Chapter 5 – The Digital Darkroom
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Perhaps you knew an “old school” photographer – an older relative, perhaps, that had a darkroom at home. Maybe it was a specially built room in the basement with two doors to block out light and a little red light outside the door that told outsiders the photographer was at work. More likely it was the guest bathroom, with towels stuffed under the door to block the stray light and the regular light bulb replaced with a special red “safe light”. Film was an interesting medium to work with; and the fact that it had to be handled in darkness (it’s cousin, photographic paper, could tolerate a little red light) lent the serious photographer an air of mystique.

Digital photography has revolutionized image making, and in the process removed most, if not all of the mystique. Grandmothers casually speak of “photoshopping” pictures of the grandkids (and then emailing them to their listserves!). The chemicals and skills of the darkroom have been replaced by computers and inkjet printers, and the whole process has been brought into the light of day. The digital darkroom allows casual users to manipulate their images in ways that only the most skilled darkroom artists could ever hope to, and, just as importantly, allows rank amateurs to work in full color – color darkroom processing was a notoriously difficult and expensive endeavor.

This chapter will deal with the elements of the digital darkroom (an admittedly oxymoronic term) to help you set one up for yourself. Actually manipulating images will be the subject of chapter 20; here we will look at the software and hardware you’ll need.

Components of the Digital Darkroom

The digital darkroom is an assemblage of equipment and software that you will need to take images and present them to others. The size and complexity of the system you assemble is up to you and largely depends on such factors as your audience and your wallet. The simplest system is a digital camera with an LCD screen on the back. With this you can take pictures and show them (to one person at a time). Many cameras also have some simple image-processing capabilities built into them, such as the ability to crop images or apply a certain color cast (such as the sepia tones that mimic old-time photos). A number of cameras can be hooked up to a TV to replay the photos, allowing for a larger audience (although image quality is often poor). The internet will allow you to send your photos to your friends; and specialized sites exist for you to post photos, make prints, and even edit your photos. Walk with your camera and a connecting cable for it into an internet café or library and you could be sharing your photos with millions with no more investment than the one you made for your camera. We’ll come back to all this later; for now let’s look at the various elements of a typical digital darkroom.
We can divide the components into hardware and software, and split the requirements into image acquisition, image organization, image processing, and image display. Each requirement requires a piece of hardware and its associated software.

First up is **image acquisition**, and we've already discussed the hardware (cameras and accessories) in the previous two chapters. I should mention, however, that the camera is useless without its software. The software does everything from calculate exposure to putting the image information into a file and storing it. Many cameras' software also will allow for limited image organization, image processing, and image display. This software is stored on "permanent" (but reprogrammable) memory chips built into the camera and is part of the so-called "firmware". Firmware is software that is basically built into a device, but as the name implies it is merely firm and not rigid or immovable. Many camera manufacturers will routinely update the firmware of a camera as bugs are discovered and resolved (at least for the first year or so; with so many new cameras coming onto the market many manufacturers rather quickly abandon development of new firmware for outdated cameras). You should make a practice of checking your camera manufacturer's web site every few months to look for new firmware (check immediately if you have a problem; sometimes firmware will be released that will fix such problems). Usually installing firmware requires you to download a program onto a memory card which you then insert into the camera. The site with the firmware will usually have instructions on how to activate it once the card is in place. A word of caution – if the firmware is not installed properly the camera will not function, so follow the directions and always have a new (or freshly charged) batteries in the camera when you install the firmware.

**Image organization** refers to sorting images, deleting unwanted images, and storing images. Although you can do some basic image organization with your camera (such as deleting images), this is where the computer really enters the process. So, before going any further, let's discuss the attributes of a computer system for a digital photographer.
Computers for Digital Photography

Personal computers have made great strides since they were introduced in the early 1980’s, and it’s a good thing since there are few activities that demand more of a computer than image processing, and each megapixel crammed into a camera increases the strain on the computer even more. Fortunately, personal computers of today, even some of the more basic models, are up to the challenge. Barring major changes in the way digital photography is done (always a possibility); it might even be that computers will advance in their capabilities more rapidly than cameras put demands on the computers in the next several years. I say this based on the fact that professional full-frame D-SLRs seem to have enough megapixels to make everyone happy, for now at least, so an increase in megapixels probably isn’t on the immediate horizon.

There are several hardware and software components of a computer system that will have direct bearing on its suitability as the centerpiece of your digital darkroom. Let’s look at these one-by-one:

CPU

This is the Central Processing Unit, the part of the computer that actually carries out the programs. Nowadays these are made by several companies – AMD, Intel, etc. and go by many names: Pentium, Athlon, etc.. Don’t worry too much about that. Assuming some competence on the chipmakers any of them will do the job assuming that it is fast enough. Look for a CPU with a speed rating of at least 2 gigahertz, and don’t lose any sleep over what a gigahertz is. Faster is better, but you pay a disproportionate price for the fastest models, so look at the next-fastest models which are often the best deal. Dual and quad processors are even better. In a few years you will buy a new computer for the same price which will be 3x faster than today’s fastest computer, anyway.

