Color-Accurate Inkjets Made EZ

Three software programs claim to bring the power of high-end color science to desktop inkjet printers. In this exclusive hands-on review, we put them to the test

By Bruce Fraser
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Color management systems such as Apple's ColorSync and Microsoft's ICM 2.0 are touted by their creators as easy, automatic tools for matching colors from your original, through your scanner, to your monitor, to your printer. In practice, they've proven to be complex and often unwieldy, but one thing is clear: color management lives or dies by the accuracy of the device profiles it uses.

If you've been struggling with color management and failing, it's quite likely that a major part of the problem is inaccurate profiles, particularly if you've been relying on the generic profiles shipped with many low-cost color printers, scanners, and monitors. Custom profiles made for the actual equipment you use can produce much better results than you'll ever get from a generic profile, but how can you obtain custom profiles to replace the generic ones? (See sidebar A Profiling Primer for an explanation of the profiling process.)

Not so long ago, getting consistent color from your printer required a substantial investment of time, money, and intellect. Building a printer profile that ensures predictable color from your printer has been a matter of buying a $1,000 software package, a $2,000 handheld measurement device (up to $2,500 for an automated spectrophotometer), plus a good chunk of time and a fair bit of rocket science. It's hardly surprising that most normal mortals were reluctant to invest the time in the learning curve involved and to spend upwards of $2,000 to profile a $500 inkjet printer. (See sidebar "Fast, Easy, and Cheap: Color Management's New Generation.")

There had to be an easier -- not to mention cheaper -- way. Monaco Systems pioneered the concept of using an inexpensive everyday flatbed scanner instead of a costly dedicated spectrophotometer to take the measurements needed to build a printer profile -- it wasn't the first company to announce such a product, but it was the first to ship one that worked. But since Monaco released its $299 MonacoEZcolor package, the company has faced competition from two other vendors with scanner-based profiling packages: Horses LLC's $229 MatchLock Profiler II and Praxisoft's $79 WiziWYG.

But do these things actually work, and if so, how well? And just how easy are they to use? To find out, we used each package to build profiles for an Epson Photo Stylus EX inkjet printer. For comparison we also built a profile for the same printer/ink/paper combination, using a high-end measuring instrument, the GretagMacBeth Spectrolino/SpectroScan, and a high-end profiling package, GretagMacbeth's ProfileMaker Pro 3.0.

How We Tested

We used third-party inks and paper that differ substantially from Epson's own media. Epson's generic profiles do a pretty good job if you're using Epson inks and papers, but numerous reports of fading after a few months or, in some cases, a few weeks, have ignited interest in longer-lived inks and papers from third-party

vendors. Of course, if you use non-OEM media, the profiles supplied by the inkjet vendors are pretty useless -- you need to create custom profiles for the particular inks and paper you use, and these relatively low-cost profiling packages seem ideal for the task.

We looked at the usability of the three products, noting potential gotchas along the way and counting how many hoops we had to jump through to make things work. We generally found them to be very easy to use, but our main focus was on the quality of the profiles the applications built.

Evaluating profiles is a tricky exercise that always involves some subjectivity. There are things we can measure objectively, by using procedures such as feeding known colors through an Absolute Colorimetric rendering intent. Absolute Colorimetric rendering attempts to reproduce colors exactly on the output device: It simply clips colors that lie outside the output device's gamut -- colors the printer can't produce -- to the nearest printable hue, sacrificing lightness and saturation. This means that, for in-gamut colors, we can judge the degree of accuracy of the profile by looking at the colors produced by the profile on the printer and comparing them with the source values in the file we used to make the print.

When it comes to Perceptual rendering, however, measurements can't really help us evaluate the profile. Perceptual rendering tries to compress the entire gamut of the source color space into the gamut of the output device. In the process, all the colors in the image may change slightly -- the idea is to preserve the overall relationship between the colors and hence, ideally, the overall appearance of the image. Evaluating the success with which a profile does this is necessarily subjective, because there is no single "correct" way to do gamut compression. You simply have to print a selection of various images that represent all the different types of imagery you're likely to print and then decide whether or not they look good and whether or not they resemble the originals. This is in fact what we did.

