Chapter 1

Preparing Your Digital Darkroom

You've taken a photo with your digital camera. A wide range of options is now open for you to produce a digital print of your photo. At the most basic end of the spectrum, many photo printers allow you to print directly from your camera or from a memory card.

Considering you've taken the time to pull this book off the shelf, you're probably interested in creating higher-quality prints than those that come straight from your camera. This book shows you that if you spend a bit of time in the "digital darkroom," you can produce much better color (and even black-and-white) digital prints.

What is the digital darkroom? It's many things — software that organizes and edits your photo files and hardware that allows you to view, store, and process photo files (see sidebar). The final stages of the digital darkroom include printer, ink, paper, and perhaps other media to create a print. This book walks you through the entire digital darkroom process, and this chapter gives you an overview of what you need and how you use it.

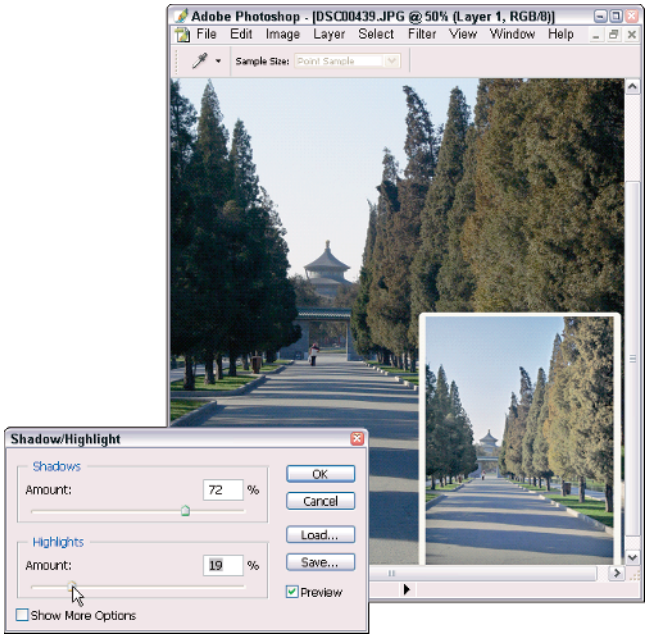

Figure 1-1: Half the work of creating a great digital print takes place before you adjust the settings on your printer.

Quality In, Quality Out ...

Keep in mind as you build your digital darkroom that equipment can do only so much. The adjustments you make to your printer, the paper and toner you select, and other printer-related elements will affect the quality of your print tremendously. That said, no printer can transform a blurry, dim, low-contrast photo into a spectacular presentation of precisely the scene you saw when you photographed it. Half the work of creating a great digital print occurs before you adjust the settings on your printer or select toner cartridges and paper.

This book guides you through the steps of transferring your quality-captured image into a spectacular print. I do not attempt to advise you on how to take photographs. There are many wonderful resources, teachers, classes, and books that can help you set up and take great photos. (Check out *PC Magazine Guide to Digital Photography* [Wiley, 2004] by Daniel and Sally Grotta.) Instead, I guide you through some photo-editing techniques you can use to enhance the quality of your prints. Even though I show you how to enhance your photos digitally to improve print quality, you still want to start with the best image you can get. Figure 1-1 shows a photo being digitally edited in Adobe Photoshop (also known as being "Photoshopped").

Evolution of the Digital Darkroom

The darkroom has always carried a kind of mystical quality. The traditional film photographer plunged into a chemical-filled, closet-like space illuminated only by red lights. After hours of experimenting with filters, cropping, and dodging and burning (brightening or darkening selected areas), the photographer emerged with a carefully crafted work of art.

The modern digital darkroom is just as exciting — but without the smell! Digital photography is just as much an art and science as its predecessor, traditional photo development and printing. The remainder of this chapter introduces you to the elements of creating great digital prints and previews the themes, topics, and techniques that will become familiar to you throughout the course of this book.

Editing Is Nothing New

Long before photos were digitized and edited with software like Photoshop, they were airbrushed, cropped, and, yes, even composited (one photo combined from several photos). A friend of mine who worked on *Playboy* centerfold photos twenty years ago once regaled me for hours about how little those photos corresponded to the actual models.

Setting aside techniques that distort or change the content of photos, darkroom techniques have traditionally been employed to add contrast to photos, to blur or brighten an entire photo or sections of a photo, to filter coloring, and so on.

Components of the Digital Darkroom

Before diving into the specific elements of printing great digital photos, it will be helpful to survey the components of your digital darkroom. Don't run out and buy everything listed here — certainly not yet. But as your standards rise, understanding these elements will help you gradually improve the quality and efficiency of your prints.

Of course, what you need first of all is a color printer. But even before you send any photo to a printer, you need the core component of your digital darkroom: a computer, monitor, and photo editing software. A properly configured monitor allows you to "proof" photos before you print them.

Which Printer Is Best?

In this chapter, and throughout the book, I explain the features to look for in a printer — inkjet cartridges, resolution, paper size, and so on. I do not, however, recommend any particular brand. For one thing, new models appear almost weekly — faster, cheaper, and better than last month's models. More to the point, there are numerous quality printers, and if you know what features you want and what you need to do to get the most from your printer, that's the most valuable help this book can provide. At the end of this chapter, I present a concise overview of the kinds of printers available for digital printing.

Table 1-1 summarizes what you want to have in place, or think about getting, to prepare to print great digital photographs.

Table 1-1 Elements of a Digital Darkroom

Component	*Why You Need It*	*Buyer Beware*
Printer	To create great digital photos.	New developments improve quality constantly. High print quality depends on special photo print cartridges and high-quality photo paper, as well as clean inkjet nozzles.
Computer	To organize, store, and edit photos. Large images are edited faster with high-speed processors. Appropriate settings and memory allow for more accurate image editing.	Image editing programs are memory hogs. You want at least 512 MB of RAM (accessible, temporary memory) and, sooner or later, one or more external hard drives.

