Chapter 1

Let's Get Digitized!

In This Chapter

- Understanding what a scanner does
- Finding material to scan
- Recognizing the different types of scanners
- Identifying parts common to all scanners
- Uncovering how your scanner works
- Explaining resolution
- Understanding bit depth

In medieval times, magicians known as alchemists used to weave tales of a wonderful box. In this box, they said, one could place an ordinary item (an egg, for example), close the lid, and — presto! — the egg would turn to pure gold or a flawless diamond. Many alchemists spent their lives trying to perfect this nifty little household appliance. In fact, some said that they actually did, and these people became the performers we know today as magicians. (A few politicians and used-car salesmen are probably in that group also.) Everyone knows that a machine like that is a fairy tale.

But, wait: What if I told you that such a box really *does* exist — one that can take ordinary paper and turn it into creative magic? Imagine a machine that can bring a smile to the faces of your friends and family or reshape opinions, safeguard your memories, and perhaps even help sell your '79 Pinto?

Computer scanners now can do all that and more, and you don't need a degree in the magical arts (in other words, a computer programming degree) to use one with your PC or Macintosh computer system. The facts get even better, too: The perfect scanner for most home and small business uses costs less than $150, and you can connect it and produce your first scanned image in less than five minutes. After all, the faster you get a picture of that '79 Pinto on your Web site, the better the chance that you can finally unload it!

In this chapter, I introduce you to the computer equivalent of the alchemist's magic box. You discover what you can do with a scanner, what types of scanners are available, what makes them tick (if you want to know), and the importance of resolution and color.

"Okay, I'll Bite — What's a Scanner?"

Although many different types of scanners are available — flatbed, sheet-fed, color, and black-and-white, just to name a few — they all perform the same function. Therefore, it's easy to define exactly what a scanner is:

> **Scanner.** (n) A machine that reproduces an image from a source object, producing an identical digital image for display or processing.

There — that explains everything, at least for technotypes. In plain English, a scanner "reads" the image from an object (typically a piece of paper) and then creates a copy of that image as a picture file on your computer. (If you're curious about what goes on inside, I explain the process later in this chapter.)

Of course, my explanation also has exceptions. It figures, right?

- You don't necessarily have to scan something from a sheet of paper. For example, your source image can be printed on fabric or some other material or can be a photographic negative.
- A scanner doesn't necessarily have to create a picture file on your computer; if you've used a fax machine or a copy machine, you've been using a scanner. After the scanner read the image, it was simply sent somewhere else. The fax machine sent the image as data over the telephone line, and the copy machine sent the image to the built-in printer to create a duplicate.
- You may not be scanning that original to create an image file on your computer. With the right software, scanners can now recognize the printed characters on a page and enter them into your word processor. I discuss this process, called *optical character recognition* (or OCR, for those who crave acronyms), in detail and show you how to use it later in this book. Another good example of a "rogue" scanning application is the familiar barcode, which has appeared on just about every inanimate object in your local shipping office and grocery store.

Most of the work you do with scanners these days, however, is performed as I describe in my definition: For example, you want an image from a magazine in a form you can use with a document you've created with Microsoft Word. Or perhaps you want to send that picture of Aunt Martha through e-mail to your folks living a thousand miles away.

What Can I Scan, Mr. Spock?

You won't be scanning the surface of an alien planet from the bridge of the starship *Enterprise*, so you won't hear me say "Fascinating!" Instead, we humans here on planet Earth scan these types of materials:

- Books
- Photographs
- Magazines
- Business cards
- Printed text
- Flat objects
- Fabric
- Photograph negatives
- Sketches and original art
- Cereal and pizza boxes

You get the idea: If it's reasonably flat and it has any type of image on it, it's likely to be scanner material. Scanners can record surface detail, too, but the results vary widely according to the material that makes up the object. (Naturally, the darker the material, the harder it is for your scanner to deliver a clear image.)

