Printer Proofing

BY RICH ADAMS, RYERSON UNIVERSITY

Are You Ready for Printer Profiles?

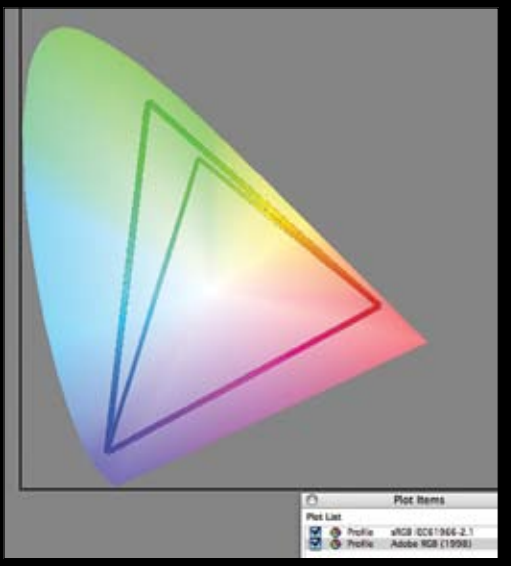

Figure 1: A standard working space is a place to store color data until you know what you want to do with it. Of the two most commonly used spaces, Adobe RGB is larger than sRGB.

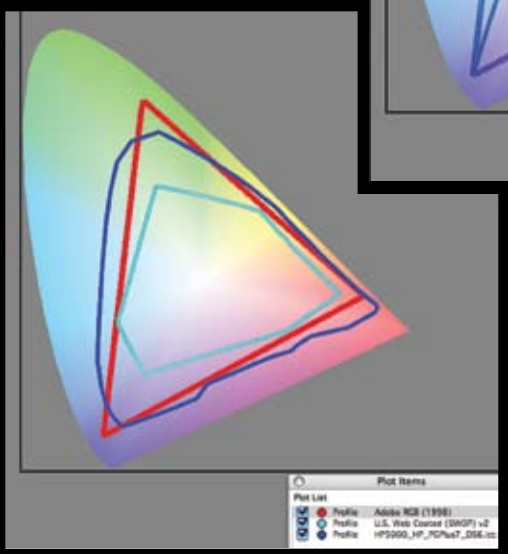

Figure 2: The Adobe RGB gamut (red triangle) corresponds more closely to that of inkjet printing (blue), which is much larger than that of offset printing (US Web Coated SWOP, cyan).

Figure 3: When saving files, customers should embed the standard working space profile into the image to maintain color fidelity. This is done by checking the "Embed Color Profile" checkbox in the Save As dialog box.

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ICC profiles make the difference between getting color that's right-on or way-off. To make the best use of printer profiles, though, you also need the proper color workflow in place. This means having files that are in RGB mode, being able to identify files' standard working space, and having the printer optimized for output.

STANDARD WORKING SPACE

What is it? Standard working spaces originated with Adobe Photoshop 5 in 1998. A standard working space is a place to store color data until you know what you want to do with it. This could include displaying it on a monitor, printing it on an output device, or archiving it for later use. Previous versions of Photoshop used one standard working space, Apple RGB. You could not select different spaces, and therefore did not have to choose. Today the two most commonly used spaces are sRGB (standard RGB) and Adobe RGB. By default Photoshop is set to sRGB. However, the working space closest to the gamut of inkjet printing is Adobe RGB (see **Figure 1**). Standard working spaces are now used by most popular electronic publishing programs.

How do I choose? The choice of standard working space should be based on the size of its color gamut, or number of reproducible colors. To avoid disappointing color, try to match the gamut of the standard working space to that of

the printer. If the working space gamut is much larger, you won't be able to reproduce all of the colors in the original file. If it's much smaller, your prints won't look as colorful as they could.

Why RGB? Generally, RGB gamuts are larger than CMYK (see **Figure 2**). This is because RGB gamuts are based on monitor profiles, which with their glowing, additive color, can reproduce more colors than CMYK. CMYK working spaces, on the other hand, are based on the most common type of printing, offset lithography. In the late 1990s, Adobe characterized two kinds of presses to make the CMYK standard working spaces. High-quality sheet fed printing prints on single sheets of paper, while lower-quality web printing prints on continuous rolls. They also characterized these presses with two types of paper. Coated paper holds out ink and produces a wider gamut, while uncoated paper allows ink to soak in and reduces the gamut.