Continued

Table 1-1 Elements of a Digital Darkroom *(continued)*

Component	*Why You Need It*	*Buyer Beware*
Monitor	To view photos before printing them. A high-resolution traditional CRT (cathode ray tube) monitor provides the most accurate view of photos. New (flat-screen) LCD (liquid crystal display) monitors are improving in color accuracy.	By age four, your CRT has typically lost so many red pixels that accurate calibration between the monitor and printed photo is impossible. LCD monitors are often less reliable than CRTs for color display.
Photo editing software	To crop, touch up, and edit photos. This software ranges from free and easy to learn to expensive and confusing.	Repeated saving of images in JPEG format degrades image quality.
Ink	To print photos on paper. New photo-cyan and photo-magenta cartridges enhance reds and blues.	For high-quality photo printing, avoid unauthorized third-party replacement cartridges for quality photo work.
Paper	To view photos outside the computer. Coated papers provide dramatically better prints, as shown in Figure 1-2.	You must synchronize appropriate toner cartridges and printer settings to maximize the impact of glossy and other photo paper.
Scanner	To convert analog photos and slides into digital images, ready for printing.	Scanners in the $300 range produce less digital "noise" (specks).
Calibration device	To measure and coordinate colors among the monitor, scanner, and printer.	These work best with a newer model CRT and are less effective with LCD monitors.
Calibration software	To match the profile (color display) of your monitor with your printer and other peripherals.	This can be helpful but less effective than physical calibration devices.

Camera Issues: The Great Megapixel Race

Better digital cameras take better pictures and create the possibility for better prints. A full survey of how to select a digital camera is beyond the focus of this book. Study the reviews, choose the best lens you can afford, and price other goodies ranging from a reliable flash attachment (necessary) to in-camera editing options and power packs.

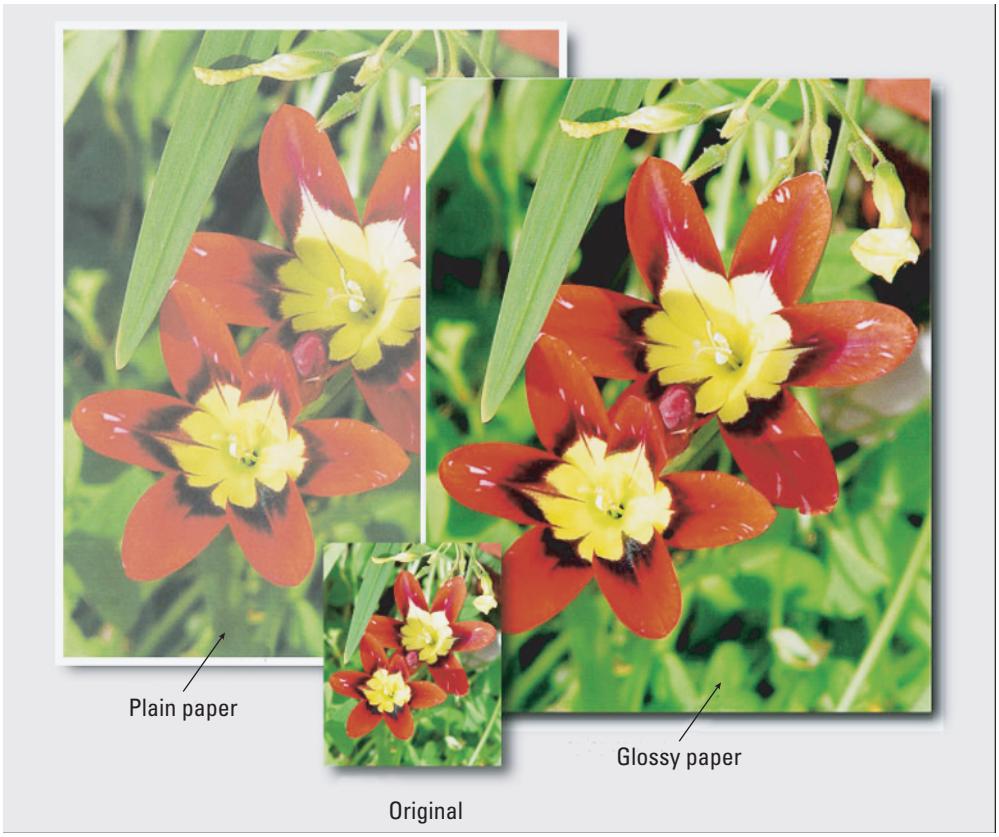

Figure 1-2: Upgrading to quality glossy photo paper produces dramatic results.

One element that is prominently displayed and discussed — and is particularly relevant to the quality of your digital prints — is the megapixel capacity of your digital camera. In short, larger megapixel values allow you to print higher-quality, larger photos. The megapixel capacity of your camera is also a major factor in the price you pay. Although you want to avoid paying for unnecessary megapixel capacity, be sure to buy a camera that takes large enough pictures to yield quality printed results.

As I write this, I'm hearing from sources in the digital camera industry that the standard is heading toward 10 megapixels — and we'll all be able to afford it, too. At the moment, however, 8 megapixels is the standard for high-end (professional quality) digital cameras and you probably do not need that much.

10 Megapixels?

While my industry sources insist we'll all need 10 megapixel cameras "soon," the fact is that more affordable 3, 5, and 8 megapixel cameras are fine for most photo enthusiasts. The additional memory in a 10 megapixel camera becomes critical only when printing poster-sized (or larger) photos.

If you're printing only 4 × 6 photos, you can do fine with a 2 megapixel camera. Your 5 × 7 prints will look good too but not as good as prints from your local photo print shop.

High-quality cameras like the Canon 10D support 6.3 megapixels, which create files that can be printed on 9 × 13 paper at a very high level of quality.

Higher Resolution Equals Easier Editing

In this section, I use a very conservative figure of 300 dpi resolution for saving photo files. For a looser estimate of what size print you can squeeze out of a particular megapixel value, double the values here (based on 150 dpi files). Many high-quality professional photos are saved in final form at 180 dpi or less but you have the most freedom to edit images when they are saved at higher resolutions.

Table 1-2 provides a rough estimate of how many megapixels you need for various print sizes (see sidebar). There are many factors to consider in choosing a digital camera and many features to investigate on your own, but this book focuses on the megapixel factor because it relates directly to print size.

Table 1-2 How Many Megapixels Does Your Camera Need?