Different Breeds of Scanner

Over the past few years, different types of scanners have evolved for different jobs. Some types provide a better-quality scan, some take up less room, and some are designed especially for one type of original media. In Chapter 2, I get into the specifics of which type of scanner is perfect for you. For now, take a moment for a scenic overview of what's available. Sit back and enjoy the tour. (Have an hors d'oeuvre!)

- **Flatbed:** Imagine the top of a copy machine. Cut off the rest of it, and you have a flatbed scanner, as shown in Figure 1-1. With a flatbed, you're likely to get the best resolution with the least distortion, and you can easily scan pages from a magazine or book.

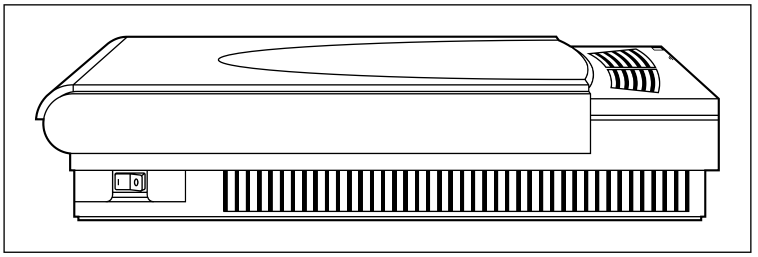

Figure 1-1: The flatbed scanner. Have you ever seen anything so beautiful?

- **Sheet-fed:** Limited space on your desk? A sheet-fed scanner may be the answer. The shortest models are about the size of a roll of aluminum foil, and other models look suspiciously like a fax machine. (As a matter of fact, a fax machine has a built-in scanner that it uses to create an image of the page.) Figure 1-2 shows you a typical sheet-fed scanner.
- **Photo scanner:** Many photo scanners are internal computer components, which means they fit inside your computer's case, as shown in Figure 1-3. Photo scanners are specially designed to read individual pictures taken with a film camera (or even small printed items, such as business cards or a driver's license).
- **Handheld scanners:** These portable scanners come in different shapes and sizes, ranging from a handheld model that can scan three or four inches at a time to a pen scanner that reads a single line of text. Handheld scanners don't offer the picture quality and convenience of a flatbed scanner. They can fit in a laptop case (or even a pocket), though, so they have their place with the road warriors among us. Barcode scanners are also typically handheld. Figure 1-4 shows a handheld scanner.

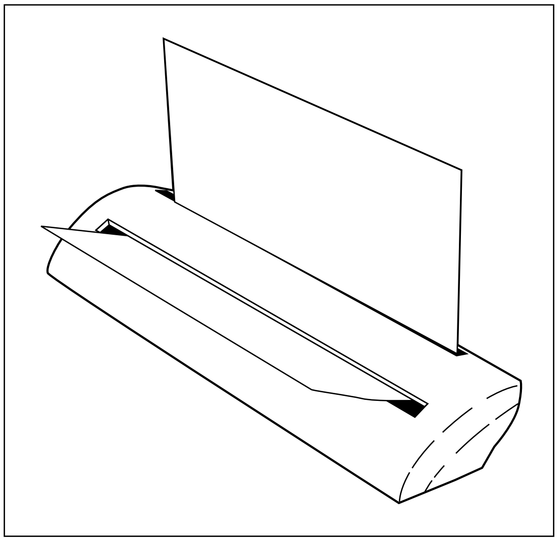

Figure 1-2: A sheet-fed scanner does a great imitation of a fax machine.

