Image Production Source Media

The Collaboratory Project • Northwestern University

When you digitize images you may use a wide variety of sources, and have many different output formats in mind. Just to give you an idea, all of the following can be scanned on a flatbed scanner:

- Black and white photographs
- Color photographs
- Black and white line art
- Color graphic art with flat areas of color
- Black and white halftone images
- Color halftone images
- Pencil drawings

Each of these presents different problems when you scan. To this list we could add the wide range of transparent images, from color slides to photocopy transparencies, plus video still images, and then multiply it by the whole range of output media:

- World Wide Web graphics and photos
- Laserwriter printouts
- Halftone grayscale and color images for newspapers, magazines, and books
- Continuous tone images in photographic prints and slides
- Video images

The result would be a dizzying range of combinations of input and output media, each of which would require different decisions during the scanning, editing, and archiving process. This document attempts briefly to help you make some sense of this vertiginous variety.

Start at the End: Consider the Output Medium

Start the image production process by taking a moment to consider your final output medium, how it will be used, and by whom. These factors affect your scanned image.

Output to Computer Media

Graphics for the World Wide Web: Keep in mind that you end users will be viewing the images on a computer screen which may have only a limited viewing area. It makes little sense to scan huge images if the end result must be squeezed onto a computer screen. 640 by 480 pixels are the standard dimensions for the vast majority of computer monitors, though newer monitors have a higher resolution. Windows and toolbars and menus take up space on a monitor and further restrict the size of your image.

Photographs: Save as JPEG files.

Diagrams: Save as GIF images if the diagrams consist of a few flat colors, otherwise save as JPEG.

Output to Printed Media

Halftone Images: The halftone printing process creates ranges of grays or colors by using variable-sized dots. The resolution of halftone images is measured in terms of the frequency of the halftone dots, typically in dots per inch. Here are some typical halftone screen frequencies for different media:

- Newspaper: 85 dpi
- Magazine: 133 or 150 dpi
- Books, fine art and photography: 150 or 200 dpi or higher.

The optimum resolution for your digital image, in pixels per inch, is just slightly over double the frequency of the halftone screen. If you scan at more than double the halftone frequency, you will be padding the file with information that is not used, and which could conceivably slow down the printing process. You can, however, scan at 1.5 times the halftone frequency with good results, or even at the halftone frequency itself. Thus, if you want to display a 2 inch by 3 inch image in a magazine with a 150 dot halftone screen, expect to scan it at 300 pixels per inch for best results, with a resulting image that is 600 by 900 pixels. You could also scan at 225 ppi with good results, or even at 150 ppi.

Continuous Tone Images: Computer images can also be printed to continuous tone devices, which include film printers of various types, dye sublimation printers, and some types of ink jet printers. With these devices, you will get optimal results by printing at the resolution of the device, so that one pixel corresponds to one blended dot in the printed image. You may improve the detail in your image by scanning at up to double the resolution of the output device and then scaling the image down 50%, provided that the scaling properly interpolates the values of the pixels in the new image. Photoshop by default uses a sophisticated interpolation method, and should give good results.

Color in Printed Media: The gamut and type of colors used in printed media is very different from the gamut and type of color used on a computer monitor. Color printing typically uses the CMYK (cyan, magenta, yellow and black) subtractive color system, while computer monitors use the RGB (red, green, blue) additive color system. While it lies well beyond the scope of this document to explain the ins and outs of color management, you should be aware that it is possible to control color from scanner to computer to print if you use the appropriate software and file formats. If you know that you will go out to print, it can be very helpful to discuss the process with a printer or digital service bureau.

File Formats: The TIFF file format is probably the best for images intended for printing, as it is handled by a wide variety of page layout applications. The LZW compression commonly used in TIFF files is lossless but fairly efficient. As an alternative, consider Photo-CD, which like TIFF can embed color calibration information and use lossy compression to get a smaller file size than LZW compression can. JPEG would also be acceptable, though not as versatile.

Output to Video

Video output requires both a standard size document (640 x 480 pixels or smaller) and a standard gamut of “safe” colors. The exact pixel dimensions of a digital file depend on the video card you are using for output. In most instances a 40-pixel wide margin will be cropped from around a 640 x 480 pixel image, simply because video images are

"overscanned" to make them fill the screen. You can force your document to use the "NTSC safe" colors by using the video filters in Photoshop. NTSC is the video standard used in North America.