Megapixels	*Price Range*	*Size of High-Quality Prints*
2	$130–$450	Excellent-quality 4 × 6 prints, fair-quality 5 × 7's, and proof-quality 8 × 10's
3–5	$200–$900	High-quality 8 × 10's
6–8	$600–$1500	Up to 11 × 17 high-quality prints

Your Computer, Your Monitor ... and Your Prints

Both accurate color representation and photo editing software put steep demands on your computer's processing capacity. Here I briefly alert you to issues related to your system and settings that will help smooth the path to great digital prints. In Chapter 2 you will discover how to use special software and calibration tools to configure a quality monitor to display colors accurately as they appear in prints.

YOU CAN NEVER HAVE TOO MUCH MONEY ... OR TOO MUCH MEMORY

A philosophical and moral argument can be made that there is such a thing as too much money. But you'll find that in working with and printing digital photos, more memory always helps.

To configure your system for accurate color display, you'll do yourself a favor by starting with a CRT (cathode ray tube) monitor that is no more than two to three years old.

Confused About Resolutions?

There are an awful lot of resolutions floating around out there, and I'm not talking about those promises you make to stick to your diet and exercise program every New Year's Eve. Your printer promises a resolution of 4800 × 1200 dpi. Your camera can capture 8 megapixels but you need a university computer lab to calculate exactly what that means. Meanwhile, your photo editing software saves images at 300 dpi (or something like that). In the course of this book, I break down each of these resolution factors in detail. For now, here's a quick explanation.

Image resolution is measured in *dots per inch* (dpi) or *pixels per inch* (ppi), the former more often to describe print resolution and the latter more often in reference to digital display (on a monitor). Image editing software can change the size of your photos without degrading the resolution of your image. Alternatively, you can reduce the size of your file while maintaining the same image size by reducing the resolution of your image. Photos you display online only (or in e-mail) will be fine at 72 or 96 dpi; however, photos you wish to print should be saved at 300 dpi. How all this works and is done is detailed in Chapter 4.

Higher resolution prints have more detail and look better in general. Your digital camera (or scanner, if you are using prints) must save image files with sufficient pixels to support high-resolution printing. How do you know if your camera is capturing enough pixels to produce a high-resolution print? You can use Table 1-2 or do the calculations yourself. Camera memory capacity is measured in *megapixels,* which is one million pixels. Printing at 300 dpi, a 4 × 6 print requires about 2.2 megapixels (4 × 300 × 6 × 300). So a 2.2 megapixel camera can produce a file that prints a very high-quality 4 × 6 print.

Inkjet printers advertise dpi resolution capacity that is much higher than required for your image file. The true resolution of inkjet printers is measured in *dots per inch* (dpi). A 1200-dpi printer means that each dot is 1/1200 inch. In general, higher resolution yields finer detail and smoother shapes. Additional resolution allows printers to generate four-color (or more) printing at higher speeds.

While it's helpful to understand the various resolution levels associated with cameras, printers, and scanners, it's even more important to understand that comparing the resolution rates for computer files and print files is an apples/oranges proposition. This is because monitors and printers generate color and content very differently. Chapter 2 explores in detail synchronizing your computer and monitor with your printer.

LCD Monitors Do Not Calibrate Well

Serious photographers rely mainly on CRT monitors for soft proofing. LCD monitors — like those wonderful, flat, space-friendly ones — do not reproduce color as reliably. As you'll see in Chapter 2, they do not calibrate as accurately either — which reduces their effectiveness for *soft-proofing* or accurately editing and previewing photos on your computer before printing. That said, I've seen pros do all the photo editing they need to do on a laptop (LCD) screen before shipping off a photo to a client. So although CRTs are better, you can get away with editing images on an LCD monitor.

You need sufficient memory in your computer to support the highest level of color display. Digital designers generally agree that 512 MB of RAM serves you much better than the recommended minimum memory that came with your operating system, or the "minimum" memory recommendations of your image editing software.

Not only is memory a huge help in enabling your system to display and edit photos; it's also a relatively good value. Your computer manufacturer or retailer is more than happy to sell you additional RAM. In many cases you can install it yourself. You've already invested money in your camera and other photo equipment; you don't want your computer to be the choke point in producing nice prints.

OPTIMIZING SYSTEM COLOR SETTINGS

One important element of relatively hassle-free color management is coordinating your monitor with what comes out of your printer. Chapter 2 explores in depth how your monitor presents colors and how to mesh that with how your printer produces color. Let's look quickly at some computer settings that facilitate calibrating and coordinating your system for consistent color management.

Your monitor generates colors using the red-green-blue (RGB) additive system. This means that colors other than red, green, or blue are created by mixing combinations of those colors. For instance, combining green with red pixels creates yellow. Your printer, on the other hand, layers cyan, magenta, yellow, and black toner to create colors. That system is referred to as the CMYK system. (The abbreviation stands for cyan, magenta, yellow, and black — the letter *K* being used to avoid confusion with *B* for blue.) The two color systems are illustrated in Figure 1-3.

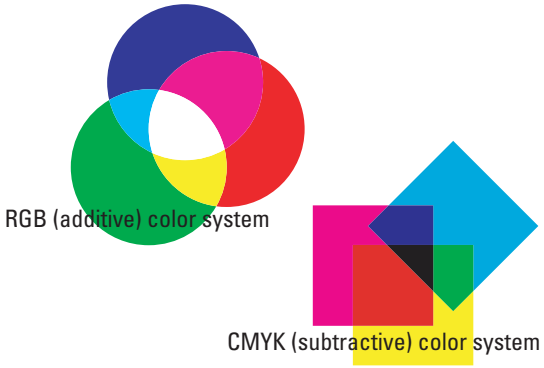

Figure 1-3: The RGB and CMYK color systems

The RGB color system that generates a wide array of colors on your computer uses more than simply red, green, and blue pixels. Each of these three basic colors is subdivided into hundreds or thousands of tones to create subtle gradations in color that are essential for accurate color presentation.

By combining elements of red, blue, and green, computers generate thousands, millions, or even billions of different colors, tones, and shades. Higher color-quality settings (defined using your operating system) produce more accurate colors. The range of colors produced by your operating system and displayed on your monitor is measured in *bits* — which is a techie term for micro amounts of data.

A Bit More on Bits

The "bit" terminology is related to how computers function — in this case how they detect, digitize, and display colors. Older (by now obsolete) systems supported 8-bit color, which was capable of displaying only hundreds of colors. By comparison, 16-bit color produces thousands of colors, 24-bit color displays millions of colors, and 32-bit color can generate billions of colors. In general, the highest setting available for your system produces the most accurate view of your photo.

