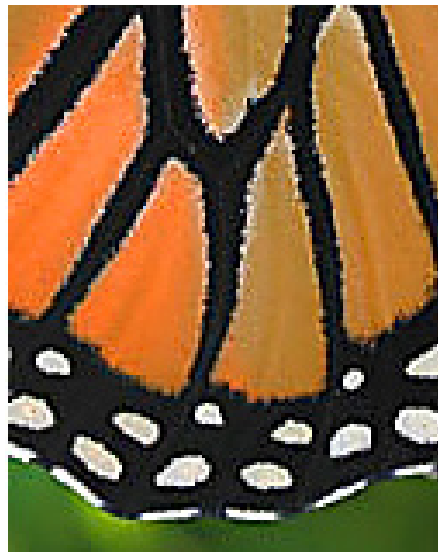
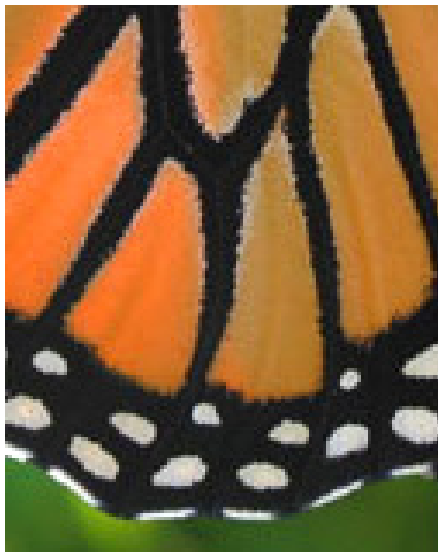
#### EVALUATING SHARPNESS

The apparent sharpness of an image depends a great deal on how much contrast there is along edges and lines. If an image looks soft, it can often be improved by sharpening, a process (technically called *unsharp masking*) that adds contrast along lines and edges. Many photographers sharpen almost every image at least a little, ignoring this aspect only for images such as fog scenes that are deliberately soft.

Sharpening (right) increases the contrast between light and dark areas to make the edges appear sharper.

### Movie

Click for a movie on sharpening an image.



Noise can significantly degrade smooth tones.

#### EVALUATING NOISE

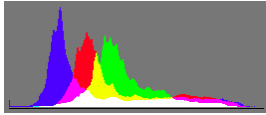
If you used a long shutter speed or high ISO setting to take a photo, it may contain noise. Look in dark areas for randomly colored pixels that look like grain.

#### GLOBAL VS LOCAL EDITING

You may have noticed that some of the adjustments discussed in this section affect the entire image and others affect just specific areas. These are referred to as *global* and *local adjustments* and are discussed in sections that follow.



## EVALUATING YOUR IMAGES—HISTOGRAMS

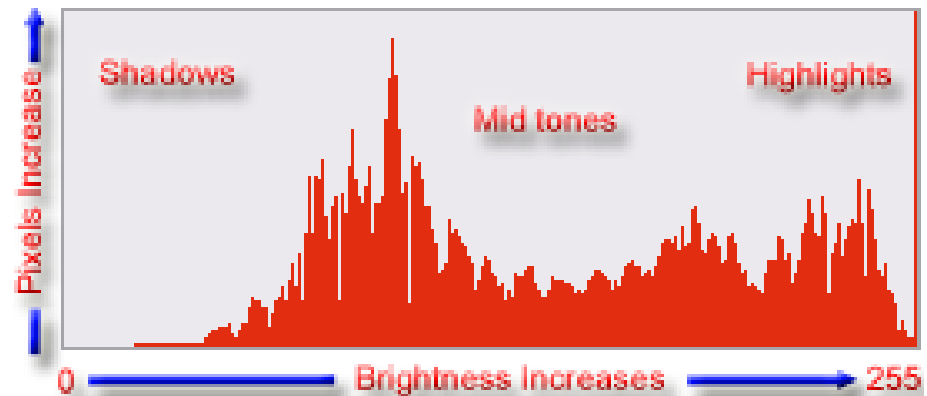


*There are two kinds of histograms. Most cameras show one of the gray scale brightness levels. A few display an RGB histogram showing the brightness of each of the three colors, red, green, and blue.*

Most serious photo-editing programs let you use a histogram as a guide when editing your images. However, since most image corrections can be diagnosed by looking at a histogram, it helps to look at it while still in a position to reshoot the image. It's for this reason that many cameras let you display histograms on the monitor in playback mode or while reviewing an image you have just taken. A few cameras even let you see a histogram as you are composing an image so you can use it as a guide when adjusting the camera settings you'll use to capture the picture.

### EVALUATING HISTOGRAMS

As you've seen, each pixel in an image can be set to any of 256 levels of brightness from pure black (0) to pure white (255) and a histogram graphs which of those levels of brightness are in the image and how they are distributed. The horizontal axis of a histogram represents the range of brightness from 0 (shadows) on the left to 255 (highlights) on the right. Think of it as a line with 256 spaces on which to stack pixels of the same brightness. Since these are the only values that can be captured by the camera, the horizontal line also represents the image's maximum potential tonal range or contrast.