Physical Memory

This used to be simply called RAM (Random Access Memory), but today there are a host of other names out there so let’s just stick with the term physical memory. This is the area where the CPU stores data it is processing. It is much faster than getting data on and off the hard drive. If there is enough of physical memory, then hard drive access is minimized and performance goes way up; next to the speed of the processor, this is the most critical component in terms of performance. Get at least 2 gigabytes. This type of memory comes in various configurations and speeds and a proper match is essential. Consult with the manufacturer as to the proper specifications if you are adding memory to an existing system.
Hard Drive
This is the long-term storage for your system; it is here that many of your images will be stored. Speeds and capacities vary; you want to get at least 500Gb (gigabytes). There are several ways to approach that 500Gb, however. My own preference is to get a computer with a reasonable size hard drive (reasonable being whatever the best deal is with a hard drive of at least 100Gb) and then adding a second, internal hard drive of at least 500Gb. My reasoning is that in this way I can keep all my images and other files (word processing files, spreadsheets, etc.) on the second drive, which can be moved to another computer at a later date. The other hard drive contains the operating system and the programs. You can also buy additional external hard drives that plug into your computer’s USB and/or FireWire ports (more on these ports in a bit...). External drives are great if you have to move images from home to work. Computer hard drives have various controller styles (EIDE, IDE, SATA, etc.) and speeds (5200 RPM, 7200 RPM); there are advantages to different controllers and faster speeds are better, but if it will fit in your computer and is a good price it will probably meet your needs. The controller style will be determined by what’s in the computer anyway, and I wouldn’t buy a computer based on which hard drive controller it has in it (this is largely determined by the manufacturer based on cost considerations and you aren’t likely to have much of a choice in it). You can, in some cases, buy a separate controller card to add a different type of hard drive. Also, beware of buying one huge disk; if it goes bad you lose everything. I prefer to use several smaller (500 Gb) disks as opposed to one huge one (1 terabyte); you pay a premium for the big drives. Capacities of hard drives increase almost as fast as their prices fall; by the time you read this 5300mb disks might be considered small and the 1 terabyte disks will be the best buy (I actually just ordered one for $139).

DVD Recorder Drive
As I’m writing this, the best DVD’s on the mass market store about 8 Gb of data; these are the so-called “double layer” drives. I’d get one of these even though at present it costs about 3x as much to buy a double layer disk as a single layer one, so for the same price you can buy more capacity in single-layer disks. But, the price of the double-layer disks will drop. Do buy a DVD “burner” or recorder; don’t buy a CD burner. The DVD burner will read and write everything a CD burner will handle, plus the DVD burner can handle DVD’s of course. You will probably want a second DVD drive (ideally a burner, but a player will work here). This allows you to copy your disks in one step, instead of having to copy them to the hard drive first. DVD’s come in various formats, DVD+R, DVD–R, DVD+RW, DVD–RW, DVD±R, etc. Get a burner that will handle all of them so that you can easily exchange disks with other computers. “Blu-Ray” disks are just coming onto the market; they can store up to 50 GB of data.
and are no doubt the wave of the future; but right now the prices are high both for the burners and for the disks. By the way, I’d avoid the RW (read-write) media; these disks allow you to erase the data and re-write it. In theory, this sounds great, but the DVD (or CD) is really a backup format and you don’t want to be writing over it. The disks are so cheap that you can afford to burn them once and keep them; if you later lose an image you can go back to one of your archival DVD’s and recover it. RW disks run the risk of losing all the data on the disk every time your rewrite part of it, and they cost more.

**Operating System**

The **operating system** is the main software component of the system. There are 3 main choices here: Windows, Mac, or Linux. Each has advantages and disadvantages and I’m not going to add (much) to the volumes already written. Yes, Windows has a lot of bugs and security flaws, but it works pretty well; anti-virus software helps a lot, and you can get good deals on software for Windows systems because there are a lot of people writing software for it. Macs probably do run better and there are fewer people writing viruses for Macs, but then fewer people are writing software for it, so you pay a premium there. Linux combines these advantages but reputedly is not as user-friendly for the non-technically inclined. Bottom line – don’t buy into the hype you hear from proponents of any one of these systems. For instance, many graphics professionals are quite happy with Windows-based systems and, contrary to what some profess; you can get a version of just about any software for a Mac (Macs can even be set up to run Windows programs!).