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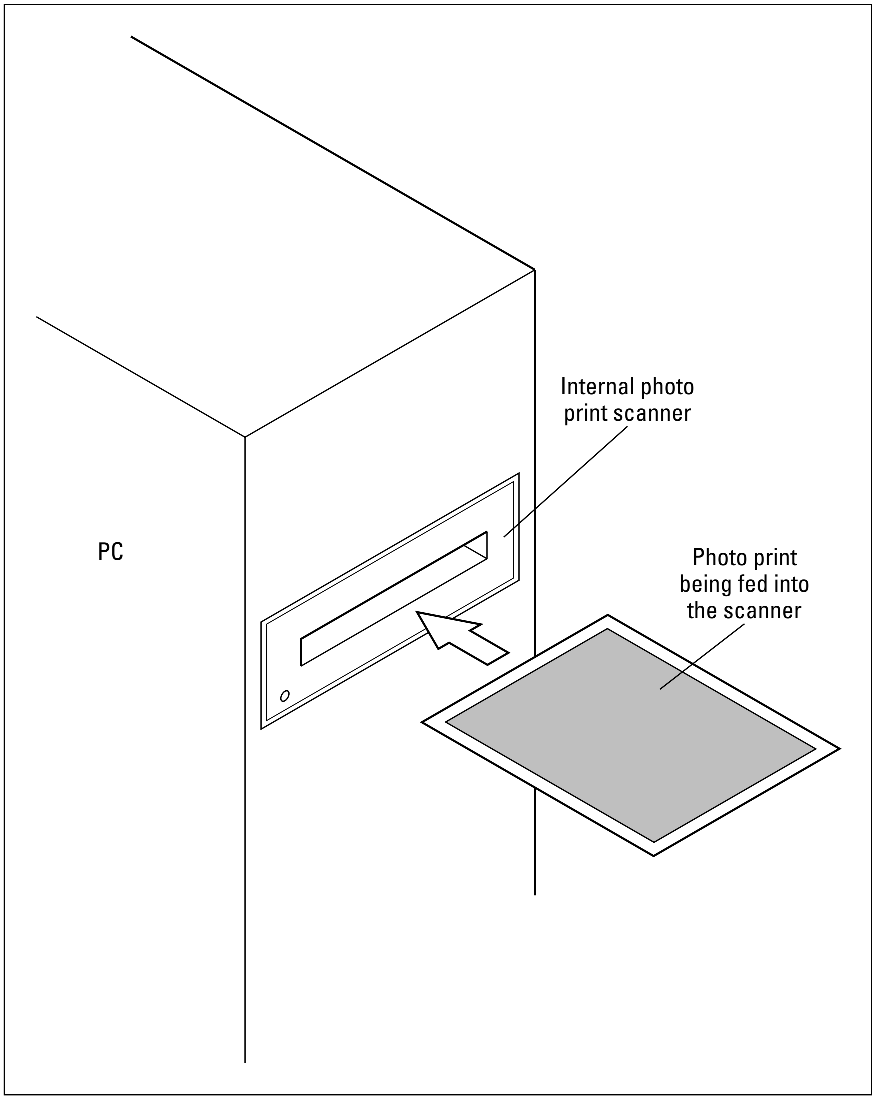

Figure 1-3: Photo scanners are installed inside your computer.

- **Negative scanners:** The snobs of the scanner world, negative scanners are designed for only one purpose: to scan photographic slides and negatives. Although these scanners are usually hideously expensive, if the images you need are on slides or you want the best possible scan of a photographic negative, a negative scanner is the only way to produce a high-quality image. Figure 1-5 provides glimpse of a negative scanner.

Quite a lineup, eh? Darwin himself would have been proud of the way in which scanners have adapted to their environment.

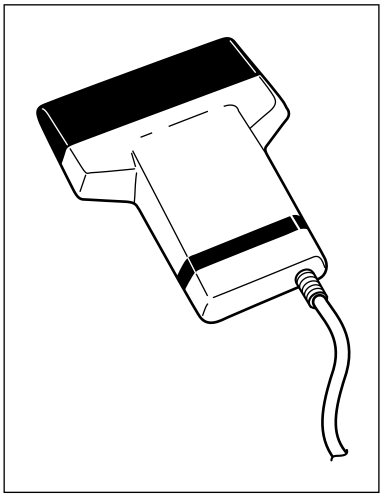

Figure 1-4: If you're on the road, a handheld scanner doesn't weigh you down.