Images are captured in RGB mode by digital cameras and scanners. In the 1990s, the standard workflow was to convert images to CMYK. If left in RGB mode, they wouldn't print on some imagesetters. However, the workflow of the new millennium is RGB. RGB retains the color gamut of the original scene, transparency, or photographic print. Modern RIPs can convert RGB on the fly to printer CMYK using an ICC profile. If customers convert them to CMYK based on a lithographic standard working space, they're setting themselves up for disappointing color on most inkjet printers.

Figure 4: Many digital cameras, including the Pentax K100D digital SLR shown, have the ability to export files into either sRGB or Adobe RGB working space. For large-format printing, choose the larger Adobe RGB space.

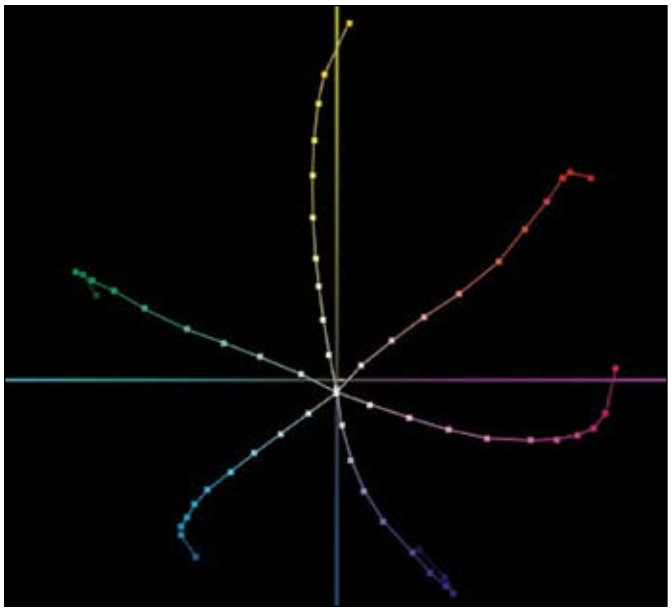

Figure 5: The first step in optimizing an inkjet printer for a media is to set ink limits. In this CIELAB color diagram of human visual space, gray is at the center, increasing saturation is toward the periphery, and hues are arranged around the edge. A plot of increasing inkjet color tones shows that, as more ink is deposited, color saturation actually decreases. Note that, at the ends, the lines curve back in toward the center. Therefore optimizing ink density is essential to getting the best color gamut.

EMBEDDING PROFILES

When customers create digital photos or scans, the camera or scanner profile can be embedded into images (see **Figure 3**). This creates a "paper trail" of documentation about how the image has been processed. Most digital cameras can be set to output images in one of the two most common standard working spaces—sRGB or Adobe RGB (see **Figure 4**). For the greatest accuracy, the camera can be profiled using a color target and color management system. In either case, the custom camera profile, or standard working space profile, can be embedded into the image to keep the color consistent.

If the customer used a custom camera or scanner profile, they should convert files into a standard working space for editing and viewing on the monitor. Embedding this profile into images maintains image fidelity from what they saw on-screen to what they see in print. If the customer didn't embed their standard working space profile, you'll either need to call them and ask which space they used, or take a guess by "trying on" different profiles to see which makes the color look best.

OPTIMIZING THE PRINTER

Inkjet printers can print a wide range of ink onto the media. Color could range from being barely visible to literally dripping off the page. An ICC printer profile merely characterizes how the printer reproduces color. Ideally, prior to characterization, the printer should be set up for optimum ink density. Here are the settings involved. They are usually determined by printing a specialized color target, evaluating it visually, or reading it with a color measurement device.

Ink limits. Ink limits control the density of CMYK (and other color) inks. If the ink limits are too low, the printer's color gamut will be too small. Color will look weak instead of vibrant. If limits are set too high, ink may take too long to try, or may actually puddle, run, and drip onto the floor. Somewhere in between these extremes is the optimum ink density. This varies by printer, ink, media, RIP, and print settings. At this optimum density, you get the biggest gamut with the minimum amount of ink. The ink dries quickly but the color gamut is large enough to print

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vibrant color. Ink limits are determined by printing a target of CMYK in ramps of 0–100%, then visually selecting the value where density stops increasing (see **Figure 5**).

