Digital Imaging Basics

Understanding digital imaging is essential both for using Photoshop effectively and for succeeding with the ACE exam. Here is a primer on some important digital imaging principles.

Bitmap Images Vs. Vector Graphics

When working in Photoshop, you are working primarily with *bitmap images*. Also known as *raster images*, bitmap images are made up of a grid of small squares called *pixels*. Pixels shine or project or illuminate (however you want to think of them) in various color values or shades—such as a light green, dark blue, or dark red—the variety of which depends on how many bits of information your file provides for each pixel. This display technique is similar to the printing process known as *halftone screening*, which enables the printing on paper of photographs and other continuous line images.

This description may be terribly confusing, so look at the visual examples shown in Figures 2.1 and 2.2.

Notice how the full-view image (Figure 2.1) appears normal, just like a regular photograph. When that same image is blown up (Figure 2.2), however, you can see how the illusion of a photographic image has been created with the grid of different colored squares. In this case, the colors are all various shades

Figure 2.1 A full-view image.

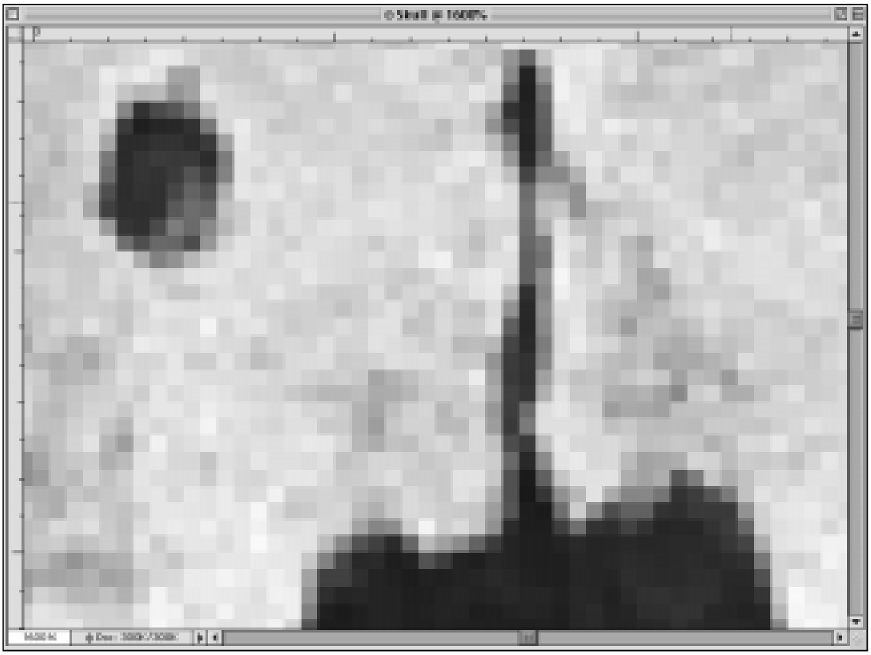

Figure 2.2 A detail of the same image magnified to 1600%.

of gray, but they also can be various shades of many other colors (they would be, if this image were in full color).

> Do not confuse *bitmap images* with *bitmap mode.* The term *bitmap images* defines a type of computer graphic, whereas *bitmap mode* is one of Photoshop's color modes.

Bitmap images must store all the data for each pixel that represents the image. So, if you have a large image, you have many more pixels and much more pixel data, which results in a larger file. If you want the file to be smaller while the image remains the same size, you must discard some of the pixel data, which results in a loss of image quality.

On the other hand, you have what are called *vector graphics*. Drawing programs such as Adobe Illustrator and Macromedia Freehand create these types of files. Vector graphics are different from bitmap images in that vector graphics define images by assigning numbers—or vectors—to the various elements that make up a *vector image*. Suppose that you open a drawing program and draw a stop sign. The drawing program stores the data that defines the image as numerical information about the placement, size, and shape of the octagon you draw, the lines that make up the letters in the word *STOP*, and even the colors that fill the octagon, the letters, and so on.

As a result, this *vector graphic* drawing of a stop sign makes a smaller file than a *bitmap image* file of a color photograph of a stop sign, which must store all the data that would tell each pixel in the grid what color to be. You also can freely resize vector graphics up or down without a noticeable loss of quality, which cannot be said for bitmap images.

> When you edit a bitmap image in Photoshop, you affect the image's pixel-based data. Photoshop alters images by altering the stored data about each affected pixel. This pixel-based method of editing an image is opposed to the object-oriented method of altering the numerical information of a vector graphic, as you would do in a vector-based drawing program.

Bit Depth

Now, go back to those bitmap images. A bitmap image's pixel information—what color each pixel should be—and the location on the grid of that pixel constitute the stored data of the bitmap image file. This pixel data directly affects the size of the image file, according to how many bits of information are stored for each pixel. In Photoshop, each pixel can have as many as 64 bits of color information stored for it.

A *bit* is the individual digit of binary code, either a zero or a one—which, in the case of computer graphics, could refer to on or off. If a pixel has a bit depth of one, the pixel will be either fully illuminated (on) or not illuminated (off). Thus, one bit has two values (on or off) or in the case of computer graphics, two colors. If you can follow that description, then you know that an 8-bit image has 256 colors. If you can't follow that thinking, here's the math:

```
1-bit = 2 values = 2 colors
8-bit = 2 values x 2 values x 2 values x 2 values x 2 values x
        2 values x
        2 values x 2 values
      = 256 values = 256 colors
```

The number of bits stored for each pixel determines a file's *bit depth* (sometimes also called either *pixel depth* or *color depth*) and directly affects the quality of the representation of color in the image.