To make sure your system is configured for the highest available color setting, execute the following steps:

1. Right-click on your desktop and choose Properties from the menu.
2. Click the Settings tab.
3. Choose the highest possible setting available in the drop-down menu in the Color Quality section of that tab.

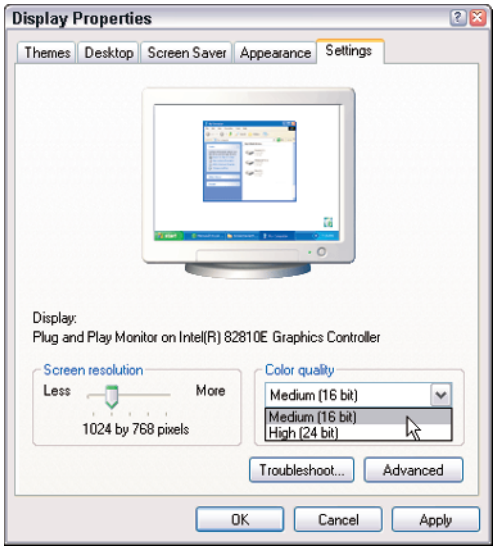

Figure 1-4: Selecting color quality in Windows XP

To define the best color quality for a Mac running OS X, follow these steps:

1. Click the apple menu icon in the menu bar.
2. Choose System Preferences → Displays.
3. Choose Millions from the Colors pop-up menu.

CALIBRATION HARDWARE AND SOFTWARE

The essential challenge you face with soft-proofing (previewing your prints on a monitor) is that your monitor generates RGB color by backlit pixels, while your printer mixes four (or more) colors of ink to generate color. These two systems do not communicate well.

One time-tested solution is simply to print, adjust the colors, and print again until your print comes out with just the right shade of red, blue, or mauve. This option can quickly become frustrating and expensive.

The better solution is to use software, and sometimes hardware, to calibrate your monitor with your printer output (see Figure 1-5). This means fine-tuning the color monitor and printer settings so they match. This calibration is not perfect, but it produces remarkably more synchronization between what you see and what you get.

Cross-Reference

Chapter 2 describes in detail how to use hardware devices, like the one shown in Figure 1-5, to detect accurate readings of what color is displayed when your monitor tries to produce that color.

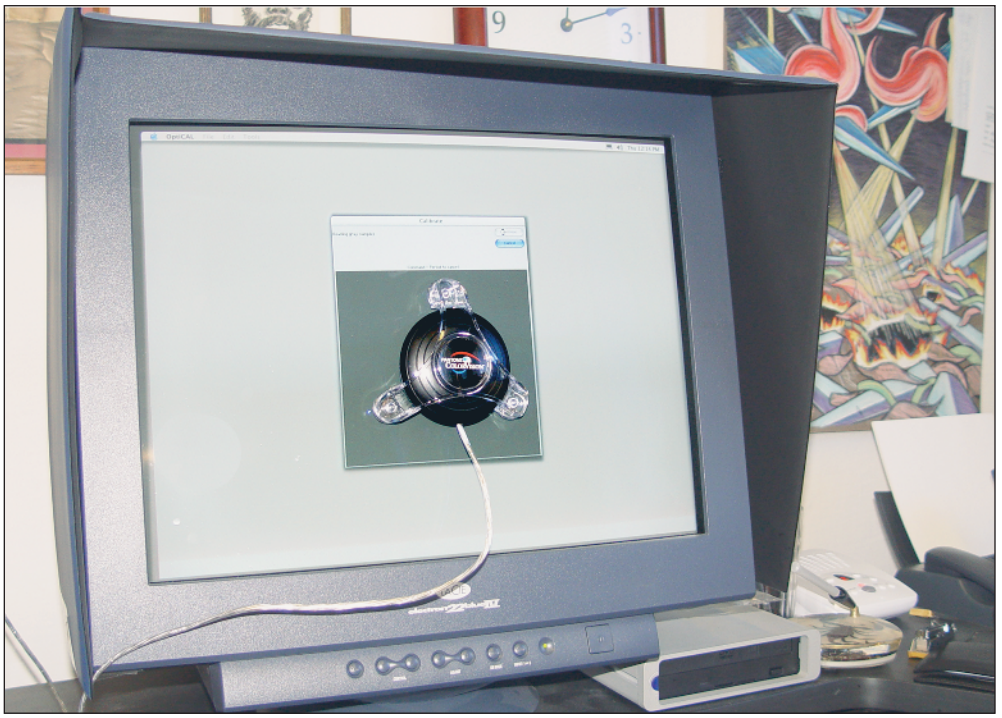

Figure 1-5: A calibration device attached to a monitor

By defining, for example, exactly what red means on your monitor and then incorporating a profile from your printer (or other hardware device), you can use calibration to greatly reduce color mismatching between the monitor and printer. A profile is a file that documents how any device (monitor or printer) "sees" a defined color. Profiles for devices (referred to as ICC profiles) can be loaded into image editors like Adobe Photoshop to manage color coordination automatically.

Generating Quality Scans

Many people convert regular (analog) photos and slides to digital files to take advantage of accessible and powerful digital editing and printing technology. Others convert older, fragile photos to permanent digital files.

If you're shopping for a scanner, resolution is not the main issue. As I mentioned earlier, 300 dpi is all the resolution you need for high-quality prints, regardless of the high resolution numbers on your printer or in your scanner documentation. What you want to look for in reviews is an evaluation of the quality of your scanner: Look for scanners that minimize distortion and noise.

Windows XP and Mac OS X integrate your scanner with their software so you can import directly into your printer an image of something scanned. For best results, scan the object in its entirety. Later you can crop and resize the scanned image in the editing software, while preserving the original.

Two settings you should concern yourself with are colors and resolution. At this point, the more colors and the higher the resolution, the better. You can always decrease the file size by reducing the colors and resolution, but it's much harder, and fundamentally impossible, to "restore" color gradation and pixels lost in the original scan. Figure 1-6 shows a photo scanned at 300 dpi and 24-bit color.

