Basic Color Management

You have long heard about the wonders of digital photography and you finally jumped in. You bought the equipment, set it all up, and your prints look terrible because the colors are not right. You make color adjustments and waste tons of expensive paper and ink, only to come up with a mediocre result. Now you're ready to throw all your equipment out the window. Nearly everyone who strives for high quality prints has gone through this frustration. Although this article is not an exhaustive technical study of color management it should get those who are new to the subject of color management started in the right direction and demystify the topic. Perhaps it will save you some of the frustration I went through years ago.

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Understanding the Problem

Every physical device deals with color in its own unique way. Film scanners may use either a LED (Light Emitting Diode) or fluorescent light source for capturing the film image on a CCD (Charge Coupled Device). Digital cameras use CCD based technology too, but several very different designs are used by the various manufacturers. Each monitor manufacturer uses its own electronic circuit design. CRT (cathode ray tube) monitors use entirely different technology than LCD (Liquid Crystal Display) monitors. Inkjet printers made by various manufacturers use different technologies to spew ink formulated by various other manufactures onto paper made by still other manufacturers to produce color prints. Without any set standard, it is obvious that any given color will not look the same on all of these devices. Fortunately, there is a solution known as color management, where calibration or profiling of each device to a known standard gives consistent and accurate results.
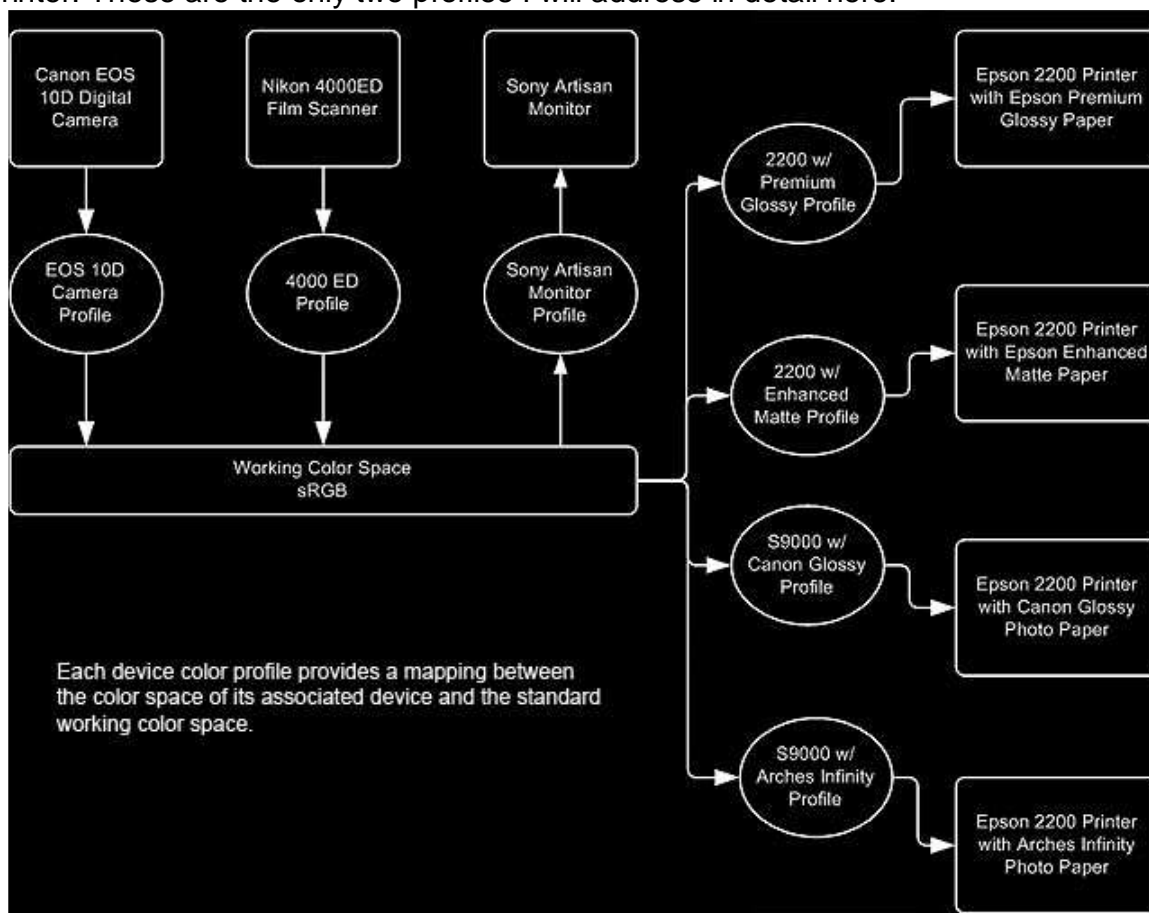
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Color Spaces

A color space simply defines a range of possible colors. Colors possible in one color space may not be possible in another, and all are more limited than the range of colors that exist in the real world. Your digital camera, film scanner, monitor, and printer all operate within their own unique and non-standard color spaces. Some devices never expose their unique color space to the outside world, and instead translate it into one of several standard color spaces internally, before you ever see the data. The first step in managing color on an imaging system is to decide on a system-wide "standard" color space within which all images will be viewed and adjusted. There are a number of standard color spaces that are used for various reasons. The most common standard color spaces for photographic imaging are sRGB and Adobe 1998. The sRGB color space is the standard for Internet use because it most closely represents the way uncalibrated color monitors reproduce color. sRGB is frequently used for color printing too, but it is one of the more limited spaces. Adobe 1998 is a larger color space that enables a wider range of tonalities and is therefore better for critical printed work. It is

important to remember that images meant for one color space will look terrible when viewed in a different one. For instance, if you put your Adobe 1998 images on a web page without converting them to sRGB, they will look dull and muted.
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Device Color Profiles
Any color can be represented within its color space by a set of three numbers that define its red, blue, and green components. It is the job of device color profiles to translate or map each color in the device's color space to a color in the "standard" color space. Once a color is translated into a standard color space it will look the same on every device that has an accurate mapping (color profile) between its own color space and the standard one. These profiles are the key to getting accurate color from your system. Device color profiles can be created, bought, or supplied free by equipment manufacturers. For a totally color managed system, digital cameras, scanners, monitors, and each printer, paper, and ink combination need a profile. Since you look at a monitor to decide on color adjustments, and you then want those adjustments accurately reflected in your prints, the most important profiles are for your monitor and printer. These are the only two profiles I will address in detail here.