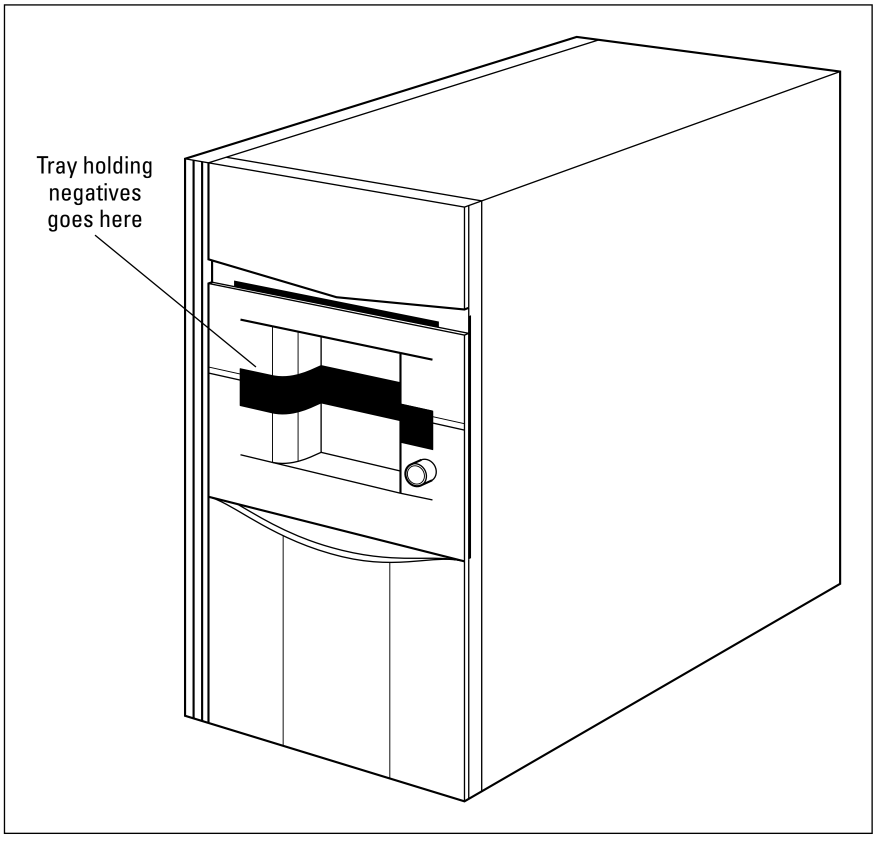

Figure 1-5: Negative scanners do only one thing, but they do it very, very well.

Examining the Innards

Okay, I know what you're thinking. (Didn't know that little tidbit about computer book authors, did you?) You're wondering, "Do I *really* have to read about my scanner's anatomy?" Ladies and gentlemen, the answer is a big, emphatic "No!" None of the material in this section has any cosmic meaning, so if the closest you want to get to your scanner's mechanical side is plugging in the power cord to the wall outlet, feel free to jump ahead to the next section (which, come to think of it, you can skip as well)!

Hey, if you're still reading, you're curious about mechanical mysteries, like I am. Did you disassemble alarm clocks when you were a kid, too? (Dad eventually had to lock his up in the garage.) Read on while I explain the common parts shared by every scanner.

The sensor

Crack open your scanner — no, don't grab a hammer, it's just a figure of speech — and you'll find that the sensor is the star of the show. The scanner sensor is comprised of an array of individual photosensitive cells. Wait — don't drift off yet — it gets better! Each of these cells returns a certain amount of electrical current to the scanner's brain; how much current is determined by the amount of reflected light the cell receives as it passes by the original image. Figure 1-6 illustrates how this process works.