File Formats: You can use any file format for video stills, as long as you can open it onto your screen and output it to video. If you want to combine stills into digital video sequences you will need digital video editing software such as Adobe Premiere or Apple's Movie Player.

Scanning Techniques for Different Source Media

While the output medium conditions your choice of image size and resolution, you will find that every image has different requirements. The following are some tips that may help you get good quality images.

Monitor Setup

Before you get started, it's a good idea to work with uniform, moderate ambient light: bright environments decrease the apparent contrast of your monitor. If at all possible, you should use a monitor set to display thousands or millions of colors. Image processing is difficult on an 8-bit monitor. Set the background of your monitor to a uniform 50% gray. Color and graphical backgrounds can actually skew the way you see color.

Figure 1: Test your monitor with a grayscale gradient

If you monitor can be calibrated, by all means calibrate it before working with images. If not, there are few things you can do to improve the reliability of the image on your monitor. First, check the border areas outside the screen image: if they are gray in color rather than black, your monitor is too bright. Next, in an image editing application create a gradient fill from white to black, passing through all gray shades in between. If the light grays are bleached out or the dark grays are black, you'll need to adjust the brightness and contrast of your monitor. First try turning the brightness all the way up and adjusting the contrast. In theory a medium contrast setting with the brightness turned up high should give you the widest range of grays. If this doesn't succeed, gradually lower the brightness and continue tweaking the contrast.

Scanning and Editing Application Setup

You should set the measurement units used in your scanning and editing applications to reflect the units used in the output medium. For images used for a computer or video project the obvious measurement unit is pixels. Images for print generally use inches, centimeters or picas.

Black and White Line Art and Text

For black and white line art such as pen and ink drawing, pencil drawings, for non-halftone reproductions such as maps and prints, and for text, you will get the best results as follows:

1. **Scan the image in grayscale.** Although many scanners have a line art setting, you will have considerably less control over the process if you rely on the scanner software.

2. **Use the Levels... command (Image menu) white and black point controls to improve the contrast of the image.** By adjusting the white point in the Levels dialog box you can turn gray pixels, especially the light gray shades of the paper itself, to white. Adjusting the black point will let you set all the darkest pixels to true black.

3. **Use the Levels... command gray point control or the Curves... command for fine tuning.** You can fine tune the contrast with the gray point control in the Levels dialog box, or open the Curves dialog for very precise control over your image.

   Note: If your editing application does not have a command like Photoshop's Levels or Curve command, you can use brightness and contrast adjustments instead.

Figure 2: Before applying brightness and contrast adjustments with the Levels command, the image shows a gray tone instead of paper white. Worse yet, images have bled through from the back of the paper. The histogram in the Levels window shows clearly where the light gray pixels are heaped at the white end. By moving the white point to the left of the heap, all these pixels become white. Moving the gray point to the right then compensates for the increased brightness in the image.

4. **Retouch if necessary.** Some images are so degraded that hand retouching is the only solution, mostly for eliminating "noise" from smudges and spots.

You may then want to convert the image to Indexed Color or Bitmapped (1-bit black and white) mode. In Indexed color mode you can reduce the number of colors used in the image, and in bitmapped mode you can use just black and white pixels for a very compact file.

Convert to Indexed Color in two steps:

1. **Choose "RGB Color" from the Image menu Mode submenu in Photoshop.** The image doesn't appear to change, although it will occupy three times as much memory.
2. **Choose "Indexed Color..." and set the color depth of the image to the number of shades of gray you want to see in the image**. Use a diffusion dither for the best quality, or no dither for a somewhat smaller file. The image changes to reflect the number of colors in its palette and the dithering method.

Convert to Bitmap as follows:

1. **Choose "Threshold..." from the Image menu Adjust submenu.** The Adjust dialog box appears.
2. **Drag the threshold point in Threshold dialog box to determine which pixels will be black and which will be white. Click OK.** The image changes to black and white pixels.

Figure 3: Setting a high threshold makes the image darker.

3. **Choose "Bitmap..." from the Image menu Mode submenu. Select the "50% Threshold" setting and click OK.** The image changes to bitmapped mode.