Our evaluation of the profiles had three components:

- An **objective comparison,** where we printed known CIE Lab colors through the profiles, using Absolute Colorimetric rendering and then measured the CIE Lab values from the printed output, using a high-end spectrophotometer and plotted the difference.
- A **subjective comparison,** using the printer profiles with Perceptual rendering to print a set of test images, comparing the prints with the on-screen appearance of the image in Adobe Photoshop.
- A **subjective comparison of scan-to-print color matching,** using both scanner and printer profiles to scan and print an image with Perceptual rendering and then comparing the prints with the original.

Although the measurement-based profile created with high-end hardware and software was clearly more accurate than those produced by the scanner-based tools, we were pleasantly surprised to find that all three scanner-based packages produced very good results on Perceptual rendering of images. The results on our objective comparison using Absolute Colorimetric rendering were a little more mixed, ranging from very good to just OK. We'll discuss these results in detail a little later.

Scan and Print the Target

MonacoEZcolor and Praxisoft WiziWYG are very similar to use. Both are standalone applications sporting wizardlike interfaces that step you through the process of building a scanner and printer profile in a single operation. MatchLock Profiler II is a different kind of animal: It operates as a Photoshop plug-in (with a copy-protection scheme that attaches to the serial number of your copy of Photoshop).

Both EZcolor and WiziWYG include a photographic IT8 target for profiling the scanner. The target has two components, the actual physical paper target you scan and a target description file (.tdf) that contains the actual measured color values the physical target contains. To profile the scanner, you scan the target and feed the scanned image into the profiling package. The profiling package then compares the RGB values produced by the scanner with the measurements in the target description file and uses this information to figure out how the scanner sees color. Once the scanner is profiled, the software can estimate quite accurately what color the scanner is seeing, which is what allows the package to build printer profiles by using the scanner to make the measurements. Although both products allow you to profile a scanner separately from a printer, they also let you create both the scanner and printer profiles in one fell swoop, which is quite convenient. (See Figure 1) The process is a little involved (although much less so than measuring 1,000-some patches with a handheld spectrophotometer), but each package does an excellent job of stepping you through it.

Figure 1a

Figure 1b

Figure 1: Monaco EZcolor (a) and Praxisoft WiziWYG (b) let you create multiple profiles at once.

The first step is to print the printer target. (See Figure 2) If you have a printer with an OS-level driver, you can print the target directly from within the profiling package. For those printers that are driven by a specialized application or a Photoshop plug-in, you can print the target to disk and then print the file from your printing application. EZColor warns you ahead of time to turn off all color management or autocorrections in the print driver, which WiziWYG does not.

Figure 2a

Figure 2b

Figure 2: Both products step you through the process of printing a target, although EZcolor (a) offers more detail than does WiziWYG (b).

Once you've printed the target from your printer, you tape the photographic IT8 target to the printer target you've just printed -- the print includes marks that show you where to place it -- and then scan the two in a single image. (See Figure 3) This is the most critical part of the process, because you must make sure the scanner behaves in a repeatable way. That means turning off any automatic features that do different things to different images, such as autoexposure or auto white and black point setting.