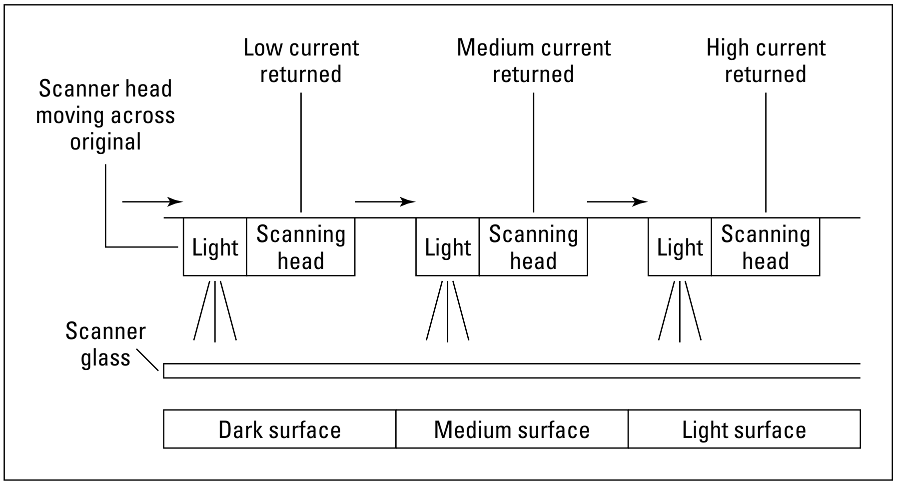

Figure 1-6: One hard-working scanner sensor, churning out the pixels.

If you're knowledgeable about your human anatomy (or, like me, you were able to stay awake in high-school biology class long enough to pass), you can see the parallels between this process and how the human eye works. In the eye, the photosensitive nerves perform the same function: They send impulses to your brain that depend on the amount of light they receive.

Each of the cells in the scanner's sensor reads a single dot of the image. And that basic building block, the *pixel,* is a unit of measure I return to time and time again in this book. Your computer monitor is also measured in pixels, as are digital cameras. All digital images are made up of individual pixels. Your eye and brain work together to combine them into the image you see.

The motor

Of course, the sensor doesn't do you a tremendous amount of good if it just sits in one place on the image. You would get a single line of pixels from the original! (That makes for a very bad scan, as you can imagine.) The designers of the first scanners knew that they needed to move the sensor across the surface of the original so that they could scan the entire thing, so they added the motor.

Figure 1-7 illustrates the two types of motors in today's scanners: In effect, one design moves the sensor head past the original, and the other moves the original past the scanner head (which is fixed in one spot). In later chapters, I explain which is better for you; both types of motor drives have their advantages.

The light

A sensor that's sensitive to light needs illumination, and your scanner carries its own built-in "reading lamp" — the light that's reflected from the original is picked up by the sensor. Most scanners have this light mounted right next to the scanner head.

The brain

Like just about everything in the world of computers, your scanner has an electronic brain for processing image data. The brain isn't sophisticated compared to your computer's central processing unit (CPU), which has a master's degree in several subjects. A scanner's brain has at least passed the fourth grade, though. I talk more about this processing in the next section.