**Display (Monitor)**

LCD’s (Liquid crystal displays) are becoming much more common on the desktop than are CRT’s (cathode ray tubes). The latter uses technology dating back to the early days of television in the 1930’s. LCD’s are newer and they use less power and take up less space on the desktop. Image quality is largely a matter of personal taste; some find the CRT display to be more continuous and smooth; others object to flicker which is usually more obvious on a CRT. I would suggest that you get the LCD simply for the energy savings. Whichever you decide on, however, get at least 1280 x 1024 pixel resolution. You can always adjust the resolution down using software, but you can’t exceed the maximum, so get a monitor with enough resolution. Finally, it is possible to run multiple monitors on many computers. I’ve found that having 2 screens, one 24” wide (1920 x 1200 pixels) and the other 19” wide (1280 x 1024) is very handy as I can work on images in the larger window with other software open in the other. It’s also handy when sorting images as you can have more on the screen at any one time.
I haven’t mentioned the video card separately, primarily because the video card comes bundled with the computer and is usually matched by the manufacturer to the other components. The video card is the intermediate between the CPU and the monitor and it can play a role in performance. An impressive array of video cards can be purchased but the pros and cons of these are beyond our scope here. Do be wary of hype, and remember that the fanciest, fastest video card may find itself waiting on your CPU or unable to do all of its tricks on anything less than a top-end monitor.

Other features
Most all computers nowadays come with the fast **USB 2.0 ports**. Since this is where you will plug in your card reader (or, in a pinch, your camera) to the USB port, you want a fast one. Another fast connection is **FireWire**; it is used by fewer peripherals than USB but may be used exclusively by a few, such as some cameras and VCR’s. There are two formats of firewire, 400 and 800, the latter is faster but much less common. Check to see if any of your peripherals use FireWire and, if so, be sure to include one of these ports on your computer. It's useful to have at least a few of these ports (USB and FireWire) on the front of the computer where they are more accessible. Some computers may come with built-in card readers; these can save some clutter and may even perform better than a card reader plugged into a port. You will also need to access the internet, so a **modem** (if you access over a regular phone line) or a network connection (if you have a LAN, cable modem, ISDN or other connection) is needed. If you have several computers in the house you may have already set up a **wireless network**, in which case your computer might need a wireless access card or attachment (unless it is close enough to your wireless network hub that it can be directly plugged into it). Although just about every computer comes with one, there is no real need for a floppy disk reader anymore. The table below summarizes the major features to look for.
Laptops
What about laptops? A good choice, but I find them limited for image processing. It is tough to get a big enough hard drive in one, and performance often lags in comparison to the desktop. Laptops come at a premium price, as well, however as time goes on laptops are becoming much more powerful and affordable. Unless you really need the mobility of a laptop your best bet for a first computer is a desktop model. Later, if you want to add a laptop (laptops are great for work in the field, especially on
trips where they allow you to evaluate and adjust your shooting using a relatively large screen), by all means get one; use the
table above as a guide. If you can only afford one computer and for various reasons it has to be a laptop you might want to look
into adding an external LCD display, keyboard, and mouse for use when it is on your desktop, as these will make the laptop
easier to use for image manipulation.

Basic Software
With the computer purchased you may still need some software for basic image organization. Windows and Macs both have
basic image organization capabilities built into the operating systems (and such capabilities are easily added to a basic Linux
system). These capabilities include the ability to view small preview images (thumbnails) of the image files, to delete the files
you don’t want, and to organize the ones you do into directories (folders) that can help you to organize the images in some
rational way – say by topic, date, camera or whatever. Also, the basic capabilities of all of the operating systems will allow you
to back the images up onto DVD’s. If you find the capabilities of the built-in software limiting (and it often is) you can turn to
third-party software for image organization. This can be found in a number of places and may not cost you an (extra) dime.
Don’t overlook the image organization software that probably came with your camera. Most digital cameras come with software, usually on a CD, that will allow you to download images directly from the camera when it is connected to the computer. Even if you don’t connect the camera directly to the computer (I recommend you use a card reader instead of directly connecting the camera) the same software will usually help you preview the images, do some basic editing, and sort the images. The editing will usually include the ability to alter the metadata, the textual information stored in the image file along with the image. This metadata includes data on how the image was made (time, f/stop, shutter-speed, ISO, etc.) and also fields you can edit such as fields for keywords, photographer’s name, copyright info, subject info, etc.) These latter fields can make finding images later on much easier and editing it is best done when the images are first placed on the computer since many of the images will share attributes (such as keywords and subject) which can be changed for a number of files simultaneously. See Chapter 20 for more information on metadata and how to edit metadata.

Perhaps the main use of the software that comes with your camera is in dealing with your camera’s **RAW** files (if it indeed has them). Since RAW files are proprietary to each manufacturer (unlike JPG’s, which are an open standard), it may be that your camera’s software is the only software able to deal with your camera’s RAW files, at least until the makers of other software have had the time to incorporate your camera’s RAW file format into their program. In this case, the software bundled with your camera will allow you to convert the RAW file (with some preliminary editing) into a file your other software can deal with.