Figure 3a

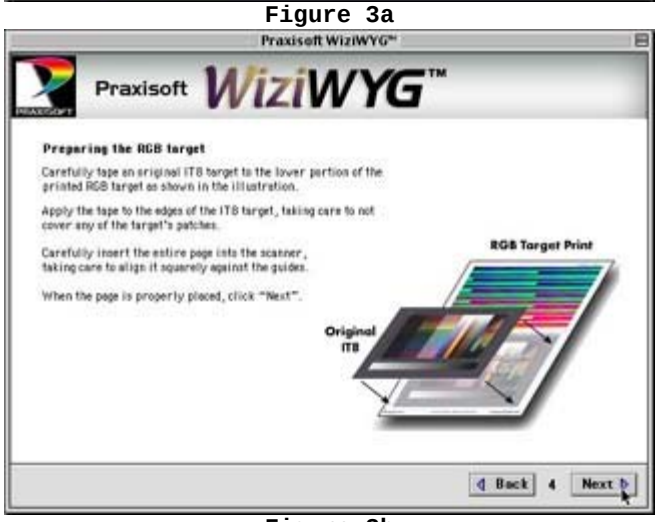

Figure 3b

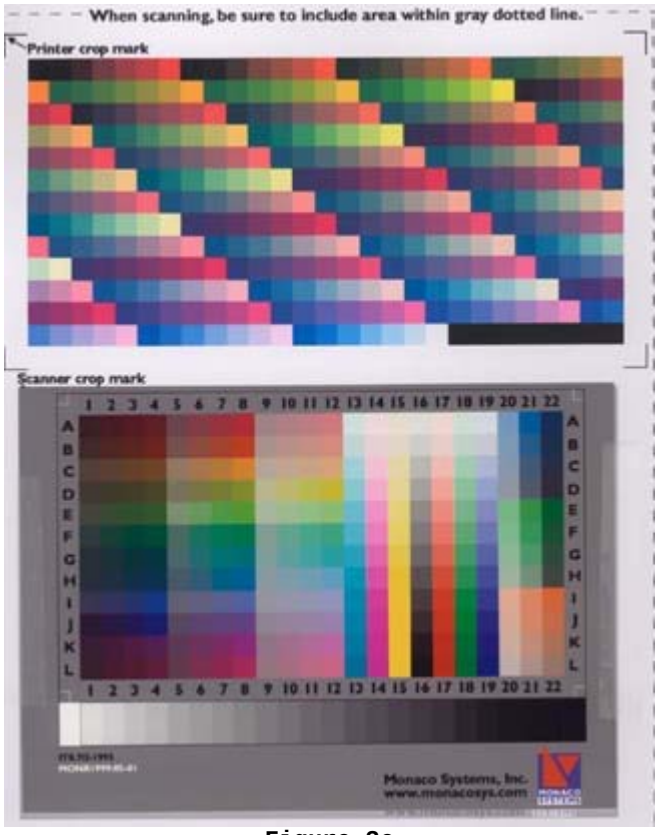

Figure 3c

Figure 3: The next step is to attach the IT8 target to the printed target. Both EZcolor (a) and WiziWYG (b) show you where to position it (c).

Needless to say, ensuring repeatability is easier with some scanners than others. We found that with those scanners that allow us to do so, we got the best results by scanning a raw 48-bit RGB image. EZcolor can process 48-bit scans directly, but WiziWYG cannot -- you must downsample the scan to 24 bits in Photoshop, without making any other adjustments. For scanners that don't allow raw high-bit output, it's worth spending some time experimenting with settings that give the best results on a range of images before you scan the target, and then use these settings henceforth for all images.

WiziWYG lets you scan the target directly into the application if your scanner uses a TWAIN driver, and EZColor supports scanners that use Photoshop plug-ins, but both applications also let you load a TIFF file from disk. (See Figure 4).

Figure 4a

Figure 4b

Figure 4: Both EZcolor (a) and WiziWYG (b) provide visual guidance as to what the proper scan should look like.

Once you've loaded the image, the applications step you through the process of locating the crop marks on both the photographic IT8 and the printer targets. (See Figure 5). Both apps are quite tolerant of slightly skewed scans, so you needn't obsess about placing the target perfectly square on the scan bed. The final step before building and saving the profiles is to load the target description file (TDF) that contains the measurements for the IT8 target supplied with the application: The lot number is printed on the target, and you simply choose the TDF that has the same lot number.