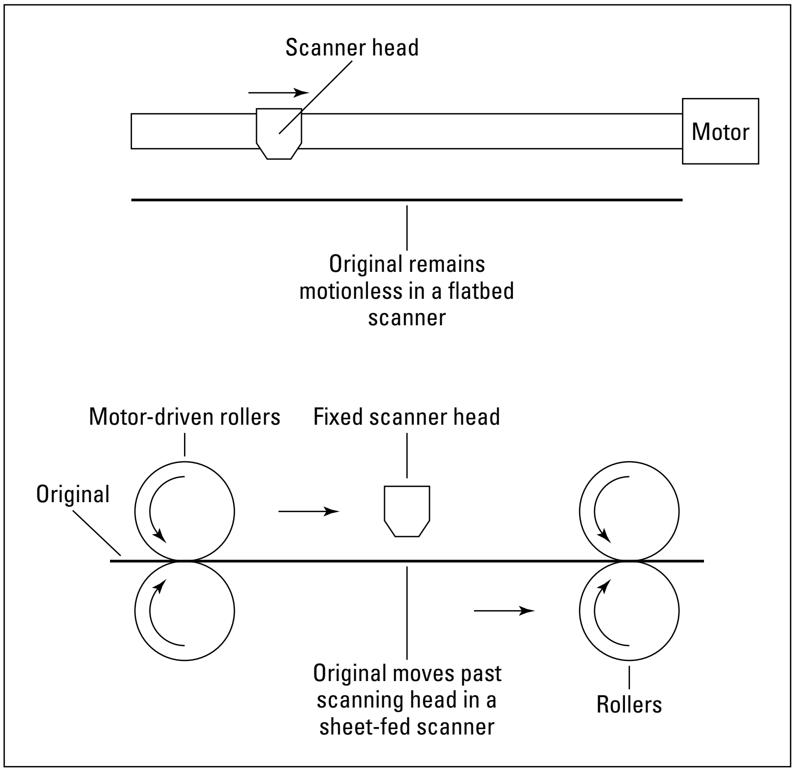

Figure 1-7: *Something* has to move in a scanner — either the sensor or the original.

The interface

Every scanner needs a connection of some sort to your computer. In all their wisdom (and their surprisingly intermittent common sense), computer hardware designers have to have a separate word for this connection. For some reason, the word *connection* didn't hack it. Therefore, they call the type of connection your scanner uses an *interface.* Although most scanners made these days use the *Universal Serial Bus* (USB, for normal human beings), I introduce you to all the connections (whoops, there I go again) — the interfaces — found on scanners. As you'd expect, I also help you determine which is best for you.

Scanning Explained (for Normal Folks)

Here I go, trying to explain the alchemist's magic box. If you don't care how the box works and you would rather jump right to the next section, I can meet you there. This stuff is *absolutely* not necessary. If you're like me, however, and you stick your head into everything electronic from sheer curiosity, keep reading!

Here's the process your scanner uses to produce that spiffy digital image (use Figure 1-8 to follow along, if you like):

1. The scanner light is turned on.
2. The sensor head moves slowly past the original, or the original is moved slowly past the sensor head. (Anyway, movement and a motor are involved, as I mention in the preceding section.)
3. The sensor reads the amount of light reflected by the original in each pixel of the current scan line and sends those signals to the scanner's brain.
4. The signals are converted to binary data and sent to your computer through the interface.
5. The sensor head moves to the next line of pixels, and the process begins again with Step 2.

This process is repeated until the scanner has read each line of pixels in the original image. Depending on the type of scanner, the sensor head typically makes as many as three full transits across the original to capture a complete, full-color image. I tell you more about this process later in this book.

Although this operation sounds lengthy, things are moving at computer speeds. For example, most scanners can read an entire page of text in fewer than 10 seconds and can read an entire full-page image in fewer than 30 seconds.

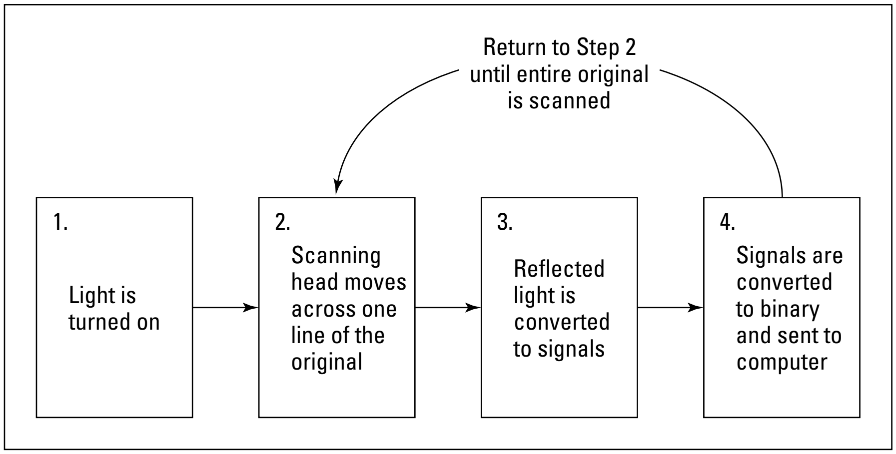

Figure 1-8: The scanning process in all its awesome glory.