**RAW Files**

RAW files contain the image information direct from your camera’s sensor. Since no processing has occurred, no information is lost, and many photographers prefer to use RAW files (available on higher-end cameras) so that they can later control the processing themselves. By contrast, the JPG files produced by most cameras do some processing in-camera, and as a result some information is lost. Each camera manufacturer has one or more RAW file formats unique to its cameras; most, but not all of these can be read by third-part software. The downside of RAW files are the lack of universality, the need for an additional step before viewing the file, and the large size of the files, often 10x the size of a comparable JPG file. This means that you can take only 1/10 as many images per memory card; you will need a larger hard drive, and download and image pressing times will be much greater than with JPG’s.
Despite their best efforts, camera manufacturer’s software often leaves something to be desired – ease of use and performance are the two most likely weak points. This leaves the door open for 3rd-party vendors to step in with software optimized to help you organize your images. These programs often have features that the camera manufacturers’ software leaves out, such as greater flexibility in viewing files, more flexibility in assembling slide shows, and, in many cases, even some image editing capabilities. Prominent among these 3rd-party solutions are Breezebrowser Pro, ACDsee, Thumbs-Plus, Picassa, and PixVue, just to name a few of the many programs out there that I have tried. Some are freeware; you can download and use them for free from the internet; others are reasonably priced (under $50) while others will set you back a bit more. In terms of image management, however, I’d put off an investment in one of these programs until you’ve decided that your camera’s free software, or the image management portion of your image processor won’t fill the bill.

**Image Processing:**

There are a host of things you can do to an image once it is in the computer. Some of these involve simply fixing problems with the original image capture, while others allow you to add elements such as text or lines, and still others allow you to manipulate the image in any way you desire, including combining images from different sources. This is the province of **image processing software**. Now, most of the image management programs mentioned have some image processing capabilities, but often these are limited. In terms of image processing, comparing image management and true image processing programs is like comparing butter and steak knives – both will spread butter and cut a steak, but cutting steak is a lot easier with the steak knife. Likewise, a true image processing program allows you to do much more and do it more quickly and easily than the image-editing functions of an image management program. If you do much digital photography you will definitely want a good image processing (editing) program.

There are several of these programs on the market, but one stands head and shoulders (in my opinion) above the pack and that is **Adobe Photoshop**. Looking through online and print sources you will find more sources, tips and tricks for doing work in Photoshop than for any other image processing program. This is largely due to the almost universal acceptance and use of Photoshop amongst photographers and its integration with other Adobe graphics products such as Adobe Illustrator that are widely used by graphics professionals in the publishing industry. It is available for both Mac and Windows systems, and will run under Linux if you have the right software. Photoshop is also one of the more expensive programs out there, but it is worth it for the serious photographer. They also have the knack of infusing each new version with at least one “must have” feature,
something that once you’ve tried it you can’t imagine working without it. The latest version as of this writing is Photoshop CS4, which also includes a very good image management program, *Adobe Bridge*.

I’m going to make the assumption that you’ll be using Photoshop, primarily because that is what I have to work with and create examples with. Fortunately, most of the other image processing programs use similar terminology and have similar – if more limited – features. I should also caution you that this is *not* a book about Photoshop although Chapter 20 will introduce the topic. There are a plethora of books about Photoshop; one I’d recommend without hesitation is Ellen Anon and Tim Grey’s *Photoshop for Nature Photographers*.

I should mention that many cameras come bundled with some sort of image processing program; often this is a reduced version of one of the major image processing programs. One common example is *Adobe Photoshop Elements*. One of these programs, combined with the image management software provided with the camera, may be enough for you to get started and wait for your credit card to cool off before investing in a full-blown image processing program. On the other hand, you may find, like I have, that the image management software incorporated into the high-end image *processing* programs will eliminate the need to invest in separate image *management* software. For instance, when I moved to the Photoshop CS2 version it came with *Adobe Bridge*, an image management tool. I’ve found that while I don’t like Bridge quite as well as either of the two image management programs I was using - Breezebrowser and Thumbs Plus – (each of which had its own advantages, so I used both depending on exactly what I was trying to do), Bridge is quite serviceable for most of my needs.

One of the more important developments has been the introduction of a new program, *Adobe Lightroom*, which falls into its own category somewhere between image organization and image processing. Some professional photographers claim that you can use it and a “light” version of Photoshop (Adobe Photoshop Elements) to do everything you need to do. I should point out that Photoshop has its own built-in image organization program, Bridge. You may want to watch a demonstration of both products before deciding which combination works best for you.

**Image Display**

Once you have organized and processed your images you will no doubt want to show them off to your friends, and that is where the other components of your digital darkroom come into play. At some level, the equipment you already have, such as the LCD display on the back of your camera, your computer’s monitor, a printer or an external display such as a television hooked up to
your camera will work to display your image. Each option has its own advantages and disadvantages; you really need to think about your intended audience. I won’t go into a lot of detail about these options as the hardware and software is changing daily.