Figure 5a

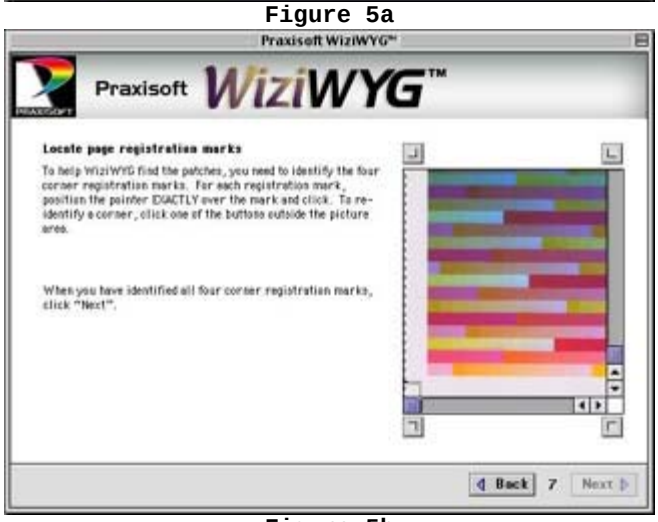

Figure 5b

Figure 5: Cropping the scanner target ensures that the applications measures the right colors. Again, EZcolor (a) gives more on-screen information than does WiziWYG (b).

Next, the applications ask you to name the scanner and printer profiles. Once you've done so, it builds the profiles and saves them in the appropriate directory for your platform -- the ColorSync Profiles folder on the Mac, the Windows/System/Color directory on Windows. Apart from determining the settings for your scanner, the whole process is very easy and takes longer to describe than to actually do. (See Figure 6)

Figure 6a

Figure 6b

Figure 6: Saving and naming the profiles is the final step in both EZcolor (a) and WiziWYG (b).

MatchLock's Approach

MatchLock Profiler II works differently from the other two already discussed. It doesn't use a scanner target at all, and it works as a Photoshop Automate plug-in. There appears to be some magic involved -- or perhaps it's just that any sufficiently advanced technology looks like magic -- but even though we're not sure how it works, it does seem to work quite well, although it seems more vulnerable to the vagaries of the scanner than do the other two packages.

Using Profiler II is, if anything, even easier than using the other two packages. First, you launch the plug-in from Photoshop's File>Automate menu and choose step a: Load Calibration Chart. This creates a file in Photoshop that you can print to the printer you're trying to profile, and also save for further use. (See Figure 7)