The vertical axis represents the number of pixels with each of the 256 brightness values. The higher the line coming up from the horizontal axis, the more pixels there are at that level of brightness.

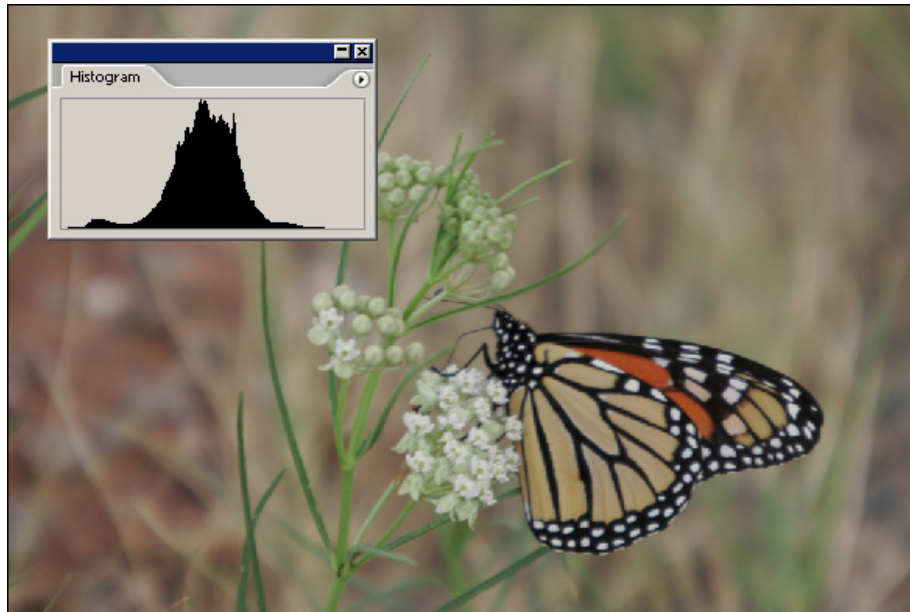
To read the histogram, you look at the distribution of pixels. Here are some things to look for.

- Many photos look best when there are some pixels at every position because these images are using the entire tonal range.
- In many images, pixels are grouped together and occupy only a part of the available tonal range. These images lack contrast because the difference between the brightest and darkest areas isn't as great as it could be. However, this can be fixed in your photo-editing program by using commands that spread the pixels so they cover the entire available tonal range so photos that appear dull and washed out become bright and vibrant. These controls allow you to adjust the shadow, midtone, and highlight areas independently without affecting the other areas of the image. This lets you lighten or darken selected areas of your images without losing detail, perhaps to bring out details in shadows and highlights. The only pixels that can't be adjusted in this way are those that have been "clipped" to pure white or black.

When adjusting the histogram at the time you are taking photos, here are some things to keep in mind:

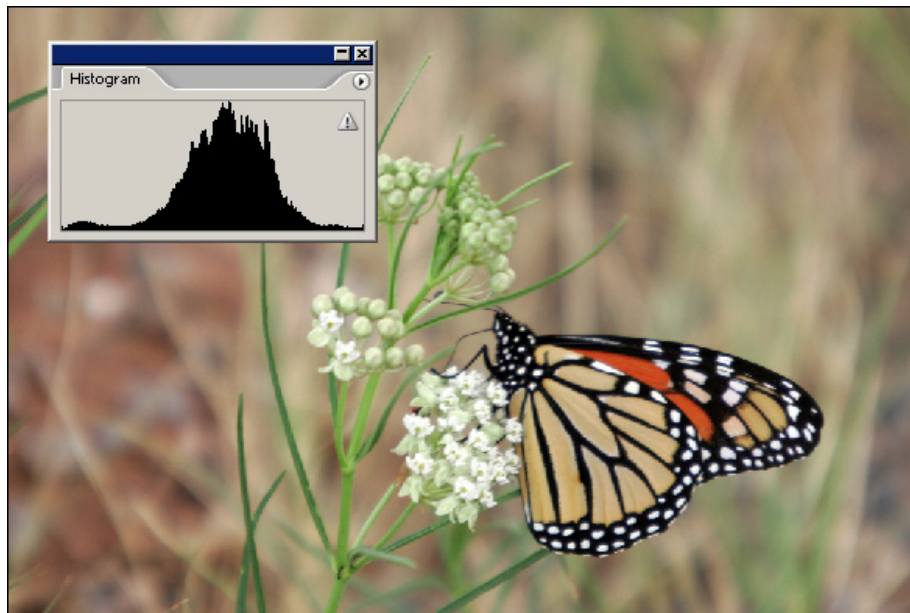
- If the histogram shows most pixels toward the left (darker) side of the graph, use exposure compensation (discussed in the next chapter) to add exposure.
- If the histogram shows most pixels toward the right (lighter) side of the graph, use exposure compensation to reduce exposure.