**Small Screen Devices**

Many electronic devices these days have color display screens; many of these are capable of displaying digital images originally captured with your camera. Since the screen on some of these devices is about the same size as a conventional snapshot print, you might be tempted to think of one of these devices as a possible display device – load the pictures on it and pass it around like you used to pass prints around to your friends. This strategy can work in some situations, but it faces several difficulties:

1. The screens are small. Often they are made of relatively large pixels; the combination means relatively low resolution when displaying images, especially those from a high-megapixel camera.
2. The screens are hard-to see in bright light. You’ve probably encountered this with the display on your camera.
3. Only one person can look at them at a time; most LCD screens are only readable from a small angle. When passing around prints everyone can be looking at one print at a time.
4. Your friends have butterfingers – awkward with prints; deadly with fragile electronics.

Despite these problems, there are times when such devices are better than nothing. You might want to store some prize photos on your PDA or cell phone, for instance, as you are likely to have one of these with you. If you do go this route, you should edit your files in Photoshop or other software so that they display well on your device; you should also resize them to fit the small screen. This will also reduce the memory they take up on that device.

**Electronic Picture Frames**

There are now a number of electronic picture frames on the market. Usually these are an LCD screen (sometimes fairly large) with a slot so that a memory card can be inserted, after which the pictures are displayed on the frame. Some units have built-in memory so the card does not have to stay there; some may have various controls to automatically advance slides and transition between them. Some even connect over the internet. These are usually marketed as devices so that your mom can see pictures of the grandkids – although that assumes you or mom can get the images loaded. Still, it might not be a bad way to show slides to a small audience without hauling a computer around.
Sharing your Photos Online

There are a number of ways you can share your photos with others on the Internet.

1. **Email** – if you just want to share images with a few people you can email them. Images can be inline – that is pasted into the body of an email message (if the message is not sent as plain text); or they can be attached. Assuming your recipient's email program can handle messages other than plain text, it is fairly certain they will be able to view (and save) your images. Plus, using a message format other than plain text allows you to explain each of the images. Images can also be sent as attachments; if you do the latter be sure your recipient has the software to display the image (JPG files are usually safe). Some Internet Service Providers (ISP’s) put limits on the size of messages and a message with one or more images (attached or inline) from a large megapixel camera can quickly exceed those limits.

2. **Photo Sharing Websites** – there are a number of these; they range from commercial to non-profit and the ways of uploading and sharing your images is almost as diverse as the number of sites. Be sure your intended audience can access the site (some charge fees); be sure they will keep your images online for a reasonable period; be sure you aren’t giving up any rights to your photos. Note: from a practical perspective once you post images online there is little you can do to prevent them from being used by others. If you post low-resolution images at least you won’t be ripped off by most commercial users who need high-resolution shots for print layouts. You can also imbed digital watermarks to help protect your images. Depending on the photo site you might need special software to upload the images. Some will charge you for hosting your images; others may make a profit by selling prints to people who see your images and order prints online.

3. **Conventional web sites and FTP sites** - If you work for an organization with its own web server (or purchase hosting services from an ISP or other web service provider) you can set up your own web site and display your photos however you wish. You have much more control this way, although you (or your organization) will have to pay for the server, its upkeep, etc. An FTP site is very similar except that it is set up more to simply transfer files than to allow someone to browse them. If you can post your files on a web site in either format it goes a long way towards eliminating the problems you get sharing big files via email, where message file limitations come into play. Programs like Photoshop can even produce online albums simply and easily.
**Computer Monitors**

How many people can cluster around your monitor? That’s the question if you want to use it as an image display device. The advantages are the fact that you probably won’t get higher resolution with any other option (other than a print); you can set the images up in a wide variety of ways using software (more below), and, with the internet, they don’t really have to be around YOUR monitor. The disadvantages are the limited number of people you can share the images with at once in the same room. If you put the images online, you trust that the person on the other end has a good monitor, properly calibrated and with the right software to view your images as you intended them to be seen. See the boxes on “Sharing Your Images Online” (above) and “Preparing Files for the Web” (below) for more info.

**Television Screens**

The familiar TV screen in the United States has its resolution set (by law) at a low standard that was breathtaking in the 1940’s and disgustingly blurry by today’s standards. Still, this is changing as new HD and other formats are rolling out. If you are stuck with an old-style TV (hopefully color!) then you can probably hook your camera up to it via a cable provided by the manufacturer and do a basic presentation to a small audience (with the right cables and interfaces you might be able to hook up your computer instead and have a little more control over the presentation). The image won’t be great, but you can get the general idea across to your victims audience. Newer TV’s, with LCD and gas plasma and other fancy displays, especially the HD models, are designed from the start to be much more peripheral-friendly and some of these will do a really nice job with your images. With a large format TV (50 inches or bigger) you can actually talk to a fairly large (20-30 people) audience. If you go this route it’s probably better to put together a good show using **Image Presentation Software** (below) than to simply scroll through the images on your camera. If you have invested in a home theater system (and managed to get it all set up and working) it is not a much bigger task to get it set up to be an excellent platform for showing off your photography.
Prefered Files for the Web