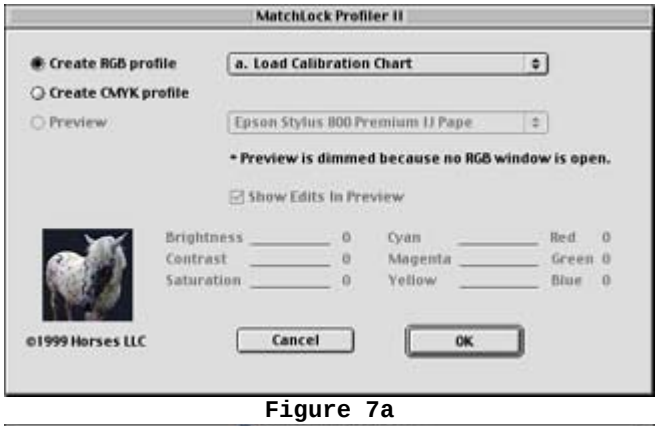

Figure 7a

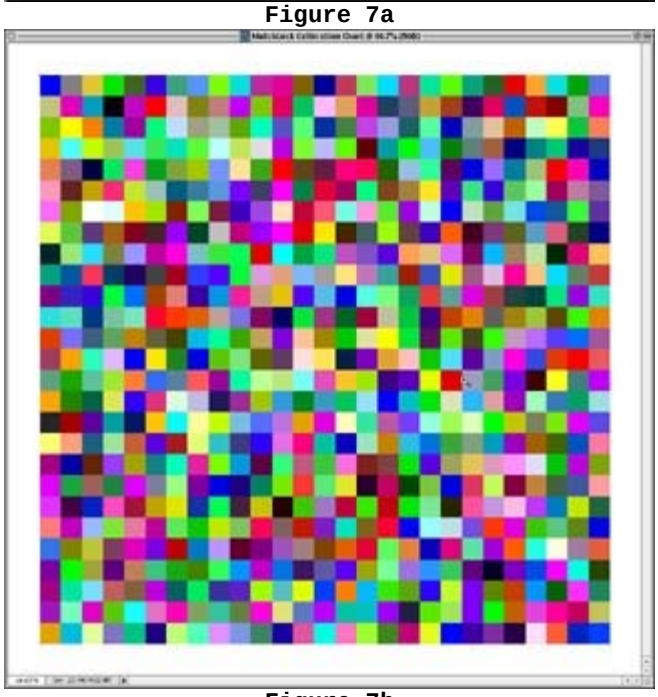

Figure 7b

Figure 7: Matchlock Profiler is a Photoshop plug-in (a) that automates the profiling process by creating a file (b) that serves as a calibration chart.

Next, you scan the printed target, incorporating a little bit of white space around it. As with the other two packages, setting the scanner to a stable, repeatable state by turning off all automatic adjustments is vital here. We also found that we got the best results from scanners that had good neutral balance: The online help recommends scanning at the scanner's default settings (which is actually a recipe for disaster with those scanners that do some kind of autocorrection by default), but we found that we could improve the results significantly with some scanners by setting them so that they captured neutral grays as neutral grays.

Finally, you launch the plug-in again, this time choosing step b: Build Profile. Profiler II asks you to name the profile and then builds it and saves it in the correct location, reminding you to quit Photoshop so that it will recognize the new profile when you next launch it. (See Figure 8)

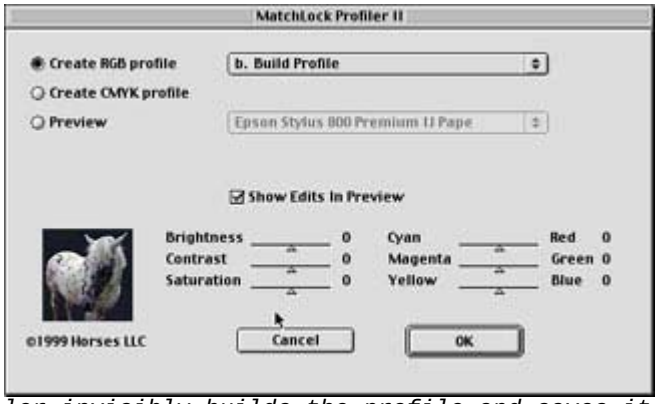

Figure 8: Profiler invisibly builds the profile and saves it in the correct location in your system.

Unlike the other packages, Profiler II also contains some basic but effective slider-based tools for profile editing: It lets you edit any output profile, not just ones created by Profiler II, while previewing the results of the edits. (Horses LLC also offers MatchLock Doctor Pro, a full-blown profile-editing Photoshop plug-in that lets you tune profiles by using any of Photoshop's tools.) With these tools, we were able to make significant improvements on the profiles.

The Profiles

For our objective test, we started off with a Photoshop Lab file of the Macbeth Color Checker, a paper target that photographers have long used to judge color accuracy. (See Figure 9) We then printed the Macbeth file through each profile, using Absolute Colorimetric rendering, and measured the Lab values of the resulting prints, using a GretagMacbeth Spectrolino/Spectroscan, a high-end automated spectrophotometer. Last, we calculated the difference between the source values and the printed result in CIE Lab delta-e units. (One delta-e is, in theory, the smallest color difference someone with normal color vision can detect. In commercial printing, hitting the target value within 6 delta-e is usually considered a decent commercial match.)

