

# Step-By-Step Scanning

How to Achieve the Best Scans Possible . . . the First Time

By Andrew Rodney

## What You Will Need

- Adobe Photoshop 4.0 or later (demo available at [www.adobe.com](http://www.adobe.com))
- Flatbed Scanner
- A Sheet of Thick White Paper, Card Stock, or Clear Film

Scanners are complex devices that consist of optics, electronics, and mechanical components driven by scanner software. Each component plays a role in the quality of scans you produce, as does the skill of the person operating the scanner. This tutorial presents guidelines for evaluating scanner performance and scanning software, otherwise known as scanning interface.

Why is it so important to obtain great scans directly from the scanner? Why not simply fix tonal or color problems in Adobe Photoshop? The answer is speed and quality. It is very time-consuming to apply multiple corrections to a 30MB file in Adobe Photoshop, even with a fast computer. But it takes no longer to scan an image with multiple corrections than it does to

scan an image without them.

The bigger issue is quality. When you perform global (whole image) tonal corrections in Adobe Photoshop on a 24-bit file, you lose data. High-bit scanners—those that scan more than 24 bits of color per pixel—create higher bit depth files. Adobe Photoshop can open these files, but the only tonal corrections it can perform on 24-bit files are Levels and Curves. In Photoshop 4.0 or earlier versions, no other Photoshop tools, filters, or options will work on a file with a bit depth greater than 24. Making tonal corrections in the scanning application will not yield better quality, but the

work will likely be far faster.

The first adjustment you should make on the prescan is to set both ends of the tonal range—highlight and shadows. Most scanning software provides white and black Eyedropper tools, much like those found in Adobe Photoshop Levels and Curves. Find an area in the prescan that has pixels you want to assign as the brightest white (highlight) or blackest black (shadow) by clicking on those pixels with the appropriate Eyedropper tool.

Keep in mind that the scanning software you use is critical. Two problems arise with poor software:

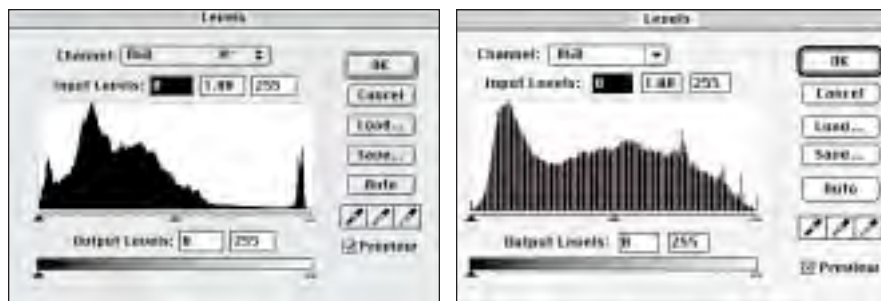


Figure 1. Here we see two histograms. The first is from a good scan without manipulation in Adobe Photoshop. Notice that there is data running from each end of the tonal scale (0 to 255) and that the histogram is solid black, meaning we captured good data throughout. The second histogram came from a poor scan that lacked tonal data from either end of the scale. Using Photoshop, the tonal deficiencies were corrected with the Levels tools. Notice the resulting histogram has a combination effect, in which each white step represents data loss.

targeting precisely the pixels you want to click on with the Eyedropper, and achieving subtle tonal variations between pure white and absolute black. If you click on the wrong pixels, you'll set the clipping of the Eyedropper tool incorrectly and likely make the prescan worse than it was before you started working on the image.

Better quality scanning software provides either a large prescan preview, a means of zooming into the prescan, or a floating palette that displays an enlarged preview (see Figure 2), allowing the user to

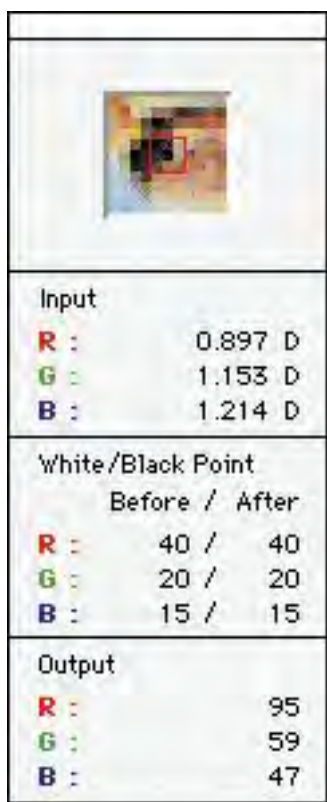


Figure 2. This is an example of an enlarged floating palette in the Agfa FotoLook 3.0 software. It provides the user with precise feedback on what's being examined in the prescan, making finding and clicking on the right pixels an easy task. Notice also that this palette provides a densitometer that shows the RGB values in the prescan.

properly set the clipping of the black and white Eyedropper tool. Since our scale of tonality ranges from 0 (pure black) to 255 (pure white), the capability to assign a

specific range for the Eyedropper tool is a great feature. For example, you may want your highlights to be set at 250 rather than 255, and the shadows to be set at 5 rather than zero (see Figure 3).