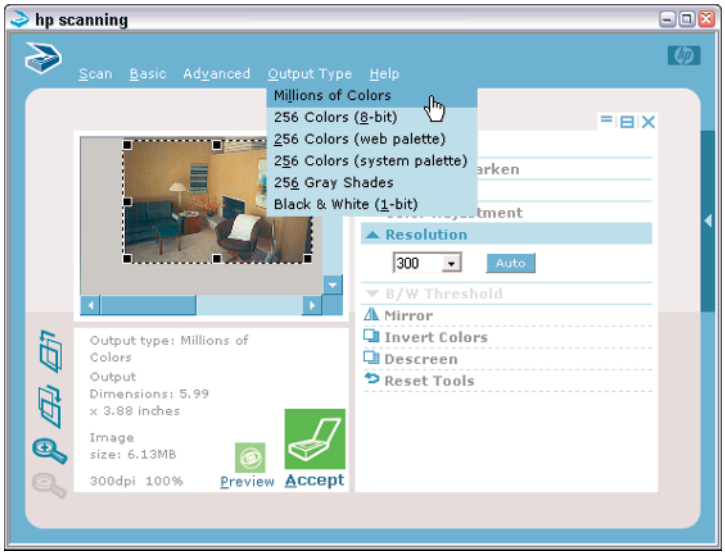

Figure 1-6: Configuring the scanner as you prepare to scan a photo

Millions of Colors?

Figure 1-6 shows an image scanned at "millions of colors," a term for 24-bit color.

Digital Darkroom Software

You cannot turn a pumpkin into a princess, but you can do a tremendous amount with photo editing software. In fact, it's safe to say that photo editing software is essential to getting great digital prints.

Cross-Reference

Chapters 3 and 4 explain how to turn good photos into great prints by brightening, cropping, resizing, color-fixing, and sharpening your photo image files.

Photo editing software is not just for correcting flaws in your photo. You may have composed your photo perfectly, set the lighting just right, and taken the "perfect" picture. Even in this unlikely scenario, your digital camera has probably integrated some digital noise — objects that aren't really there — into the file. In any event, you can still do quite a bit to enhance your photo with photo editing.

Use Camera Card Readers to Rough-Proof

You will not get great digital prints simply by popping your camera's flash memory card directly into a printer slot — even if your printer performs some minimal image editing. Although this technique is useful for seeing a *rough proof* of what your digital camera saw, it's not an acceptable way to maximize the quality of your final print.

Very basic photo editing tools come with your computer's operating system. They allow you to organize, rename, and view your photos. In Windows XP, for example, you can view photo thumbnails in Windows Explorer. Double-clicking a photo in Explorer previews a full-sized, zoomable version of the image in Windows Picture and Fax Viewer, as shown in Figure 1-7.

Many of the features I explore in this book are available in almost any photo editing package, of which there is quite a good selection. Your printer may have been bundled with its own photo editing software, or with Adobe Photoshop Elements. Photoshop Elements is essentially a subset of the professional-level Adobe Photoshop. An example of editing in Photoshop Elements is shown in Figure 1-8.

Whenever I explore touching up photos with photo editing software, I'll keep my advice and instructions generic, so that you can comfortably use whatever tool is at your disposal. If I ever need to describe a specific tool in Photoshop, I'll take you there. For instance, Figure 1-9 shows me touching up just the blue in the sky with Photoshop.

Figure 1-7: Windows XP comes with the Windows Picture and Fax Viewer.

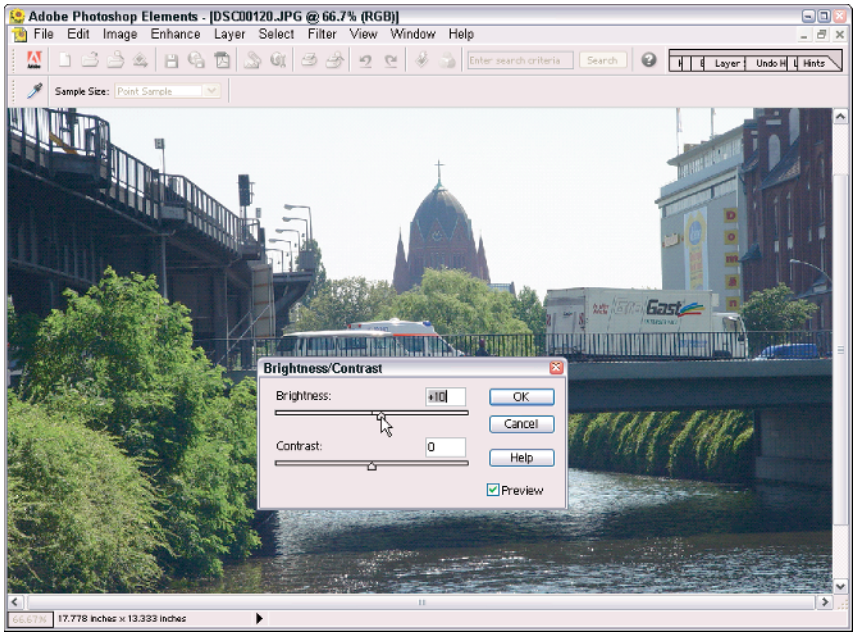

Figure 1-8: Editing an image in Adobe Photoshop Elements 2.0

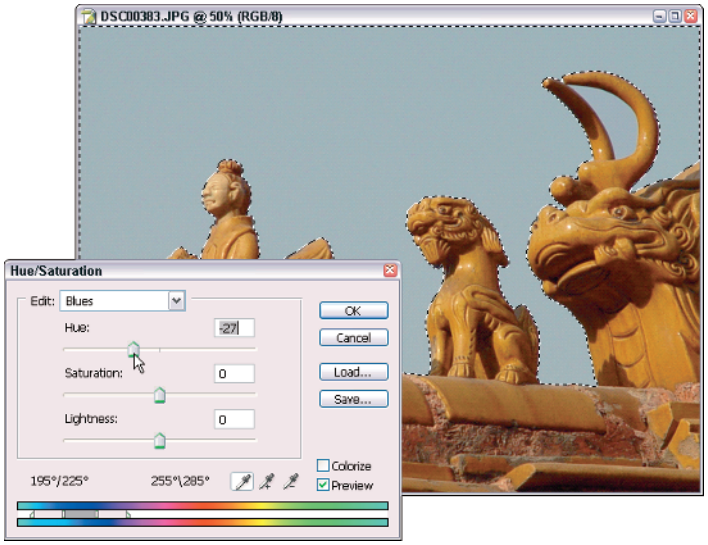

Figure 1-9: Adobe Photoshop ships with some powerful selection and touch-up tools.