*The original image (top) is flat and its histogram indicates only part of the tonal range is being used. A photo-editing program was then used to expand the tonal range (bottom). You can see the change in both the image and in the histogram.*



## Animation

*Click to explore histograms.*



## Animation

*Click to explore how overexposed highlights blink.*

### HIGHLIGHT WARNING

One thing you want to avoid is overexposing highlights so they become so bright, or “clipped”, they lose details. To help you avoid this many cameras display a highlight warning when you review or compose your images. Areas that are so overexposed they have no detail blink or are outlined in color.

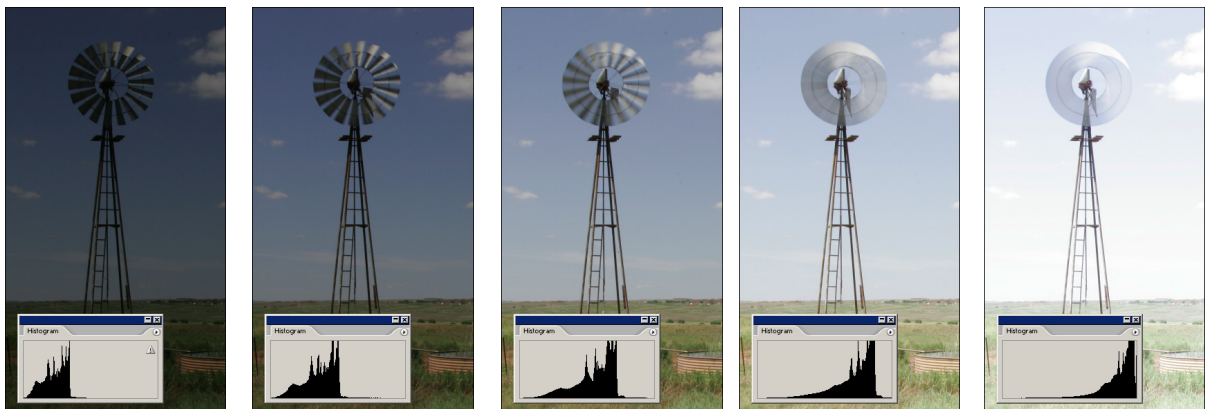
## CLIPPED PIXELS

When a histogram shows pixels at the extreme ends of the range, in the 0 and 255 positions, it means details in those tones are lost or “clipped” in your image. These extremes should be reserved for specular highlights (reflections) and small dark shadows. When large areas lack detail an image suffers.

*In the top image you can tell from the histogram that some of the highlight pixels are pure white and hence clipped. There is nothing you can do later to display details in the area of these pixels. However, if you reshoot the scene at a different exposure you can shift the pixels to the left and avoid the clipping (bottom).*



To avoid clipping and better place the tonal values in subsequent shots, you use exposure compensation. Increasing exposure shifts pixels to the highlight, or right end of the histogram. Decreasing exposure shifts them the other way. Unless you are deliberately trying to get pure whites or pure blacks, you should shift the pixels if any are being clipped. You can then adjust the tone of these pixels in your photo-editing program while still retaining details.



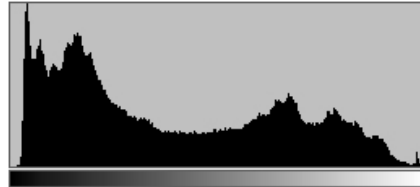
*This series of photos was taken one stop apart using exposure compensation. As the exposure increased, pixels on the histogram shifted right. You can tell from the way the fan blades blur that the shutter speed was changed to change the exposure. In the image where it was faster, the image is darker and the blades are frozen. As slower speeds were used to increase the exposure, the images get lighter and the blades more blurred.*



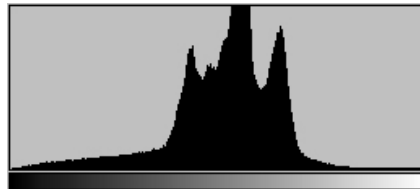
## SAMPLE HISTOGRAMS

The way a histogram looks depends on the scene you're shooting and how you expose it. There's no such thing as a good or bad histogram other than one that shows unwanted clipping. Whether a particular histogram is good or bad depends on what you are trying to accomplish. In fact, you may prefer to trust your visual reaction to the image more than the very numeric image data provided by a histogram. However, even if you never use a histogram, you can learn about digital photography by understanding what a histogram can show about an image. Following are some histograms from good images along with a brief summary of what each histogram reveals.

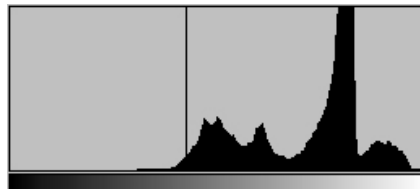
*In this well exposed portrait there is a fairly even distribution of values in both the shadow and highlight areas of the image. There are no pure blacks in the image as shown by the gap at the far left end of the scale.*



*This brown moth on a gray card has most of its values in the midrange. That's why there are a number of high vertical lines grouped in the middle of the horizontal axis.*