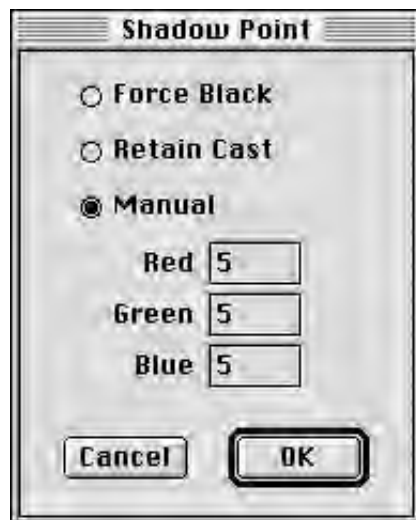


Figure 3. The software that runs the Polaroid SprintScan ES and Plus allows the user to precisely set the clipping of the Eyedropper tool. Here I have double-clicked on the black Eyedropper tool, set to produce a value of 5/5/5 on any pixel I click on in the prescan.

Setting the highlights and shadows with the Eyedropper tool has an additional benefit. Since the highlights and shadows are a set value of red, green, and blue, you are essentially removing any color cast that may be in the original prescan. While there may be some scanned images that should retain a color cast, such as a photo taken at sunset, most images benefit by having both ends of the tonal curve set, and the end values forced into neutral highlight and shadow. This technique adjusts the tonal and color corrections as well.

A histogram, such as that found in Adobe Photoshop, is another nice tool for setting both ends of the tonal curve, as well as the midtones. Unfortunately, few scanner interfaces I've seen provide such a tool. Most interfaces provide a standard curve dialog, much like

the Curves dialog in Adobe Photoshop. Curves are one of the most powerful ways to adjust color and density throughout virtually any portion of the image, and a good one allows the user to adjust a curve on every color channel. For example, if you wish to remove a cyan cast in only the highlights, you can pick the Red channel in the curves dialog and adjust the curve in just that portion of the tonal curve (see Figure 4).

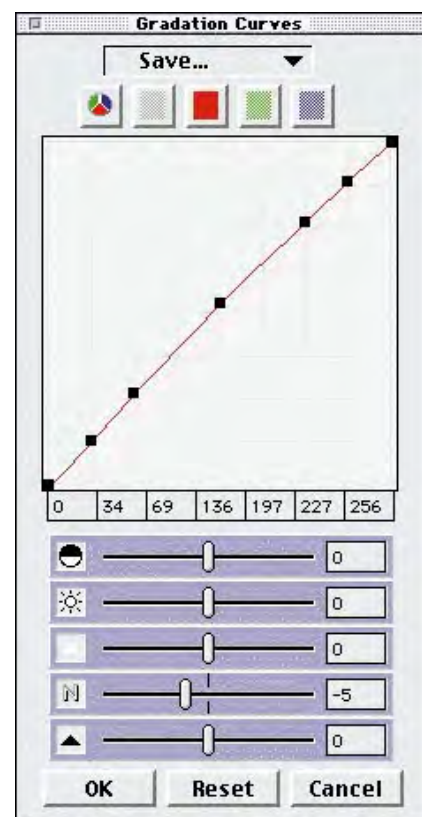


Figure 4. Here I have opened up the Curves dialog from the LaserSoft SilverFast scanning interface. By setting the curves to only the red channel, I can manipulate that color in any area of the tonality, based on where I pull a curve.

As for controlling color at the scan stage, manufacturers write various tools into their software products. I prefer to use curves for precise color adjustment, but you might prefer to use sliders for red-cyan, green-magenta, and blue-yellow corrections. Bear in mind that these controls are usually applied to the entire tonal range of

the prescan, resulting in far less control than with curves.

Some software provides a third Eyedropper, which can be used to force selected pixels to a neutral value. If you happen to have an area in your image that you know should be neutral gray, this tool can be very useful for eliminating color casts. More sophisticated desktop scanning software may even provide selective color controls, which were once found on only high-end drum scanners. Agfa FotoLook 3.0, Linotype LinoColor, and SliverFast Silverscan provide this powerful feature, which allows users to adjust selected colors (or densities) in the prescan without affecting others. Let's say you are scanning a landscape. You're pleased with most of the colors in the prescan, but the sky appears to have a cyan cast. A selective color control in the scanning software allows you to add red in only the blue areas of the image.