Note that only grayscale images can be converted to bitmap mode. You must change images in Indexed or RGB mode to grayscale mode before you can convert them to bitmap mode.

Note also that the threshold command is only useful for true black and white line art. If you want to preserve more of the gray areas in your image but still create a strictly black and white image, skip steps 1 and 2 and use a diffusion dither in the Bitmap dialog box.

Black and white images can be changed to RGB mode, colorized (Hue/Saturation command) and saved as indexed color GIF files to create interesting, compact web graphics.

Grayscale and Color Continuous Tone Images

These are very simple to scan. Just use the grayscale or RGB setting on your scanner. If the image has a sepia or other tone that you want to preserve, scan it in RGB mode (24-bit color) and then convert it to an 8-bit indexed color image. If you want to create a uniform color tonality for several images, convert a grayscale image to RGB color, colorize it (possibly using a color sampled from an RGB scan) using the Hue/Saturation command and noting the values you enter, and convert the image to Indexed color. See the Collaboratory Project's "Image Production Tipsheet (2)" and "Image Production Reference" for details on working with scanned color images.

Grayscale and Color Halftones

Images scanned from printed matter present a particular challenge because the scanning frequency of the scanner (the number of samples per linear inch) may be very close to the frequency of the halftone screen of the image. This can cause periodic patterns called *moiré patterns* to appear in your image. Some scanning software includes a filter to eliminate moiré patterns. You will usually need to indicate the frequency of the halftone when you scan, and you may need to determine this by trial and error (though there are simple devices for determining halftone screen frequencies, sold by graphic arts suppliers).

Figure 4: Filtering a halftone image eliminates moiré patterns.

If your scanning software does not have a halftone scanning mode or halftoning filtering, you can still eliminate most moiré patterns. If you have enough memory available, simply scan the image at a resolution over twice the halftone frequency and then scale it down to size in Photoshop. You can also try scanning with the image at different angles (45 degrees, for instance) to see if that produces less noticeable patterns. Blurring the image before you scale it down and then sharpening it afterwards can sometimes improve quality, too.

Transparencies

Scanners with a transparency attachment can scan transparent images, including slides and photographic negatives. You should use the scanner settings appropriate for the image you are scanning. Many transparency scanners include "profiles" that describe the color characteristics of different types of film. If you know the film type and manufacturer, you can select one of these profiles in the scanning software.

3D Objects

You can scan many three dimensional objects such as medallions, jewelry, and other objects, thanks to the shallow but useful depth of field most scanners afford. You can improve the scanning of these objects by placing a piece of black velvet behind them. Cleaning the surface of your scanner can be important, too, since dust and fingerprints show up very nicely when the lid is not fully closed.

File Formats

For Grayscale and Color Images

There is a wide variety available. Which you use depends on your eventual output medium.

- **TIFF:** Use this for files destined for printed output, especially if the image will be used in a page layout or word processing application.
- **EPSF:** This file format, the Encapsulated PostScript Format, is used in print publications, especially if the image is going directly out to color separations. It is not an efficient, compressed format, and should only be used if your printer requests it. You can easily convert TIFF files into EPSF files in Photoshop.
- **Photo-CD:** This file format can be convenient if you are creating archives of images that should preserve color information, especially if you take film, negatives, or slides directly to a service bureau for scanning to a Photo CD-ROM.
- **GIF:** If your image is diagram with flat colors to be shown on the World Wide Web, save it in GIF format.
- **JPEG**: If your image is a photograph or multi-colored diagram, save it as a JPEG file.

For Black and White Line Art

You can save you image in black and white or grayscale, and there are several alternatives:

• **TIFF:** There are several different strategies. If you want to keep all your grayscale information, save the image as an 8-bit grayscale TIFF file. If you want to get more compression, convert the image to RGB and then to Indexed color with 4 bits of color depth (16 colors).

• **GIF:** If your image will be shown on the World Wide Web, save it in GIF format. Use the fewest number of colors you can in Indexed Color format.

• **JPEG**: Save as a grayscale (8 bit) JPEG, preferably with high quality compression. This file format is only appropriate if you need compression for the World Wide Web, since it can introduce artifacts. The artifacts will make it difficult to get good compression in GIF or TIFF format, so it's a good idea to archive a copy in one of those formats.