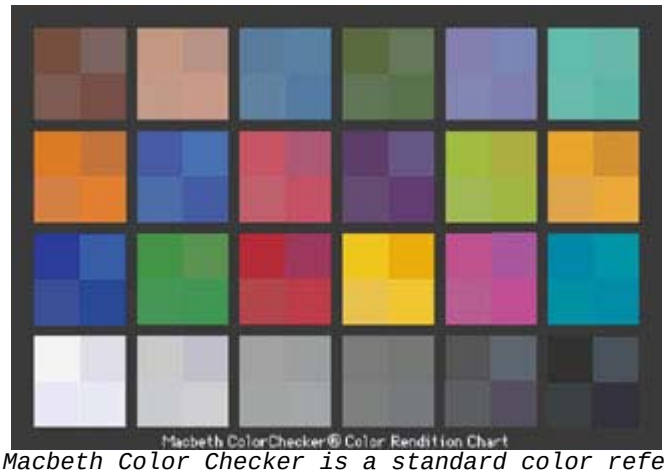

Figure 9: The Macbeth Color Checker is a standard color reference tool for photographers.

When we factored out the four colors (R1C6, R3C1, R3C3, and R4C1) in the Macbeth Color Checker that were simply outside the gamut of the printer, we found that MonacoEZcolor gave the most accurate result of the three packages, with an average delta-e of 3.97 and a maximum delta-e of 7.7, followed by WiziWYG, with an average delta-e of 7.41 and a maximum delta-e of 16.9, and then Profiler II, with an average delta-e of 10 and a maximum delta-e of 19.6. In comparison, the profile we built from measurements we made with GretagMacbeth's high-end, industrial-strength ProfileMaker Pro 3 package had an average delta-e of 2.53 and a maximum delta-e of 5.6. (To see a spreadsheet of the numerical results, click here.)

Although MonacoEZcolor was the clear winner on this test, it's important to put the objective results in context. Feeding known CIE Lab values to the printer through the Absolute Colorimetric rendering intent should, in theory, produce colors on the print that are nearly identical to the source colors if the printer is physically capable of producing those colors. If your main concern is with accurate reproduction of spot colors, or if you want to use an inkjet printer to proof output from a printing press, the profile's Absolute Colorimetric performance is important, but you should also realize that this comparison says essentially nothing about the profile's ability to produce good-looking images.

On our subjective evaluation of real images, the results were much closer to each other, and all were quite acceptable. (See Figure 10) The biggest differences between the profiles are the way they compress the tonal range of the original into the smaller tonal range of the printer and the way they handle out-of-gamut colors. The differences in gamut mapping are most evident on the saturated red detergent container and the red towel. (See Figure 11)The MatchLock Profiler II profile had noticeably lower contrast than the others: In case you desire a higher contrast, Profiler II allows you to edit the profile by simply adjusting the contrast slider and rebuilding the profile.

We should reiterate that there is no "right" way to do perceptual mapping -- it really is largely a matter of taste. You may find that you prefer one profile's rendering of some image components and another's rendering of others. This is not unusual. It's unlikely that any perceptual rendering scheme will do equal justice to all images. That's why color management doesn't, and probably never will, replace color correction.

Note: Displaying accurate color on the Web is a near impossibility with the current state of the art. We scanned all the images directly into sRGB, using the same scanner settings. To the degree that your monitor is different from the sRGB spec, the color you see in your browser will differ from the hard copy. However, the relative differences between the different prints should be accurately represented, since whatever distortion your monitor imposes applies equally to each image.