Resolving Resolution

If you've read the "Examining the Innards" section, earlier in this chapter, you may remember the array of photosensitive sensors I mentioned. (If not, don't worry about it; I don't give you a test on that stuff.) The sensor array in a typical scanner is comprised of hundreds of individual sensors. The density of these individual sensors leads to what's likely the most important single specification you should consider in a scanner: *resolution.*

Scanner resolution is commonly measured in *dots per inch*, or *dpi* — the number of individual dots scanned per inch of the original image. The dpi measurement is usually expressed as horizontal (the number of individual sensors in the array) by vertical (the distance the sensor head moves between individual lines), for example, 600 x 1200. I call this measurement the "common" dpi because most scanner manufacturers use it in their specifications.

Other scanner manufacturers may give you only one dpi figure. That's what I call the "true" dpi because it measures only the number of pixels horizontally. It's the resolution measurement used by professional graphic artists, service bureaus, and publishers, so high-end scanners often provide only a single dpi figure.

TIP

If you're comparing a scanner that's listed with two figures, such as 600 x 1200 dpi, with a scanner listed with just one figure, such as 600 dpi, don't panic! Just compare the first figure, which is the horizontal dpi measurement. In fact, because both scanners offer 600 dpi, they have the same horizontal resolution.

TECHNICAL STUFF

If you want to be a stickler, however, using a dpi rating to describe a scanner's resolution is technically incorrect. I tell you more about this subject in the nearby sidebar, "Positive peer pressure!"

A high-resolution picture is worth a thousand words (somebody famous said that, I'm sure) — and the next two figures are a good illustration. In Figure 1-9, you see the same photograph of an apple printed at 300 x 300 and at 600 x 600 dpi. Figure 1-10 shows a close-up of one edge of the same two images (illustrating why a higher resolution results in sharper edges in your digital image).

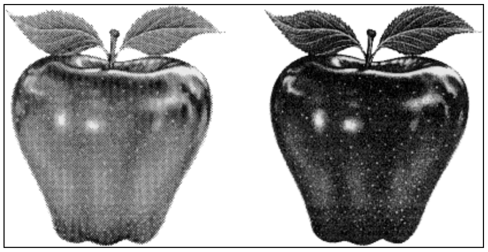

Figure 1-9: Tell the truth: Which apple would you rather eat?

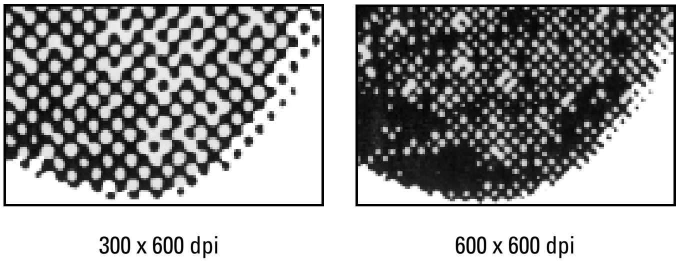

Figure 1-10: Those extra dots really make a difference.

As you may expect, the *general* rule calls for a higher dpi: The higher the resolution, the better the quality and the higher the detail of your digital image. However, a higher resolution also results in much larger image files, and not every original benefits from an astronomically high resolution. Therefore, you probably don't need to spend the extra $100 to buy a 1200 x 2400 dpi model when a 600 x 1200 dpi scanner will satisfy just about any PC owner or office worker. I discuss this subject in more detail in Chapter 2.

Positive peer pressure!

If I'm going to be completely accurate here, I should use a different measure of resolution, called samples per inch rather than dots per inch. *Samples per inch*, or spi, refers to the number of individual sensors in the array. A scanning purist would say that dpi is a term that belongs with computer printers, which print — rather than scan — dots.

You may be saying, "Now, wait a second. Isn't samples per inch *effectively* the same method of measuring as dots per inch?" You bet! That's why virtually every manufacturer of scanners on the face of this planet uses dpi when referring to resolution in their advertisements and specifications.