If you will be sending image files over the web, you want to make them as small as possible. This will reduce download times and make it less likely that you will run afoul of your ISP’s message size restrictions. This usually means a) cropping your pictures to remove unneeded material; b) sizing your file appropriately, and c) using a compressed file format. In terms of sizing the files, think of their intended use. It doesn’t take as big a file to display your image if it is sized for a computer screen as opposed to a poster (my computer screen needs 1,310,720 pixels at 1280x1024 resolution to fill the screen; a 20 x 30” poster on our lab’s big printer needs 54,000,000 pixels or a file 41x as large). The two most common compressed file formats are JPG’s (which work by lumping like pixels together) and GIF (which works by reducing the number of colors AND lumping the pixels). Chapter 20 tells you how to do all these things and explains further about the different file formats.

Projectors

Digital Projectors take your image and throw it up onto a screen. The size of the image is only limited by the size of the room and the screen (although it might get a bit dim if you try to make it too big). Newer models have resolution comparable to a computer monitor; are bright enough to use even in a room with the lights on, and will accept signals from a variety of devices, including computers, TV tuners, camcorders, and digital cameras. They can be even smaller and lighter than the traditional slide projector.

There are disadvantages. They can be costly; a good one will cost more than many digital cameras do. A recent (January, 2007) web search revealed that a good resolution projector suitable for a large room would run between $1,000 and $4,000 dollars. Besides the up-front cost for the projector there is also the cost of the bulbs; many replacement bulbs are priced in the $300-$500 range. Also, you will probably need a screen. In a pinch, a white wall or a white sheet tacked up on a wall will work, but at the cost of resolution and image brightness. The good news is that more and more venues have projectors; it is likely that any school, for instance, will have both a digital projector and a screen, so you might be able to put off such a purchase unless you are routinely making presentations.
Image Presentation Software

The simplest slide show is to use your camera’s review feature and thumb your way through the pictures one by one. Boring! At a minimum, you need to cull out the bad slides and arrange the rest into some kind of interesting order, and create a good story to draw it all together. Your computer is the place to do this. **Image Presentation Software**, from the much maligned Microsoft PowerPoint (which is really a fantastic tool in the right hands) to freeware available online, is your tool to turn a bunch of images into a compelling event. Depending on the sophistication of the software, you can add text, tables, graphics of all kinds, videos, even transitions between slides. The software will then format everything for its intended mode of display, whether it be on the web, in print, or on a screen.

The Road Warrior

Some things to think about if you take your show on the road:

1. The safest thing is to have a computer (usually a laptop) with the presentation software and your slide show loaded, along with a projector of your own. Set up and practice your talk with this equipment to make sure it all works; be sure to pack all the cables. Be sure your venue will have a screen and power. A remote control for your computer is also a great thing to have along.
2. If you don’t have a projector, the next best thing is to see if your hosts have one and that it will be ready for you to use. It’s a good idea to bring your own laptop as well as a standard cable to connect it to a projector.
3. If you can’t take a laptop, be sure your host has the same version of your presentation software, AND make a second copy of your presentation that does not require the software to run (most presentation software can “pack” up all the files you need to show your talk for you, but you won’t be able to make last minute changes). Copy your files onto a USB “thumb” or “jump” drive. Put another copy on CD (preferably) or DVD (if it is very large). If you are very paranoid put a copy on the web (or email it to yourself).
4. If you do take your laptop, make the copies on the jump drive and CD anyway in case your laptop fails.
5. Email your presentation to your host.
6. Snail mail a CD of your presentation to your host.

Am I paranoid? I’ve either had all of the failures alluded to above happen to me as I went to give a presentation or as the host of a presentation.
Your slide show doesn't have to be limited to your images. You can add text that explains the images, have images dissolve into one another, or place screen captures from your software to show, for instance, how you edited an image. Title slides, outlines of your talk, etc. can all be added to help your audience follow along. And, of course, you can add an appropriate background, from a simple black frame to a complicated textured border.

About transitions, animations, and effects: As a college instructor I tell my students not to go overboard with these. One effect in PowerPoint is to have each letter of the text appear on the screen one-by-one, as if it were being typed, complete with audio of a typewriter. Every year, at least one student uses this technique and is left standing next to the screen as the text is slowly, slowly, embarrassingly slowly, typed on the screen. I…………n………….t……….r……......d. Be cautious in your use of transitions, and test them out on the computer you will be giving the talk with. What is acceptably fast on your new desktop computer with tons of memory may be very slow on your old laptop.