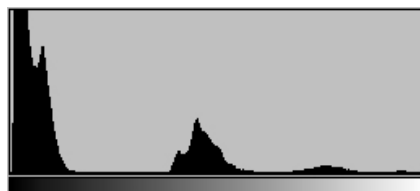
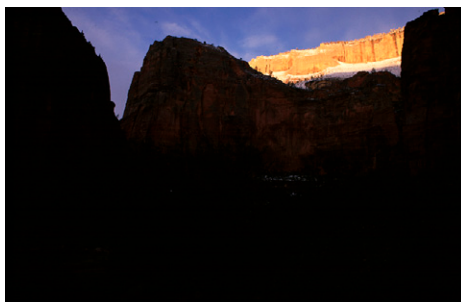


*This high-key fog scene has most of its values toward the highlight end of the scale. There are no really dark values in the image. The image uses only a little more than half the camera's dynamic range.*



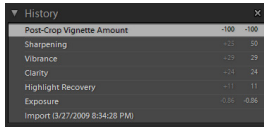
*The distinct vertical line to the left of middle gray shows how many pixels there are in the uniformly gray frame border added in a photo-editing program.*

*This low-key scene has the majority of its values in the shadow area with another large grouping around middle gray. There are wide levels of brightness that have only a few pixels.*





## PHOTO-EDITING—GLOBAL EDITING



The Lightroom History Panel in the Develop module.

## Movie

Click for a movie on improving a photo.

## Movie

Click for a movie on changing a photo into something quite different.

### THE GOOD OLD DAYS?

In the days of film, control over prints in the darkroom was limited. You could control contrast by your choice of paper and contrast filters. You could make local changes by dodging to lighten areas or burning to darken them. When making color prints you could adjust color balance using filters. Before getting too carried away with the things you can now do, keep in mind that almost all of the greatest photos in the history of photography were made with these few adjustments.

In 1932 a group of young photographers including Ansel Adams and Edward Weston started a group they called f/64 to champion straight photography over the heavily manipulated pictorial photographs so in vogue at the time. The movement grew and when Edward Steiglitz published the work of another straight photographer, Paul Strand, in his magazine *Camera Work* he wrote “... *The work is brutally direct. Devoid of flim-flam; devoid of trickery and any ‘ism’; devoid of any attempt to mystify an ignorant public, including the photographers themselves. These photographs are the direct expression of today...*” This movement became known as “straight photography” and there are still echoes of the arguments it generated. The pictorialists of today are those who use Photoshop to heavily manipulate their images so they fall out of the field of photography and into the realm of the graphic arts. There is an entire industry of these people offering newsletters, Web sites, workshops, conventions, videos, books, and magazines, all devoted to manipulating images in this way. On the other hand, straight photographers try to have their photos accurately represent the world as it is. It’s helpful to understand these arguments because Apple’s Aperture and Adobe’s Lightroom are really tools for straight photography and straight photographers and it helps you to put them in a historic context.

Straight photography doesn’t mean you don’t try to improve an image, in fact it’s the rare image direct from a digital camera that doesn’t need some tweaking. However Photoshop has become so complex, and has so many graphic arts features, that there was a need for programs that were more photographic in philosophy. Serious amateurs needed one that was more intuitive and easier to learn. Professionals needed one that would allow them to work faster and more efficiently—especially when dealing with a large number of images. Thus were born Aperture and Lightroom, programs that emphasize global procedures that affect the entire image.

One interesting aspect of Lightroom and Aperture is that any changes you make don’t alter the original pixels in your image so you can undo any edit at any time. This *non-destructive editing* is accomplished by storing a list of your edits in the database along with the image itself. When you open the image in Lightroom, it uses that stored list to reapply the edits so they are used when you display, print, or export the image. In essence these programs treat your images as digital negatives or masters and preserves them as such. If you ever want to return an image to its original form, you do so with a click of the mouse.

Lightroom and Aperture are designed to make working with RAW images as easy as working with JPEGs. You can display, zoom, adjust, add keywords, print, and create Web page layouts using both formats without intermediate format conversions. Both programs also let you work in the same way with other image formats including TIFF and Photoshop’s native PSD.

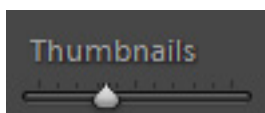
### THE ANATOMY OF LIGHTROOM

When you first start Lightroom, you’ll notice it’s divided into sections.

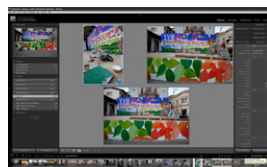
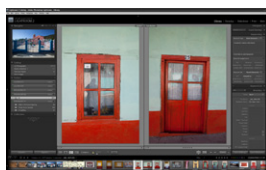
1. **The menu** at the top of the screen offers access to commands. The commands change as you change modules.
2. **The module picker** in the top right of the screen is where you select *Library* so you can import, organize and select photos for editing, *Develop* so you can perform image adjustments, *Slideshow* so you can create slideshows