No matter which control you use, good numeric feedback is a very important feature in scanning software. Most packages have at least one densitometer, which provides the numerical values for the red, green, and blue (or other color space) values of all pixels under a certain tool. This allows the user to read the colors and come up with the necessary feedback to produce a good scan. Better software packages allow the user to pick multiple areas in the image and produce multiple densitometer readings (see Figure 5).

Before and after densitometer readings give users some idea of what kind of tonal or color moves they have applied to the prescan. You can select the number of pixels to be read by the densitometer and correction tools—ideally a matrix of 5x5 or 3x3 pixels. Some software packages allow the user to pick multiple pixel samplings, which is

Probe#2		Probe#1	
x	390	x	273
y	165	y	234
89.9	L	51.6	L
13.5	C	67.5	C
111	H	159	H
8	C	98	C
4	M	15	M
18	Y	92	Y
0	K	0	K
Probe#3		Probe#4	
x	545	x	202
y	52	y	254
33.9	L	60.1	L
8.2	C	10.1	C
113	H	114	H
70	C	42	C
58	M	31	M
75	Y	47	Y
31	K	5	K

Figure 5. Linotype CPS LinoColor allows the user to create an unlimited number of "trigger windows," before and after the densitometer. These small palettes give the user numeric feedback on the prescan. Notice in LinoColor that the user is provided CMYK and LCH (luminance, chroma, hue) readings, rather than RGB readings. Each software package may provide different kinds of numeric feedback.

especially useful for setting the tonal range of a prescan with the Eyedropper tools.

Many scanners allow the user to apply sharpening to a scan. In some cases, sharpening at the scan stage produces quality superior to sharpening in Photoshop, and it can greatly accelerate workflow. This is especially true with high-end scanners that have a hardware processor for handling this kind of work. Few scanning interfaces allow the user to obtain an accurate preview of the sharpening effect on the prescan data, which can cause problems in setting the correct

sharpening parameters. Test your software to see if you can use the controls to produce the sharpening needed for your specific output. There may be cases where you can set your scanning software to provide just a smidgen of sharpening, and then do the rest in Photoshop, targeting the amount of Unsharp Mask filtering based on the image content and output requirements.

With the software issues behind us, let's look at the hardware. I've devised some tests to help you evaluate your scanning equipment. Most of these tests are designed to evaluate flatbed scanners; however, some will work equally well on film scanners. Try these tests on a number of different scanners as a basis for comparison. The software used to drive the scanners could influence the test results, so keep the software controls in mind while testing the scanners.

### Test 1

The first test is a simple way to see if the scanner's light source and optics are up to par. All you need for this test is a piece of thick white paper or card stock (if you have a film scanner, a clear piece of film should do the job). Place the paper on your scanner, make a prescan, and crop so that the entire piece of paper is included in the scan. If you have a tabloid scanner, you may need two sheets of paper; we want to try to scan the entire area of the scanning bed. It's important that the software be set so that the paper won't be scanned as pure white (255), because we want to see some subtle tonal data in the scan. This is a good place to test the Set White Eyedropper tool, if your software has one. Because each scanning software operates differently, you might want to consult your manual. If you can't set the clipping value to around 240 or 250, see if you can use the curves

or similar control for tonal range to make the paper appear as a light shade of gray in the prescan.

Import the scan into Photoshop or your image editing application. Examine the scan at different magnifications. We're looking for a white or gray scan with no hot spots or unevenness. You may want to invert the image (Image>Adjust>Invert) to view the scan as a dark representation. Use the Photoshop Eyedropper tool and the Info palette to read the numeric values of the scan on all four corners and in the middle. In the best case scenario, the scan will appear evenly "illuminated" over the entire image. You may find that your scanner has a "sweet spot" that is too hot (bright), or that the edges of the scans are too dark. There isn't much you can do about this, except to place originals to be scanned away from these problem areas.

Here's another quick tip: If the scanned image appears to be even, always place your originals on the



Figure 6. This is a screen dump showing the prescan of the bed of a Linotype Opal Ultra tabloid sized scanner. Notice that I have the long axis of the original placed on the scanner bed in a direction opposite from the way the CCD moves up and down the bed. This means that the CCD travels over a shorter area of the scanner, which can speed up scanning.

scanner bed so the long axis of the original is running along the same

axis as the CCD (usually the short axis of the bed). Your prescan and actual scans will be faster, because the CCD doesn't have to travel as far up and down the bed (see Figure 6).