REMOVING DIGITAL NOISE

You can improve almost any photo using features like contrast, color, and brightness correction. But there are also issues related specifically to images captured with digital cameras (or scanners) that require some correction to remove artificial input (junk) that ends up in your photo.

Noise is sometimes short-handedly described as grain in a photo. Noise can be unintended visible specks in a photo. On the other hand, photos with no noise at all can look artificial — resembling designed graphics more than real photographs. Image files with too much noise look grainy and distorted.

Decreasing "Digital Noise"

Cameras and scanners collect digital noise as they digitally imprint objects. Higher-quality cameras and scanners produce less digital noise. Image editing software can help correct digital noise, as well as other distortions that occur during the digital capture process.

IMPROVING COLORS AND CONTRAST

Because art imitates life and, more specifically, because your digital camera reflects part of what you see, you can almost always enhance your image by raising the brightness and, often, the contrast of your photo.

There are times when, for effect, you won't want to do this; you might want to darken a photo for artistic reasons. In any case, the brightness and contrast controls available with the most basic photo editing tool can improve your printed photos tremendously. Figure 1-10

shows a photo enhanced by adding brightness — the simplest, most universally available tool for image editing that comes with every operating system and photo software package.

Figure 1-10: An image improved by brightening

HANDLE DIGITAL FILES WITH CARE

While an exploration of the whole process of taking and transferring digital photos to your computer is beyond the scope of this book, I do want to caution you against repeated resaving of files in some formats, such as JPEG.

Most digital cameras save by default to the JPEG format. This format records enough data to preserve a highly accurate image. More expensive, professional-quality digital cameras also allow you to save photos in the RAW file format, which captures even more data and allows for more freedom in digital editing.

However, you need to take caution when saving your photos. The JPEG format is very "smart" — perhaps too smart. It tries to economize the file size by eliminating some of the data associated with the photo. Every time you edit a photo in JPEG format, you lose some of the quality. This happens quite invisibly. For example, if you use software that comes with your camera or operating system to resize a file, you will likely lose the data that would allow you to enlarge it later to the original size.

Cross-Reference

For more on why JPEGs do not work well for editing purposes, see Chapter 3.

For optimal digital archiving of photos, do not reduce the file size. It's wisest to save your image files in the RAW format from your digital camera (if available), or to the stable TIFF format, at the original resolution with which they were captured. You can then save *copies* of your file as JPEGs for sharing on the Web, or smaller sized TIFFs for digital printing.

Printers

All three components of printing digital photos are in the process of undergoing revolutionary changes:

- Cameras continue to add features and capability, and drop in price
- Image editing software has become firmly embedded as the middleman between camera and digital prints
- Printers are improving rapidly in quality

Of these three components, probably no element of the equation has developed as rapidly as accessible, almost professional photo-quality printers.

The most rapidly developing and widely accessible printer for the home or home-office enthusiast is the adaptable inkjet printer. Inkjets have evolved in a few short years from office machines for folks who couldn't afford a laser printer to high-quality equipment capable of producing color photos that most people cannot distinguish from traditional photographs.

At the same time, you should be aware of other digital photo printers, some that may, in fact, well suit your requirements as you acquire the need for either higher-quality or faster printing. The four main print options are as follows:

- Dye sublimation (or dye transfer) printers
- Inkjet printers
- Laser printers
- Photo printers

Each of these types of printers has distinct technology and provides quite different results. Don't rush out and buy any new printer(s) just yet. The techniques described in this book to help you prepare photos for printing are equally appropriate to each type of printer. I identify unique considerations for different print output options along the way.

INKJET PRINTERS

Intuitively named inkjet printers shoot out tiny jets of ink to create dots on a page. High-resolution, photo-quality inkjet printers spew out dots so tiny that they are hardly discernable to the naked eye.

Given that inkjet printers provide the best overall mix of quality, value, and speed for most of us, it's worth taking a moment to climb inside one and see how they produce those nice prints you want to admire and show off.

Inkjets reproduce photo images by generating lots and lots of really small dots. The higher the resolution (dots per inch), the less noticeable those dots are. That said, high resolution is

not required to conceal the fact that an inkjet photo is composed of dots. Most people cannot detect dots in a print with a resolution of much more than 800 dpi, unless they use a magnifying glass. Therefore, when your inkjet promises 2400 dpi, realize that there are many, many more dots than are necessary to create a smooth-looking print.

The high resolution in photo-quality inkjet printers is there to facilitate accurate color reproduction. Essentially, inkjets use *dithering* — the combining of several tiny cyan, magenta, and yellow dots of ink next to each other — to generate the appearance of a wide range of colors. The colors generated from these three primary colors (plus black ink and, in some cases, other colors) represent the spectrum of color that can be reproduced on paper. Figure 1-11 shows the Canon i860, a photo-quality inkjet printer.

Figure 1-11: The Canon i860 inkjet printer

In general, inkjet printers do not provide the range of dot sizes that dye sublimation printing can — much less the dot sizes that old-fashioned chemical processes provide for traditionally developed prints, which allow for color elements at the molecular level. Not only do different colors depend on how many dots appear in a small area, but the density or saturation — for instance, a range from dark red to light pink — depends on the resolution value (see sidebar).

DYE SUBLIMATION PRINTERS

Dye sublimation has been around for many years. It produces marginally higher quality photos than inkjet printers. The look, and the underlying technology, is closer to that of traditional chemistry-based photo developing than any other print technology.

The Math of Inkjet Printer Resolution

In an earlier sidebar, "Confused About Resolutions?", you learned about the various kinds of resolution values you may run into. Let's look more closely now at the apparent paradox that says you can save a photo file in Photoshop safely at 180 pixels per inch and yet get better prints if you use a 4800 dpi printer to print it. What the heck happened between your image editor and your printer that requires all those extra dots?

Take the following example: A very high-quality photo file saved at 300 dpi is translated to a 4800-dpi printer by making 16 printer dots available for each photo file dot. Those 16 printer dots are dithered (placed side by side) to generate what looks like the color and shade that is captured in the file and reproduced on your monitor. (Monitors can combine portions of red, green, and blue into a single pixel and therefore do not need extra pixels to reproduce color.)