## SAVING WORK

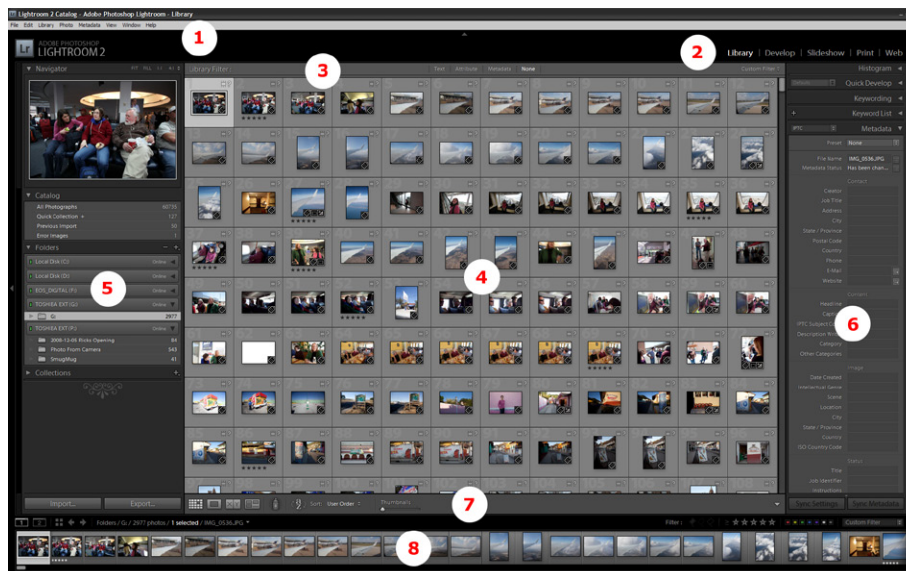
One of the best things about Aperture and Lightroom is the way they retain your workspace when you end a session. There is no need to save your work. It's all saved automatically and the next time you start the application everything is the way it was when you quit. If you were editing 100 photos for a book, they are all right there. There is no need to open each of the images before you get started.



In grid view dragging the thumbnail slider adjusts the size of the images.



In compare view Ctrl-clicking images displays two or them for comparison. In survey view the same technique lets you compare 2 or more images.



for on-screen viewing and exporting as PDF files, *Print* so you can set up your printouts, and *Web* so you can create Flash or HTML web galleries. On the left side of the screen is an identity plate and progress monitor.

3. **The Library Filter bar**, displayed only in Grid view, lets you find photos by specifying text such as keywords; attributes such as star ratings, color labels, and flags; or metadata fields such as the camera or lens used.

4. **Image display area** in the center of the screen is where selected images are displayed in all modules.

5, 6. **Panels** to the left and right of the image display area contain tools, layouts, and information you use when working with images. The available panels change as you change modules so you always have access to just those tools you need for the immediate task. In most situations panels on the left contain content and preset browsers, while panels on the right contain the tools you need for the current task. Clicking a panel's header collapses and expands it.

7. **The toolbar** has buttons you can click and these perform different functions in different modules. You can display and hide this toolbar by pressing T. In the Library and Develop modules clicking the drop-down arrow on the right end of the toolbar lets you specify which buttons are displayed.

8. **The filmstrip** at the bottom of the screen shows the photos in the selected folder, collection, quick collection, or keyword set and they remain displayed when you change modules. Unless photos are in the filmstrip, they cannot be accessed from the other modules. The only way to change which images are displayed is to return to the Library and make the change there. Immediately above the filmstrip is a *tool strip*.



## THE LIBRARY MODULE

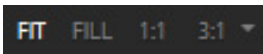
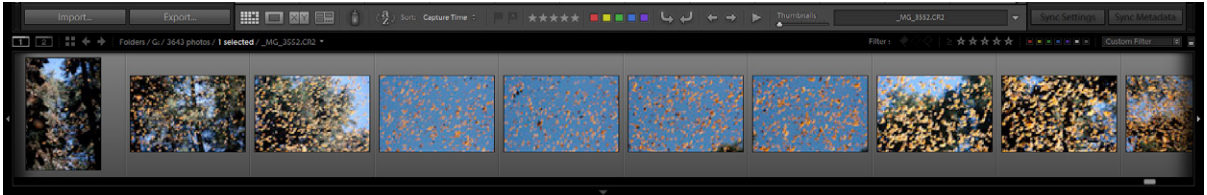
The first time you use Lightroom, you open the Library and import photos from drives on your system or directly from a camera or memory card. You



Icons you click to change the content area to grid, loupe, compare or survey views.

have the choice of leaving the original images where they are (as you might when importing from folders on your system) or moving them into a folder you specify.

- **The image display area** has four modes between which you switch by clicking buttons on the toolbar (below): *grid* for thumbnails, *loupe* for full screen or zoomed display of an image, *compare* with two images side by side, and *survey* to compare one image against any number of others. In grid view thumbnails can be set to various sizes from extra small to extra large.

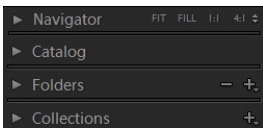


Buttons in the navigator panel let you specify the size of the image you are editing.

- **The toolbar** in the library module has buttons that change the view in the image display area, stars to rank photos, pick and reject flags, and rotate buttons. Any or all of these tools can be hidden or displayed.

- **Filmstrip buttons** above the thumbnails change the view in the content area, navigate through images, and turn filters for stars, flags and colors on and off. Photos that don't meet the criteria are filtered out and not displayed.