It may not be strictly accurate, but everyone (and I mean *everyone*) uses it. In this book, I've caved in to peer pressure and elected to use dpi rather than spi.

Scanning purists can complain all they like. As long as I'm writing this book, I think that it's more valuable for you to know what people really use, not a technical term that you'll probably never see in an online store or on the side of a scanner box. (Besides, this way, you can discuss scanners with the "in" crowd at your next cocktail party while the technonerds sulk in the corner and grumble about spi.)

Before I leave the subject of resolution, however, I want to familiarize you with the difference between raw and interpolated resolution. Here are the definitions:

- The *raw resolution* value (also called the *optical resolution*) is the optical resolution at which the scanner reads an image — in other words, the number of dots the scanner reads from the image.
- The *interpolated resolution* (also called the *enhanced resolution*) is an inflated figure delivered by the software provided with the scanner. The interpolated value adds a large number of extra dots to the scanned image by using a mathematical formula, *without* reading them from the original material. Interpolation is supposed to improve the quality of the image, which is why the interpolated resolution advertised for a particular scanner model is always higher than the raw resolution. (Those additional dots are ghosts!)

Here's the payoff: I *strongly* recommend that you judge scanners by their optical resolution while shopping. Forget about the interpolated value. It's nothing more than a guess made by a program, and in my experience it doesn't visibly improve the image. If an advertisement doesn't list the raw or optical resolution, find it on the manufacturer's Web site or the specifications on the box. This factor is important when comparing two different scanners.

How Deep Is Your Color?

I have one other massively important scanner topic to introduce here: color depth. The whole concept of color depth probably hasn't been a featured topic of conversation around your table (I know that it has *never* been mentioned around mine), although it can dramatically affect the appearance of your final scanned images and is the other criteria that will probably help you decide between those two or three different scanners on your shopping list.

In the computer world, *color depth* refers to the number of colors in an image (whether that image is on a computer monitor, captured by a digital camera, or captured by a scanner). Color depth is referred to in two ways:

- The maximum number of discrete colors (as in 256 colors or 16 million colors).
- The number of bits of information required to store color information for a single pixel (as in 8-bit or 24-bit color). This form of measuring color depth is also called *bit depth*.

Will that be Web color or print color?

When it comes to color depth, "higher is better" is not the rule of thumb used on the Web! If you're experienced at building Web pages that feature full-color images — especially large ones — you've probably decided to use a color depth of 256 colors, or 8 bits. Why? The answer is simple: The lower the color depth, the less time it takes a 56-Kbps modem to download the image to your visitor's Web browser. (Downloading a huge 16-million-color image over a telephone modem connection brings new meaning to the name "World Wide Wait.") Also, some computer owners still set their display color depth to 256 colors, so a 16-million-color (24-bit) image is mostly wasted data. Until more people have high-speed Internet connections, such as cable modems or DSL, 256 colors is probably the best choice.

On the other hand, if you're printing your images, anything less than 24-bit color is simply unacceptable. The fewer colors in your image (and the fewer colors your printer can deliver), the more your beautiful high-resolution digital photograph looks like a Sunday comic strip printed on cheap newspaper.

Which is best? That depends on two things: your output device (such as your monitor or your printer) and your own eyes. Only you can determine whether the quality of the finished image is acceptable, so experiment when you create Web pages with scanned images or print your scanned photos.

Most scanner manufacturers use the second method to describe the color depth of their products. Again, the general rule is the higher the bit depth, the better the color because your scanner is better able to capture subtle differences in color and shading from the original.

The scanner you select *must* capture a minimum of 24-bit color, although most models sold these days can reach 30-, 32-, 34-, 36-, 42- or 48-bit color. (The higher bit depths allow a more accurate color capture, even if the final image is printed at only 24-bit color.) That's all there is to color depth — no confusing acronyms, no exceptions, and no gimmicks. Refreshing, isn't it?

In Chapter 2, I describe other features and specifications you should look for while shopping for your scanner.