If your printer had a resolution of 300 dpi, only one dot would be available for each dot in your photo. It would therefore not be possible (unless the dots were cyan, magenta, yellow, or black) to reproduce the color on the page accurately.

All that said, print quality is not reducible to resolution. There are very sophisticated techniques available that generate and mix dots coming off your inkjet. It is quite possible for a printer at 9600 dpi to produce worse prints than a printer at 1200 dpi. Generally speaking, however, you do need a lot of dots, and a resolution of at least 1200 dpi, to produce the best-quality photo prints.

Dye sublimation is available in 4 × 6, sometimes 8 × 10, photo printers that are widely available at computer and electronics stores. These are not multipurpose printers; you won't pop out a photo cartridge, replace it with normal color, and whip out some letterhead or a business card — the size, technology, and cost prohibit that.

Unlike inkjets, where each dot is the same size, dye sublimation printers create spots of infinitely variable size, corresponding to the actual placement of color in a photo. Not only do the generated dots vary in size, but the dye sublimation process itself creates very soft dots, in contrast to the relatively hard-edged dots that inkjets generate.

Dye sublimation printers produce color from a ribbon covered with three colors — the same cyan, magenta, and yellow used in all nonphoto printers. The dye is sensitive to heat. When the ribbon is pressed against paper, individual heating elements generate vapors that transfer to the photo paper with very smooth edges. Figure 1-12 shows a dye sublimation printer.

Because the quality is so high, why doesn't everyone print photos with dye sublimation printers? The main reason is cost. While the printers themselves are loss-leaders (sold under value to rope you in), the print cartridges drive the cost of an 8 × 10 print up to around $8. Compare this with the cost of printing an 8 × 10 on an inkjet, which is closer to $1.25. However, if you're mainly looking to print small quantities of 4 × 6 photos, the dye sub printer cost of 40 cents for a 4 × 6 print is in the ballpark with what you'd pay at a photo lab, after you figure in shipping. Dye subs also offer you the advantage of seeing your prints instantly — only minutes after shooting a photo.

Figure 1-12: The Canon CP-330 dye sublimation printer

LASER PRINTERS

Color laser printers, like the ones you find at Kinko's or in many corporate environments, are an additional option for photo prints. The quality is a bit lower than that of inkjet prints because the resolution is not as high, but the cost of prints is significantly lower, particularly if you print a large number of photos.

With laser prints, the upfront cost is much higher but the long-term cost per print is much lower. The much faster speed of a laser print is an additional consideration. A $5000 laser printer, shared with a room full of professionals, can be an effective way to churn out decent 8 × 10's in 30 seconds.

PROFESSIONAL PHOTO PRINTERS

Photo printers use the same chemical technology to create prints that have been used to develop and print traditional prints. Photo printer technology is the highest quality available for printing but a professional photo printer hardly fits in the budget, or even the home office, of most digital photographers.

Photo printers, like the Fuji Frontier line, run $150–$200. Before you jump online and order one, that's in ***thousands***. They work by exposing photo paper to stimuli to generate color; they are not constrained by dot-per-inch resolutions.

While photo printers are not accessible to most of us, photo printing is. You can easily order professional photo printer prints online from companies like Yahoo Photos, or from professional-quality print shops like Printroom.com. Or, you can walk into a Walgreen's or generic camera shop and print digital photos using traditional photo printing technology.

Cross-Reference

I address issues related to preparing photos for print shops throughout the book and return to them in detail in Chapter 10.

CONFIGURING YOUR PRINTER

Every printer has its own settings, like those shown in Figure 1-13. Printer manufacturers work hard to set the defaults in these printer dialog boxes to print quality photos but for *great* photos you'll want to understand, and tweak, these settings.

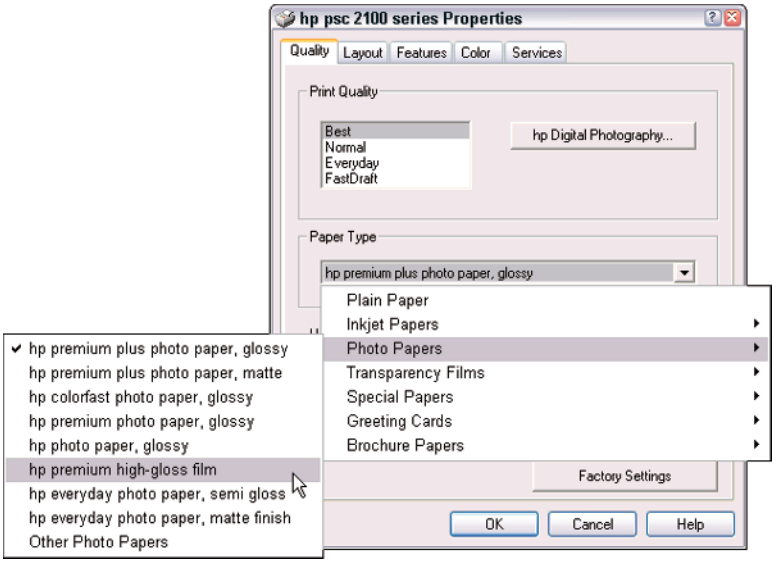

Figure 1-13: Defining printer settings

Cross-Reference

Chapter 7 walks you through the types of choices you can make when you send your files to your printer to maximize the quality of your prints.

Photo-Quality Paper

So now you have the camera, scanner, monitor, calibration device, editing software, and ever-important printer. You're missing only one thing: paper. Photo-quality paper is not just a "little bit better" than regular office paper; it's a lot better. The process of merging tiny droplets of ink from your inkjet printer, or congealed gaseous ink from a dye sub printer, requires a surface that accurately absorbs ink without smearing it. The good news is that there is a competitive market for photo-quality paper and many online vendors provide a huge variety of sizes, qualities, and types of paper.

Photo-quality printer comes in two basic styles. Glossy paper has a shiny, highly reflective surface that tends to produce brighter colors, but more glare. Matte paper is a flatter, more "normal" surface. Within these basic styles, you find many variations — high-gloss, semi-gloss, and so on.