## Test 2

One of the best subjects you can use to test a scanner is a good old U.S. greenback. I use a crisp \$20 bill to test the quality of fine detail in a scan. Warning: Do not output any of the test scans you make using currency! Here's a good test for evaluating whether or not your scanner is consistent between scans, and to gain an idea of the exactness of the registration.

1. Place a \$20 bill on the scanner and perform a prescan.
  2. Crop the bill any way you wish.
  3. Set the scanner software to obtain the best possible prescan.
- We'll scan the image twice with the scanner set in exactly the same way for each scan. This is critical for a good evaluation of the two scans. If you have to save all the scan parameters as a file to reload for the second



Figure 7. The two scans of the \$20 bill should appear identical. But notice the third image, which is the two images on one layer with the Difference mode applied. You can see the subtle lines, which illustrate the minor differences between the two scans.

scan, do so. If you have a scanner that remembers the settings between scans, that's ideal. If in doubt, don't make any changes to the prescan, even if it looks poor. The scans must be as close to identical as possible for this test to be valid.

4. Set the resolution to its highest true optical resolution. (For example, if your scanner is rated at 1,000x2,000 ppi, set the resolution to 1,000. Later, we will use other settings.

5. Make the scan and save it to disk as "Scan 1."

6. Open the scanning software to verify that the parameters are set exactly as they were for Scan 1. Make a second scan at exactly the same parameters as the first, and name it "Scan 2."

Now we have two scans that we need to open and compare in Photoshop. They should look the same. But now we will use a technique I often use to evaluate files that appear to be identical:

1. With Scan 1 and Scan 2 both open in Adobe Photoshop, click on Scan 1 to make it active.

2. Click on the Move tool in the Adobe Photoshop tool palette.

3. Click and drag Scan 1 to move it over the open file, Scan 2, while holding down the Shift key. This ensures that when you drag and drop Scan 1 over Scan 2, you are making a new layer with the files in perfect registration.

4. Scan 2 should now have two layers. Make sure the Layer palette is open to verify this.

5. On top of the Layers palette is the Mode pull-down menu. Click on this menu, dragging down to the Difference mode. This mode examines both layers, and displays the differences between the pixel data in the two layers. If the files were 100 percent identical, you'd see a completely black image. But I'll bet this is not what you are seeing. Instead, you are likely see a

dark image with subtle lines (see Figure 7). You're seeing the minor differences between the scans. In a perfect world, your scanner would create identical scans each and every time. With better scanners, there will be only minor differences in registration. In this example, we've asked the CCD to travel up the bed  $1/1,000$  inch, which is a pretty fine step. If you see more than fine lines in the two layers in the Difference mode, you could be seeing color and density differences between the two scans, and that's not a good sign. If you want to see a major change between the two scans, select the Move tool and move the arrow keys on your keyboard a few pixels. If the resulting image is completely black, then you've got a very fine scanner.

If you wish, try performing the same registration test and increasing (and decreasing) the resolution. Try using a resolution that is higher than the optical resolution to test the interpolation of two scans.

### Test 3

Speaking of interpolation, just how good is the algorithm for resampling data in your scanning software? We can easily check. The sensors in most flatbed scanners are a single row of CCDs. In the case of a scanner that has a 600x800 ppi, the CCD has the capability of creating 600 real pixels per inch. The figure 800 ppi tells us that the stepper motor that moves the CCD up and down the bed of this scanner can move  $1/800$  inch. Since the pixels are square, not rectangular, the CCD actually captures a maximum of 600 pixels per inch. It's not possible for this scanner to capture 600 pixels in one dimension using the true optical resolution of the CCD, while simultaneously moving up the bed  $1/800$  inch; therefore interpolation

comes into play. A 600x800-pixel specification indicates that if you intend to use the finest step available to produce an 800 ppi scan, the scanner software must interpolate data on the other axis that is capable of producing only 600 ppi. In other words, 200 ppi of data has to be interpolated in order to actually scan at 600x800 ppi. When you scan at the true optical resolution of the scanner, the stepper motor simply matches the resolution as it moves up the bed.

In many cases, scanning and interpolating one dimension will provide better quality than scanning at optical resolution and interpolating in Photoshop, which has to interpolate both dimensions to increase the size of the file. But not all interpolation algorithms are created equal. Let's try the following test to see how your scanner stacks up to Adobe Photoshop when the time comes to interpolate. Once again, use the \$20 bill in your scan test.