Linearization. Once the printer's ink density is optimized, the tones in between need to be aligned and evenly spaced. The process of linearization calibrates the printer for consistent output from print-to-print. Printer linearization is something like Ansel Adams' "Zone System" of photography: it produces good contrast in the highlights, midtones, and shadows. Linearization is usually done by printing tone scales from your RIP, then reading them with a color measurement instrument.

Total ink coverage. Printers use subtractive-color CMY inks, which are the complements of additive RGB system. They add black to correct the color of the non-ideal CMY inks and to darken the shadows. However, when printing black, it is not necessary (and can even be wasteful) to print full CMY solids along with black. RIPs and printer profiles use gray-component replacement (GCR) to reduce CMY colors, where they add up to gray, and replace them with black. GCR is measured as total ink coverage (TIC). If 100% of each color was printed, their sum would equal 400%. Depending upon the RIP, ink, media, and printer settings, the actual TIC may range from 200–360%. GCR is similar to ink limits, but for the combination of inks printed. Similarly, it helps optimize color gamut and ink drying. The GCR setting is usually determined by printing a total ink coverage target, and evaluating it visually to determine the optimum coverage.

ICC PROFILES

Let's assume you have files in known RGB standard working spaces, and that your printer has been optimized with proper ink limits, linearization, and total ink coverage. Now you're ready for the printer ICC profile. There are three ways to get the profile:

1. Manufacturers' Free Profiles. Many manufacturers offer free ICC profiles for their media. These can be downloaded from the manufacturer's Web site and are offered for the most common media, printers, inks, RIPs, and RIP settings.

One problem with such profiles is that, even with the same components and settings, color might look slightly different due to variables and settings. For example, the manufacturer's printer might have a slightly different linearization than your printer. Another problem is that profiles may only be available for the most common media, printers, and settings.

2. Your Own Color Management System. If you use a lot of unusual media or settings, or simply want the best color match on your own system, you may benefit from a color profiling setup. Getting into printer profiling is easier and more economical than ever before. You'll need a color measurement instrument and software. The most economical instruments are handheld scanning ones like X-Rite's Eye-One and Pulse. These will suffice for one to several profiles per day. If you need to do more than a few profiles, an automated instrument like X-Rite's i1 IO, i1 iSis, or DTP70 can read charts unattended.

You will also need a profiling program to go with the instrument. X-Rite's programs include i1 Match, an entry-level program aimed at designers and content creators and ProfileMaker Pro and MonacoPROFILER, both advanced programs with more settings.

3. Profiling Services. If you need an occasional profile, or one that is technically challenging, a profiling service may be the best route. Services like Chromix's Profile City (www.chromix.com), Cathy's Profiles (www.cathysprofiles.com), and those from local or regional dealers may offer instruments and expertise not otherwise accessible.

For example, if you want a profile made on cloth, it may be helpful to measure the profiling test chart with a polarizing filter attached to the instrument. This reduces glare from the cloth fibers, which makes the color more saturated. The only measurement instrument with an available polarizer is GretagMacbeth's SpectroScan, which has been discontinued. However, a profiling service may have one available. Another technical challenge is presented by media with UV brighteners. These make the paper appear bluer, but fool the spectrophotometer into making the profile too yellowish. One solution is to use an instrument with a UV filter attached. Some instruments are available with UV filters, but they are not user-replaceable. Again, a profiling service may have the necessary instrument.

FURTHER READING

On my Web site at Ryerson University, I have posted some PDF handouts that may be of interest to readers who want to know more about printer profiles. These are available at www.ryerson.ca/~r3adams/signbusiness.html and include:

- Profiling Inkjet Printers
- Ambient Light Measurement
- Color Management in Photoshop

Descriptions of the handouts and instructions for downloading are on the Web page. SB

What You'll Need to Effectively Use Printer Profiles

1. RGB Files. Ask customers to supply print files that are in RGB mode directly from the digital camera or scanner. They have a wider color gamut than CMYK files and will print to best advantage.
2. Standard Working Space Profiles. Customer-supplied files should have an embedded standard working space profile. This helps maintain color fidelity from what the customer saw on his or her monitor to what they get from your printer.
3. Printer optimization. To make the best profile (or best use of a supplied profile), the RIP must be set up for ink density, tone reproduction, and total ink coverage.