> A file with a higher bit depth can more accurately represent color than a file with a lower bit depth.

Now, depending on the color mode (see Chapter 4 for more details about color and color modes), you have what are called color *channels.* Think of channels as individual files for each color of the mode. For example, if you are working with an RGB file, which represents its range of color by using mixtures of red, green, and blue, you have three files—or channels—each one storing the pixel information for one of those colors. These three files are synchronized so that they display their individual pixels in the appropriate place on the grid for that file. As a result, they combine their colors to display the image accurately.

Each channel stores the level of its particular color—the shade of that color—to illuminate for each pixel on the grid. That shade is determined by the pixel's bit depth.

Consider these examples:

- Bitmap mode images are black-and-white images with no shades of gray. They have a bit depth of one, and they are known as 1-bit files because they have only one channel, or color, and they store only one bit of information about each pixel. That one bit is on or off—white or black. This type of file usually is reserved for black-and-white line drawings, sketches, and other high-contrast images that have no shades of gray.
- The 8-bit grayscale images are black and white with 256 shades of gray. Remember the bit depth math? Because a grayscale image shades only one color, a grayscale image needs only one channel. Therefore, it is an 8-bit file.
- All 24-bit RGB images are full-color images that mix three colors to represent 16.7 million colors. Think of it—16.7 million colors! The 24 in 24-bit comes from the three 8-bit channels (one 8-bit channel for red, one 8-bit channel for green, one 8-bit channel for blue, or $3 \times 8 = 24$). Each of those three 8-bit channels has 256 shades of its specific color. Those three channels, then, combine for the 16.7 million possible colors ($256 \times 256 \times 256 = 16,777,216$).

> Although Photoshop supports files with up to 16 bits per channel (16-bit grayscale, 48-bit RGB, and 64-bit CMYK images), not all Photoshop tools and commands work with 16-bit images. The tools and commands that do work on 16-bit-per-channel images include the following:
>
> - Marquee
> - Lasso
> - Crop
> - Measure
> - Zoom
> - Hand

- Pen
- Eyedropper
- Color sampler
- Rubber stamp
- Duplicate
- Feather
- Modify
- Levels
- Auto Levels
- Curves
- Histogram
- Hue/Saturation
- Brightness/Contrast
- Color Balance
- Equalize
- Invert
- Channel Mixer
- Image Size
- Transform Selection
- Rotate Canvas

If you need to use any of the other Photoshop tools and commands, you must convert the image to an 8-bit-per-channel image.

Resolution

Simply put, *resolution* is the display quality of the image, regardless of the medium. That display quality of an image is determined by the amount of pixel data that it has. More pixel data means higher quality. So, higher quality images have more pixel data, and image files with more pixel data are larger. Get it?

The sharpness and clarity of on-screen and printed images and the size of image files are both related to resolution. Resolution can be originally specified by the amount of information that is either gathered during the original scan or set by the user during creation of a new file. After that, you can alter an image's resolution by changing it, using Photoshop's Image Size command.

Resolution, which is measured in *dpi* (dots per inch) or sometimes *ppi* (pixels per inch), determines how large or small an image can be displayed or printed while maintaining image quality. "Dots per inch" means just that. It's the number of dots—pixels—that a digital image has in every inch, to represent the colors and lines and details of an image.

Do not confuse dpi with lpi. The term *dots per inch* refers to scanning resolution or image resolution, whereas the term *lpi* (*lines per inch*) refers to the halftone screen density specified for printing an image on a press or printer. (For more information on printing specifications, see Chapter 12.)

Remember the description of bitmap images earlier in this chapter, where I said that if you reduce an image's file size while maintaining its screen or printed size, you lose image quality? That's resolution. To reduce that file's size, you have to throw away a bunch of pixel data. If you do so, you don't have as many pixels representing the same colors and shades of colors, so the resolution—the image quality—goes down.

On the other hand, suppose that you have an image with a low resolution—say, 72 dpi. If you want to increase the dpi to 266, while leaving the image the same size, you can use the Image Size command. However, if you use this command, Photoshop has to fill in all those extra, new pixels by guessing—interpolating—what color they should be. Consequently, you lose image quality.

Imagine, on the other hand, that you want to change that image's file size, and you intend to reduce its reproduction size at the same time. You can do so without losing image quality because you use the same number of pixels to represent the image.

What this description boils down to is that, to retain optimum resolution, you should reduce an image's pixel data only if you are also reducing its size. If possible, scan at the highest possible resolution, and then reduce images down to whatever size you need.

(For more details on resolution, see Chapter 5.)

Installation and Configuration

Installation

You can install Photoshop by placing the Photoshop CD-ROM in your computer's drive and following the instructions for installation. You need to consider the issues shown in Tables 2.1 and 2.2.

Table 2.1 Minimum installation requirements.

	Windows	Macintosh
Processor	Intel Pentium class	Power Mac
Operating system	Windows 95, NT/4	Mac OS 7.5
RAM	32MB	32MB
Disk space	60MB	60MB
Video display	8-bit	8-bit
Sound	card required	built-in