Figure 10a - Original Image

Figure 10b - EZColor and 10c - WiziWYG

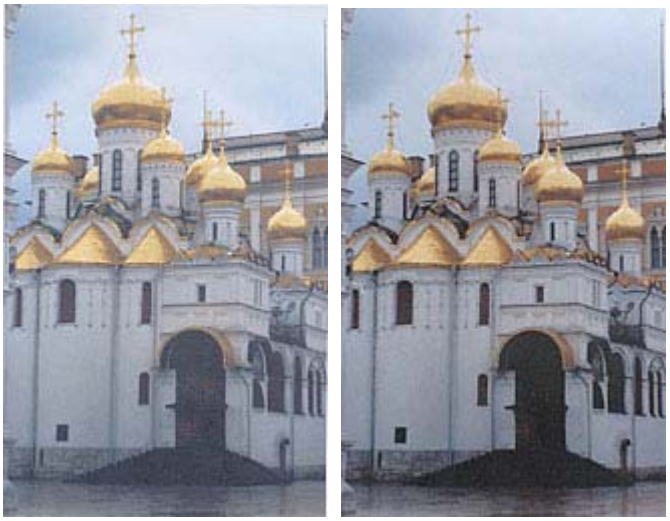

Figure 10d - Profiler and 10e - GretagMacbeth's ProfileMaker Pro 3

Figure 10: Original Image (a), EZColor (b), WiziWYG(c), Matchlock (d), ProfileMaker (e)

Figure 11a - Original Image

Figure 11b - EZColor

Figure 11c - WiziWYG

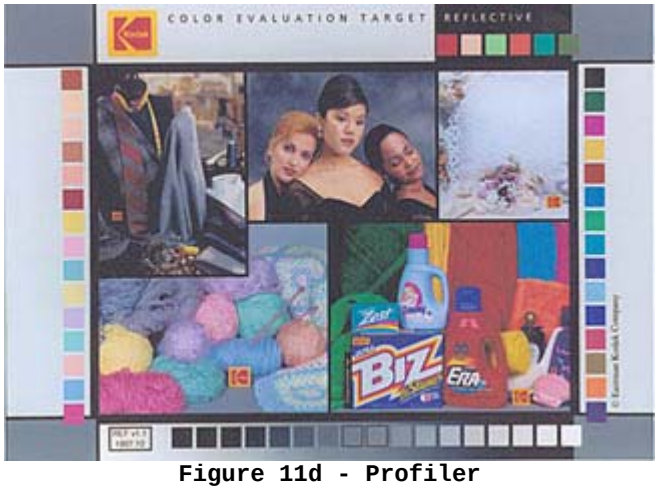

Figure 11d - Profiler

Figure 11e - GretagMacbeth's ProfileMaker Pro 3

Figure 11: Orginal image (a), EZcolor (b) WiziWYG (c), Profiler (d), and GretagMacbeth's ProfileMaker Pro 3 (e).

The Bottom Line
The one huge variable with all three packages is the scanner. Although we believe that the results we obtained are typical, there's no guarantee that your scanner will give results that are as good -- but then again, it might give *better* results. Clearly, scanner-based profiling is a viable technology, and all three packages work surprisingly well.

If your work involves matching spot colors or you want to use your printer as a proofer, then MonacoEZcolor is almost certainly your best bet -- it came very close to rivaling the performance of an instrumented profile on Absolute Colorimetric rendering and also did a very good job on Perceptual renderings. Praxisoft WiziWYG fared rather less well on our Colorimetric test but still produced very acceptable Perceptual renderings, and the aggressive $79 price point is hard to beat. MatchLock Profiler II is also compelling -- you don't have to worry about keeping a scanner target in good shape, and the RGB preview and profile editing capabilities it offers aren't found in the other packages. If you want to fine-tune Perceptual rendering for different types of images, you'll find that Profiler II does the job nicely.

RATINGS:

Monaco EZColor 1.6 - 90 out of 100
Praxisoft WysiWYG - 85 out of 100
HorsesLLC Matchlock Profiler II - 85 out of 100

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