1. Set the software to create a good quality scan.

2. Save the settings or write down all the parameters; we want to make the two scans look as close as possible to each other. For an accurate test, be sure that no sharpening controls in your scanning software are turned on.

3. Make the first scan at the highest optical resolution. If your scanner has a specification of 600x1,200 ppi, set the software to 600 ppi.

4. Save the file to disk as "Optical Scan."

5. Now you'll make a second scan that you can crop and correct to exactly match the first. But this time, scan at more than the optical resolution of your scanner. Shoot for a resolution somewhere between the highest optical resolution setting of your scanner and the highest resolution setting the stepper motor provides. For

example, if your scanner has a specification of 600x1,200 ppi, scan at 1,000 ppi. This will ensure that the software in the scanner interpolates over only one axis. Now save the file to disk as "Interpolated Scan."

6. Open both scans in Photoshop. We will now interpolate the first, smaller file to match the second, interpolated scan.

7. Make the Interpolated Scan active by clicking on it (Window>Interpolated Scan).

8. Under the Image menu, click on Image Size. Write down the exact pixel dimensions of the height and width.

9. Make Optical Scan active by clicking on it (Window>Optical Scan).

10. Under the Image menu, click on Image Size. Make sure the Resample check box is on. This will allow us to add pixels to the file, thus interpolating it.

11. Make sure the Bicubic interpolation is set next to the Resample check box. We need to match the pixels in Optical Scan to Interpolated Scan. That means we need to type in the same number of pixels for height and depth that you wrote down in step 2. Click OK.

After some time, you should have a much bigger file (in size) that exactly matches the file called Interpolated Scan. Now we want to evaluate the two scans side by side. You may need to resize both windows so you can see each without overlap. Zoom into both images at 100 percent to provide the most accurate on-screen view of the digital files. You want to have the same sections of each file on screen so you can evaluate the two images. With the fine lines in the \$20 bill, you should be able to evaluate which interpolation method works better. Are the lines sharper and clearer on one scan versus the other? You may now want to zoom in on both scans past

100 percent to evaluate the two interpolation methods.

You should try this interpolation test for both dimensions to determine which method produces a better file. In theory, a scanner that uses a good interpolation algorithm should produce a file superior to one interpolated in Photoshop, especially when the scanner has to interpolate on only one axis. Some scanner manufacturers consider scan speeds to be more important than interpolation quality, so don't be surprised if the files resized in Adobe Photoshop look better.

### Evaluating an Output Device

Don't forget that no matter how good your scan is, the final image quality is going to be determined by your output device. Here's a quick step-by-step test file you can create for evaluating your output device. In essence, we are going to create a perfectly neutral 21-step gray wedge. If you could output this on a good printer, you could, in theory, scan the wedge to evaluate the dynamic range of your scanner. This step wedge is great as an output test because numerically it's a completely neutral gray, with a tonal range from pure black to pure white. Next time you want to see how calibrated (linearized) a certain printer is, simply send out this file and then examine the print under controlled lighting (daylight standard is D50).

1. In Adobe Photoshop, create a new file (File>New), and name it "Step Wedge."

2. Set the width and height to a size you wish to output (it needn't be a huge file), such as 10x3 at 200 ppi resolution. It should be long and skinny.

3. Be sure that the mode is set to RGB. Click on the OK button.

4. Set the foreground and background colors to the default

(black and white). A quick way to do this is to click on the "D" key.

5. Click on the Gradation tool or hit the "G" key. Make sure that the Options palette is open, and set to: Mode: Normal; Opacity: 100%; Gradient: Foreground to Background; Type: Linear.

6. With your new document active, click and drag the Gradient tool from one end to the other, while holding down the Shift key. The Shift key ensures that you will draw a straight line from end to end. Try to draw the gradient as close to the far left corner of the file as you can, and then extend it as far to the right as you can to the end of the file. This will guarantee that the gradient is even.

7. Select the Image menu, move to the Adjust menu, and select Posterize (Image>Adjust>Posterize).

8. When the Posterize dialog comes up, simply type 21 in the field, thus creating 21 steps in the gradient. Click OK.

9. Save the file.

The beauty of this RGB file is that the patches are completely neutral. Move a tool over any of the patches while examining the Info palette and you'll see that all three values of red, green, and blue are exactly the same. You can open this file while examining other files so you can see if areas you wish to be neutral match this control file. In addition, you can send the file out with other images to make sure your output device is really laying down neutral values. This file will work only with printers that accept RGB files. ◀

More info? Reader Service Numbers are listed on page 60.