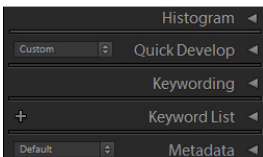
- **Navigator** panel lets you scroll around zoomed images.



- **Catalog** panel lets you specify if all photos are listed or just those in the quick collection or previous import.

- **Folders** panel is where folders of imported photos are listed.

- **Collections** panel lets you gather together related photos for a project.



Left and right panels in the Library module.

- **Histogram** panel shows the distribution of tones in the selected image and a few of the camera settings used to capture it. You can adjust the displayed tonal range with sliders or by dragging the histogram itself.

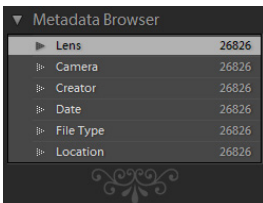
- **Quick Develop** panel lets you make adjustments to your images. The choices are described in the section on “The Develop Module.”

- **Keywording** panel lets you add keywords to selected photos.

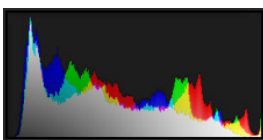
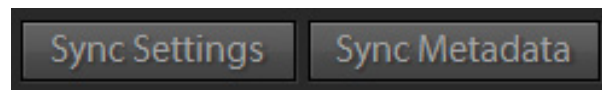
- **Keyword List** panel is where you click keywords you have assigned to images so just images with the selected keywords are displayed.

- **Metadata** panel lists Exif and IPTC metadata for the selected image and lets you enter additional IPTC metadata.

- **Sync** lets you select one image, then select others. When you then click the *Sync Settings* or *Sync Metadata* button the edits or metadata in the first image are copied to the others.



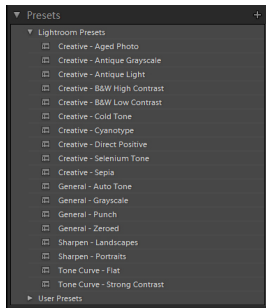
The metadata browser.



The histogram is a good way to locate the white and black points and adjust the tonal range.

## THE DEVELOP MODULE

For a complete discussion of all Lightroom features, you need a book devoted to the program. However, here are the procedures listed in Lightroom's *Basic* editing section—the ones almost every photographer thinks about for almost



*Presets, either those that come with the program or those you create and save yourself can be applied to all selected images with a click of the mouse.*

every image.

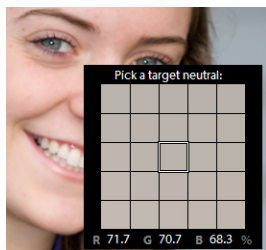
- **Navigator** panel lets you specify the size of the image and scroll around images larger than the screen display.
- **Presets** panel lists stored settings you can apply to images. You can create and save your own presets and they are added to the list.
- **Snapshots** panel lets you name and save a photo at any point in the editing process so you can return to that version just by clicking its name.
- **History** panel lists changes you made to images so you can undo them.
- **Histogram** panel shows the distribution of tones in the image.
- **Local editing tool strip** (see next section).
- **Basic** panel contains sliders you use to adjust the colors and other characteristics of your images. (This section is discussed in more detail shortly.)
- **Tone Curve** panel adjusts the tones in the image: highlights, lights, darks, and shadows.
- **HSL/ Color /Grayscale** panel adjusts hue, saturation and luminance; colors; and the grayscale mix.
- **Split Toning** adjusts hue and saturation independently in highlights and shadows.
- **Detail** has controls to sharpen, smooth and de-noise an image.
- **Vignetting** adjusts lens vignetting and applies a vignette (dark or light corners and edges) to a cropped photo.
- **Camera Calibration** lets you calibrate your own cameras if you find that Lightroom's generic profile doesn't meet your needs.

#### TOOL STRIP FOR LOCAL EDITING

Although Lightroom is primarily a tool for global adjustments, it does include the following essential tools for local adjustments. The buttons for each are displayed just below the Histogram panel on a tool strip.



- **Crop overlay tool** crops and rotates an image.
- **Spot Removal tool** repairs a selected area of a photo using a sample from another area.
- **Red Eye Correction tool** removes red-eye from flash portraits
- **Graduated Filter tool** applies exposure, clarity, brightness, and other tonal adjustments gradually as you drag across an image.
- **Adjustment Brush tool** locally adjusts exposure, brightness, contrast, saturation, clarity, sharpness, color and softens skin by painting the corrections with a brush.