Printers
For many photographers, an image just isn't done until it has been printed on nice, glossy paper. It's true that with existing computer equipment the best monitors can't quite match the resolution of a $100 photo printer. Printing technology has made amazing leaps from the days of the IBM Selectric (an electric typewriter modified to accept commands from a simple computer). We don't have to make images by arranging different shaped letters anymore!

More good news on the printing front is that astonishingly good prints can be made on inexpensive (less than $200) printers. I once saw a decent printer for sale with the other office products (pens, loose-leaf paper, binders, pencil boxes, crayons, inkjet printers) in an aisle at the grocery store for $30! There are a lot of options out there; let me give you an overview of the printing technologies and make a few recommendations.

**Dot-matrix Printers:** These printers work by forcing tiny wires to strike the paper through a ribbon to make a small dot; the computer arranges these dots to make an image. Here are the advantages of such printers for imaging: Now for the disadvantages: they are noisy, produce lousy pictures, and don’t handle color well – if at all. If someone offers you a dot-matrix printer turn them down and take your $30 to the grocery store. Aisle 7.
Inkjet printers: These printers work by placing tiny dots of ink on the paper (the actual method of placing the ink ranges from sprays to bubbles and other interesting methods that we’ll lump here as inkjet technology). They draw a liquid ink from a reservoir and deliver it to a printhead which moves over the paper (often the ink reservoir or cartridge is integral with the printhead). The printhead and/or cartridge are replaced when print quality decreases. With good ink and good paper even some inexpensive ink-jet printers can achieve some remarkable results. The cost differences arise from the inclusion of a number of improved performance, features, and durability. In terms of performance, one key variable is print speed, usually given for both sheets of text (documents) as well as for full-color prints. Fast printers might print 20 or so color images per minute (note: these are probably not color photographs but rather simpler color graphics, color photographs will have more information and will take longer to print). Expect to pay a premium for faster speeds. Another key performance factor is resolution; some of the better consumer models can place 1200 dots of ink per inch (compared to less than 100 for most monitors). Of course, it takes more than one dot of ink to re-create one pixel on the page, and by the time the pixel is printed by a number of such dots the actual resolution is close to 300 dpi. Anything over 300 dpi (dots per inch) final resolution may be overkill unless you routinely make prints for birds of prey, which can resolve images better than us humans. The bottom line is: don’t buy on the specifications here; buy based on your perception of the final product’s quality (see below).

In general, inkjets fall into one of 3 categories. There are the general-purpose machines which can handle a term paper one minute and a high-quality print the next. There are photo printers which are more at home with the photo prints (they’d print the term paper, but do you want to print the term paper with 3 shades of expensive black ink?). Third, there are the combo machines which are often combined with a scanner or fax machine. Features to look out for include the ability to print on a wider variety of media (both in terms of size and composition of the media; there are some inkjets that will print on the frosting of birthday cakes). Inkjets that can print posters from a roll of photo paper can cost in the thousands of dollars, while printers limited to 4x6 or 8.5 x 11 inch media will be much more reasonable in terms of cost. Many serious photographers compromise in the middle looking for printers that can make larger (13 x 19”) prints. Other features include flexibility in the paper path – such as the ability to print on both sides of the paper automatically (something that you don’t want to do when making prints, anyway). Some printers have the hardware to allow them to interface with a network and thus be shared by all the computers on the network; others have wireless capabilities and can get images from the computer (and some cameras) without cables. Others can interface directly with the camera – no computer needed – to make prints; some even have a small color LCD screen for basic editing. I hope after reading this book, particularly Chapter 20, that the thought of printing an unedited picture directly from the camera will horrify you; if so, some of these “features” become gimmicks (although the ability of some small battery-operated printers to make prints wirelessly in the field from the camera might be useful in some situations). The printers combined with
devices like scanners or fax machines often work as well in the one combined machine as any individual machine would, thus making them a good buy. Durability is often expressed as the number of pages printed per month and ranges from units good for heavy home use to almost-industrial printers.

How to decide? Set yourself a price range. Assemble a few good images and copy them from your computer onto your memory card (many printers have slots for the more popular memory cards). Go to a store (the grocery store probably isn’t an option here, but most office supply stores are) and look at the models out on demonstration. Look at the models in your price range that have the features you can’t live without. Get a salesperson and use the printers to print one or two of your images on the best quality paper they will let you use (try to use comparable paper between printers). Write the name of the printer on the back of each print. Take all the prints home, shuffle them randomly, spread them out, and evaluate them. Pick the best. Repeat under a different kind of light. Hopefully the best print in each type of light will be from the same printer and you will have a winner.