Standard photo paper sizes are 3½ × 5 wallet size, 4 × 6 snapshot size, and regular letter size (8½ × 11) paper. For traditional photo sizes suitable for framing, like 5 × 7 or 8 × 10, you generally want to print on letter-sized photo paper and trim it to fit the frame.

Cross-Reference

For a full discussion of framing photos, including trimming paper, see Chapter 11.

You can't go wrong if you purchase photo paper made by (or for) your printer manufacturer. Epson, HP, Canon, and other printer manufacturers offer full sets of photo paper in different sizes, finishes, and quality. Other paper manufacturers (like Kodak, or boutique photo paper available online) provide software files (called ICC profiles) that configure your printer to work well with their paper.

Cross-Reference

Chapter 5 explains how paper and ink work together with ICC profiles.

Creating a Budget

Many considerations go into planning a budget for a digital darkroom. You have to think about what you already have that you can use, how many prints you make in a given timeframe, and what you do with those prints (mail them to Grandma, make calendars as holiday gifts, print flyers for your home-based business, offer marketing services to small businesses, create advertisements for your work, and so on). Still, there are some generic guidelines to follow. This section gives you a barebones list with upgrade options and what you can expect to spend.

Surprisingly, perhaps, I'm going to start by emphasizing the importance of having a computer with at least 512 MB of RAM. As you expand your collection of digital photos and increase your level of photo editing skills, you may well want to add an external hard drive (and, later, more than one) to store photos. Without enough RAM to process your image files, however, you'll experience frustration, slowness, and infuriating crashes. Digital darkrooming isn't much fun with less than 512 MB RAM; in fact, 1 GB (*gigabyte = 1000 megabytes*) is a good baseline level if you plan to do a lot of editing with more advanced image editors like entry-level Photoshop Elements or professional-level Photoshop.

Good photo printers start at $200; you can produce really excellent photos from printers that cost less than $600. You might elect to get a high-quality photo printer right away, or you may decide to squeeze pretty decent photos out of a regular home inkjet printer for a while and get your higher quality prints from an online or walk-in photo shop.

The calibration alternatives explored in Chapter 2 range from free (downloadable eyeball tools for tuning the color in your monitor) to several hundred dollars for automated calibration systems. Calibration is an option, not a requirement, and most amateurs will not need to start out with a super-accurately calibrated monitor.

Quality photo paper is available at a wide range of prices. Feel free to start out with whatever you find on sale online or at your local computer mart or office supply store. Later you can raise the quality of your prints by ordering special paper configured specifically for your printer.

Ink costs vary widely, too. More expensive printers usually have lower ink costs because they require individual color cartridges to run. Because I print a lot of red, I replace the magenta (near red) cartridge in my printer twice as often as I replace the green cartridge. If had to throw away a four-color cartridge every time I used up the red, I would be throwing away too much money. On the other hand, cartridges with three or more colors in a single cartridge, like those that ship with most HP color photo printers, are convenient.

Like every other endeavor, printing great digital photos involves nonquantifiable costs — better lighting, an upgraded workspace at home, shelving for materials and supplies, space for larger printers, connecting USB cords, and additional outlets. But hey, why worry about that now? Start pumping out awesome digital prints and *then* approach your significant other, parents, or roommates and break the news that you'll be taking over more of the house and using most of the budget so they can enjoy your great prints. If you prefer a more rational plan for paying for all of this, perhaps Table 1-3 can help.

Table 1-3 Planning a Digital Darkroom Budget

Item	*Considerations*	*Cost Range*
Computer memory	You need at least 512 MB of RAM to keep your computer from freezing up when you edit large photos. Make sure the RAM you purchase is compatible with your system!	Adding 256 MB of RAM to your system costs between $50 and $100.

Item	*Considerations*	*Cost Range*
Hard drive storage	External hard drives store hundreds or thousands of photos. Without them, you'll eventually fill up your computer's hard disk space.	Expect to pay about $130 for 80 GB, $170 for 160 GB, or about $250 for 250 GB of storage.
Printer	Inkjet quality (and therefore price) depends mainly on resolution (dots per inch) and the number of inks.	Lower resolution, four-color ink photo printers start at less than $200. Very high-resolution, eight-color personal photo printers start at around $500.
Ink	Individual cartridge refills are cheaper (but a bit more hassle) than replacing all-in-one ink cartridges.	Individual photo ink cartridges cost $10 to $20 each. Many all-in-one color cartridges range from $30 to $40.
Paper	Paper prices vary widely depending on quality, size, and coating. You can find competitive sales online and at stores.	You can find very good 4 × 6 paper priced at under 25 cents a sheet. Very high-quality glossy, letter-sized paper can be found for as little as 50 cents a sheet but can run up to $10 a sheet for the best, longest-lasting paper.
Monitor	Good quality CRT monitors reproduce color best. LCD monitors take up less space, produce less heat, and can produce sufficient color for most amateur photographers.	High-quality 17-inch CRTs cost under $400. The same size LCDs begin at about $500.
Software	Image editing software comes free with most operating systems. More powerful software is often bundled with printers and even packs of photo paper. High-powered photo editors can be downloaded from the publisher and tested for 30 days or more.	Adobe Photoshop CS costs over $600. Photoshop Elements, the stripped down version with most of the tools a serious amateur needs, sells for under $100 online.
Calibration	Follow the advice in Chapter 2 to hand-calibrate your monitor. When you find you need more accurate color synchronization between your monitor and printer, purchase a precision calibration hardware and software kit.	The Pantone ColorVision calibration suite is available for under $300.

Prices May Vary

This industry grows daily, so prices are never final. Keep your eye out for good sales and know that the prices you see here might be different by the time you read this book or go shopping.

Summary

For great digital photo prints, you want more than you get from plugging your flash memory card into the slot on a printer. A digital darkroom allows you to turn your wonderful photos into great prints.

The digital darkroom has three main components: computer and monitor, image editing software, and printer with ink and paper. The remaining chapters survey these elements in detail and show you how to use them to print vibrant color photos.

Survey your existing equipment and prepare it to manage your photo printing. This includes the following:

- Max out your computer memory, if possible
- Configure your operating system for optimal color display
- Capture photos at 300 dpi, where possible, for the most freedom to resize, edit, and adjust photos for printing
- Survey the image editing software you have; if you don't have Adobe Photoshop Elements, consider a trial download (available at `www.adobe.com/products/tryadobe/`)