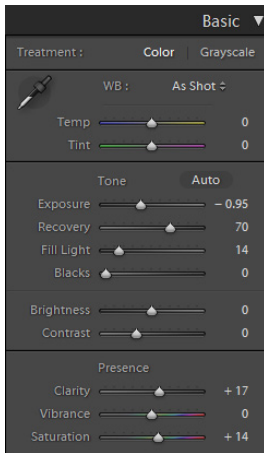


*Lightroom's white balance selector tool shows the colors of the pixels that it points to.*

#### DEVELOPING IMAGES

Most of the changes you make to an image are done using the Basic section in the Develop module so it's worth a closer look. Here are what each of the

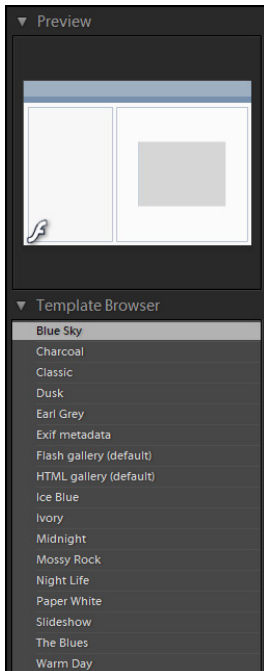




The Lightroom Basic Panel in the Develop module.

### ALT-DRAGGING

While dragging the *Exposure* and *Blacks* sliders to adjust the tonal range, you can see the levels where black or white details begin to emerge in the image if you Alt+drag the sliders.



Web gallery templates are listed by name and when you point to one a preview is displayed in the Preview panel.

controls does.

- **Treatment Color/Grayscale** converts the selected photos to grayscale or color.

- **White balance selector tool** (the eyedropper icon) lets you click a neutral pixel in the photo to remove color tints throughout an image. As you move the eyedropper around the image it enlarges the pixels under and around it and displays the center pixel's RGB values so you can find a neutral pixel to click.

- **White balance, temp** and **tint** can be adjusted so that white or neutral gray areas don't have a color tint. *Temp* adjusts the color from blue to yellow, while *Tint* adjusts from green to magenta. The *WB* drop-down menu lets you select from a standard selection of white balance presets. The default is *As Shot*.

- **Tone's Auto** button sets the sliders to maximize the image's tonal scale and minimize highlight and shadow clipping.

- **Exposure** adjusts the tonal range or contrast of the image by changing the *white point* to brighten or darken an image. *The white point* is where tones become pure white with no detail (255). As you adjust, watch the histogram.

- **Recovery** lets you restore detail in bright highlights without darkening the rest of an image.

- **Fill light** lightens shadow areas without lightening other areas.

- **Blacks** adjusts the tonal range by changing the *black point* to brighten or darken an image. *The black point* is where tones become pure black with no detail (0). As you adjust, watch the histogram.

- **Brightness** adjusts the *midtones* (sometimes called *gamma*) to lighten or darken the overall image without affecting the black and white tones and the details they contain. By default, the Brightness slider has a value of +50.

- **Contrast** adjusts the white and black points simultaneously to adjust contrast in the image.

- **Clarity** adds depth by increasing local contrast.

- **Vibrance** adjusts the saturation of primary colors while leaving skin tones and other secondary shades unaffected. This allows you to boost saturation without unrealistic hue shifts.

- **Saturation** adjusts the saturation of all colors in the image.

### OTHER MODULES

In addition to the Library and Develop modules discussed above, Lightroom also has modules devoted to displaying or distributing your images in various formats.

- **Slideshow** creates slideshows you can display on the screen, or export as PDFs.

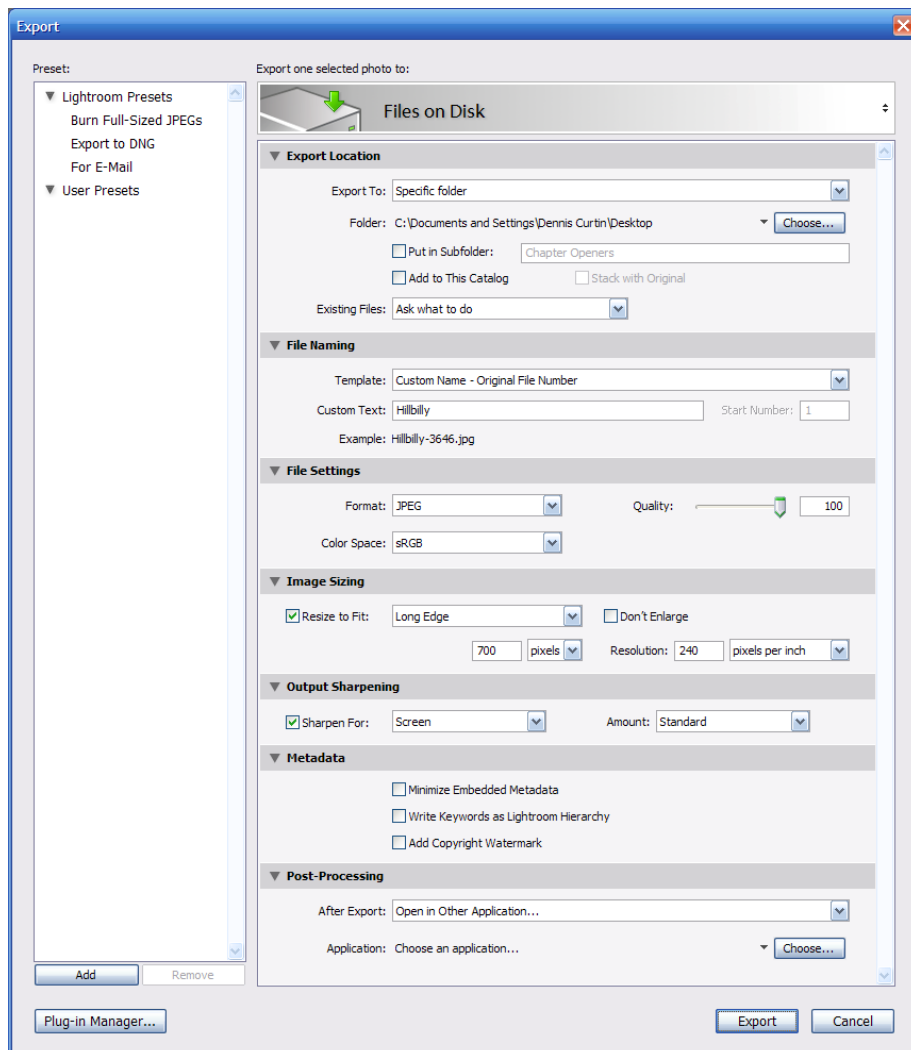
- **Print** lets you lay out and print selected images using templates.