One last item about inkjet printers: There are a number of different inks and ink combinations out there, and these DO have an effect on the final output. The basic inkjet uses 3 colors (cyan, magenta, yellow) and black (the so-called CMYK print colors, see box below). Most have the 3 color inks in one cartridge, and another cartridge with black ink only. This allows you to print text documents with black ink only and save the color ink. Others use 6, 8, 9 or more different ink colors; more inks at least theoretically mean better handling of color. Inks also vary in their durability; some common inks will fade in a few years (sooner if left in the sun); other inks are archival and will last a long time (if also printed on archival paper and kept out of direct sun). The cost of ink will be one of the biggest costs in making a print; before buying a printer, price the cartridges (and printheads, if separate from the ink cartridges) for it and estimate the yearly costs (some manufacturers give a per-page cost figure which can be used for comparison).

**Dye-sublimation Printers:** These printers can produce fantastic prints. They work by heating a ribbon of dyes; these dyes then vaporize and fuse onto the media. Cost of both the ribbons and the media make this technology only affordable for small printers printing regular 4x6 inch prints.
Color Production on a CMYK Printer
These printers use 3 colors (cyan, magenta and yellow) plus black to re-create colors on paper. The illustration here shows some of the colors that can be reproduced with just the 3 colors (not using the black). Note that the intersection of cyan and yellow produces green; magenta and yellow mix to form red, and cyan and magenta together make blue, the RGB colors of the computer screen (and the primary colors). Every schoolchild knows that in theory at least you can make any color from red, green and blue; a fact that does not in the least diminish the desire among those same school kids for the biggest possible box of Crayola Crayons.

Color Laserjet Printers: The good news is the cost of these printers continues to come down, the bad news is they lag behind inkjets in terms of quality and cost per page. Both of the latter will continue to improve as well. The competition to provide business with low-cost, color, photographic color printing at high speeds (the big advantage of laser printers) will ensure that this technology (or something better) will soon emerge to challenge the inkjet. Already color laserwriters can compete with inkjets in terms of cost for the printer; better wait until per-page costs come down and quality goes up.
Other Technologies: There are a number of other printing technologies on the market; few of these are found in the consumer marketplace, however. Still, technology changes so rapidly that something new could appear any day; again the best thing to do is to compare printers based on overall cost; per-page cost, features you must have, and the final quality of your printed work, as determined by you.

Printing Services:
Some of those newest technologies might be available commercially; while you might not want to spend $20,000 or more on a printer you might find it affordable to buy prints from companies which can afford those technologies. In the collapse of the film processing industry a number of different business models have sprung up to compete for your digital print business:

Photo Kiosks: Here a fancy printer – usually dye-sublimation or fancy inkjet printer – is housed with a computer and some editing software in a stand-alone unit, often in a grocery, drug, or photo store. It will accept your images from a memory card, CD, or DVD, allow you to do some basic editing (cropping, exposure revision, etc.) and the select the size an number of prints you want. The quality of the prints is top-notch; you might want to do the editing at home, however. Critical editing is tough to do at a kiosk next to the Lotto desk.

The Traditional Photo Store: Your photo store is still there and desperately trying to stay relevant. Fortunately for them many consumers need a helping hand in the digital age and these stores are filling that gap. They probably have a photo kiosk or two for the do-it-yourselfer, but their real bread-and-butter is taking raw images from a consumer and printing them. For the more discriminating photographer, these stores may stock the specialized inks and papers used by higher end photo printers (things that the office supply stores may not carry). Finally, they can arrange to have prints made by a higher-end lab, often sending them out for this service (see below).

The Photo Lab: These operations specialize in making high quality prints of all sizes. They have the really expensive machines. They also tend to cater towards graphics professionals, such as the people at advertising companies who can deliver images in the right format already set up for the lab’s particular equipment (this is where your photo store may come into play, taking on the role of getting your images ready to play with the big-boy’s toys and handling all those details for you). Other photo labs do cater towards individual consumers. Many of these operate over the internet; you electronically submit your images and
they mail you the prints. Some of these operations will supply you with the instructions and/or the software needed to set up your images for their equipment.

Depending on your printing needs you might find it economical to make use of any or all of these printing services. In all cases, particularly when starting out, it's a good idea to find someone experienced to help lead you through the process. I'd recommend your local camera store, even if it's just to learn how to get the most out of the photo kiosk.

Evolution of computer memory. The big bronze thing is a computer hard drive, circa 1988. It holds 80 megabytes; some DSLR’s makes single images so large less than one dozen would fit on this drive. The smallest chip holds 2 gigabytes; that's about 25 times as much data as the monster drive. The larger chip holds 4GB; that's 50x as much as the big drive (and chips this size are available that hold 32GB, that's 400x what the big drive holds). The black box on top is a modern hard drive that holds 320GB – 4,000x as much data. Since the photo was taken in 2008, we can see that in 20 years the size of the memory in our cameras and computers has shrunk considerably. If you consider an “average” JPG file from my DSLR at 3MB, the old drive would hold about 25 photos. The new hard drive would hold about 106,000 similar photos; that’s more than I’ve taken in 6 years of digital shooting (where 70,000 images take up about 237GB of space). The old drive cost more (in 1988 dollars) than the new drive (in 2008 dollars).