- **Web** lets you create HTML or Flash galleries using templates supplied with Lightroom.

## EXPORTING

When working on images in Lightroom, your changes do not permanently affect the image. However, changes are made permanent on versions of the image that you export. At the time you export images, here are just some of the choices you can specify after selecting the images:

- **Export Location** specifies in which folder the image will be saved.
- **File Naming** lets you specify unique names to the exported images.
- **File Settings** specify a format (JPEG, PSD, TIFF, DNG or Original), color space (sRGB, AdobeRGB and ProPhoto RGB), and quality (0–100) for the exported image.
- **Image Sizing** specifies how large the exported images will be. For example, *Constrain Maximum Size* lets you resize an image by specifying that the width or height is not to exceed a specified number of pixels.
- **Output sharpening** specifies if sharpening will be performed and if so, what kind.
- **Metadata** specifies what information is embedded in the images.
- **Post Processing** lets you see an exported image in Explorer or Finder, open them in another application, or go to an export action folder.



## PHOTO-EDITING—LOCAL EDITING



The tool strip in Lightroom's Develop module lists icons for tools used in local editing. All other tools are for global editing.

## Movie

Click for a movie on changing perspective in a photo.



Photoshop's toolbox contains many of the tools used to make local adjustments. These include healing, dodging, burning, cloning, and painting tools.

Local editing lets you change selected areas of an image. Although programs such as Aperture and Lightroom focus on global changes, they also integrate essential local editing tools such as those used to remove spots and red-eye and adjust exposure. However, to make many local changes you have to export a photo to Photoshop or similar program. When you do so you can specify its format. For example, when exporting an image to Photoshop, you would probably export it in Photoshop's native format, PSD. It is then this PSD file that you edit and when finished, reimport into Lightroom.

When using a program such as Photoshop here are some of the things you can do to an image that you can't do in Aperture or Lightroom.

- **Selecting.** If you first select an area of the image, you can edit just that area without affecting other areas. You can also delete selected areas, perhaps to remove a background.

- **Masking** confines adjustments to selected areas of an image. Unlike a selection, a mask is a grayscale image just as your images are. This means you can edit one just like you edit images; using brushes, erasers, fills, filters, and almost every other tool and technique you have learned. Having all of these tools at your disposal means you can create more complex selections than you can with just selection tools. Because masks make precise selections possible, they lie at the heart of compositing—the creation of a new image by piecing together parts of other images. You can either cut and paste selected areas or make some areas transparent so layers below show through. Once you master a few basic tools, the possibilities are endless.

- **Compositing.** You can copy or move selected parts from one photo and paste them into another to create a composite image.

- **Adding text** to images is usually the realm of graphic designers, more so than photographers. However, you should be able to do so to create title slides for your slide shows, add copyright notices to your images, or just invent ways to combine text and images in creative ways.

- **Layers.** When you first open a digital photo, it has only one layer—the background layer containing the image. Any changes you make to this layer become part of the image and permanently change its pixels. To avoid permanent changes, you add additional layers and make your changes on those layers. It's as if you were covering an original photo with sheets of glass on which you drew, painted, made adjustments that affected the image below, entered text, or added fills.

- **Blending modes** determine how a color you apply with a tool interacts with the colors you paint over or how the colors on one layer interact with colors on the layers below.

- **Transformations** let you scale, rotate, skew, distort and add perspective to selections.

- **Effects** let you add drop shadows to text, bevel the edges of an image, or add a frame. You can also combine effects, using first one and then another. For example, you may soften a portrait to make it look more romantic, vignette it, and then add a frame around it.



- **Animated GIFS** can be created by layering images on top of each other. When then saved as an animated GIF and posted on a Web site, the images play back like frames in a movie.
- **Stitching panoramas** from a series of side by side images lets you create seamless panoramas that capture a broad sweep of the landscape.



*The background of the monster has been selected and removed (top), a new photo opened (middle) and then the monster copied in (right) to create a composite image.*



*The background of the original image (left) has been selected and removed (right).*