Each device color profile provides a mapping between the color space of its associated device and the standard working color space.

Monitor Profiles
Since it provides a basis upon which all other things are judged, your monitor should be the first device profiled. There are two ways of doing this. No matter which method you use, be sure to let your monitor warm up for at least thirty minutes before calibrating it. Colors, brightness, and contrast can vary dramatically during a monitor's first thirty minutes of operation. The least expensive monitor calibration method is by

eye using a software tool like Adobe Gamma that comes with Adobe Photoshop. There are other similar programs available from different manufacturers. You will find Adobe Gamma in your computer's control panel after Photoshop is installed. Simply run it and follow the on-screen instructions. Note that:

1. In the beginning of the process you need to pick a profile to use as a starting point. Pick "Adobe Monitor Profile" or a profile named with the model of your monitor from the list.

2. When adjusting the color sliders later in the process, move back from the screen, or take off your glasses, or squint, so the horizontal lines in the center of each colored block blend together. The idea is to match the resultant color inside each box to the color on the outside. If you take your time with this step, reasonably accurate results can be achieved.

3. When you are finished, name the profile you just created and save it. From now on, every time you start your computer this profile will be automatically loaded.

The second and most accurate way to profile your monitor is to purchase a package that uses software together with a hardware device to measure the colors produced by your monitor and automatically produce a very accurate profile. There are several such packages available. One is [ColorVision](#) by Pantone. ColorVision comes in several flavors that vary in the software they include. Serious photographers will want the package that includes Spyder3Pro software. It is not their most sophisticated software, but it has everything a professional single user needs. It is priced at about £120 from many retailers. Once the software is installed you plug the "Spyder" into a USB port on your computer and attach it to the front of your monitor. Follow the on-screen directions and in a few minutes your monitor will be very accurately calibrated.
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Printer Profiles

There are a few different approaches you can follow to get accurate color from a printer. They are:

1. Buy a hardware and software package that creates a profile for any printer, paper, and ink combination you choose. At about £270 ColorVision has a package that includes Spyder3Print software. It comes with a small scanner and uses it to read a calibration image from your printer to produce printer profiles. It may be worth getting if you experiment with many different paper and ink combinations, each of which requires a profile, or if your printer manufacturer has no color profiles available for your printer model.

2. Buy a profile for your printer, paper, and ink combination from a third party supplier. You can easily find suppliers on the Internet. These are not particularly cheap, but if you only need one for a particular printer, ink, and paper combination it can be cost effective.

3. If your printer manufacturer supplies profiles for their printer, ink, and paper, you can simply use these and stick with the paper and ink recommended by the manufacturer. Some Epson printers are supplied with excellent color profiles that are hard to beat.

4. Equipment from some printer manufacturers comes calibrated for sRGB when using the manufacturer's paper and ink. You can use the sRGB color space and not profile the printer.

5. Use controls in the printer driver to adjust the printer to print what you see on the calibrated monitor. From then on, use those settings when you print using the same paper and ink. This method is the least accurate and it is more easily described than done.

Obtaining a good profile is the hardest part of getting good color from a printer. Before profiling your printer, read the owner's manual, check the manufacturer's web site, and do a general Internet search for profiles and other information relating to your printer. You may be surprised at what you find. Some paper manufacturers supply free profiles for using their paper on various printers along with the printer manufacturer's ink.
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Manufacturer's Generic Profiles and Other Devices
Many digital cameras and scanners are calibrated for sRGB or have selectable color space profiles that include sRGB and Adobe 1998. These settings invoke generic manufacturer supplied profiles that translate the camera's color characteristics to the appropriate color space. Sometimes individual cameras, scanners, and printers can vary significantly from the average for a given model. Manufacturer supplied generic profiles for all of these devices may or may not be adequate. It all depends on how close your individual device is to "normal" and how critical you are. If your monitor and printer are accurately calibrated you will always see what you'll get before printing, so minor inaccuracies in camera and scanner profiles may be acceptable. More accurate results from digital cameras can be obtained by using profile aware RAW file conversion programs like Capture One. Adobe Camera Raw, supplied with Photoshop CS, has a *Calibrate* tab with tools that allow you to fine tune the profile used for your camera.
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Installation and Use of Color Profiles
All color profile file names end with ".icm" or ".icc". To install a profile on Microsoft Windows systems, simply copy the icm file to the same folder that contains all of the other icm and icc files. On Windows XP systems this will be C:\WINDOWS\SYSTEM32\SPOOL\DRIVERS\COLOR.

Alternatively, in file explorer, right click on the file name, and select "Install Profile".

Using the profiles after they are installed requires a profile aware image editing program like Adobe's Photoshop. To use profiles in Adobe Photoshop set up the program as follows:
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Edit – Color Settings dialog: Set up Photoshop according to the screen shot below. Your chosen working color space should be substituted for "Adobe RGB (1998) if it is different.
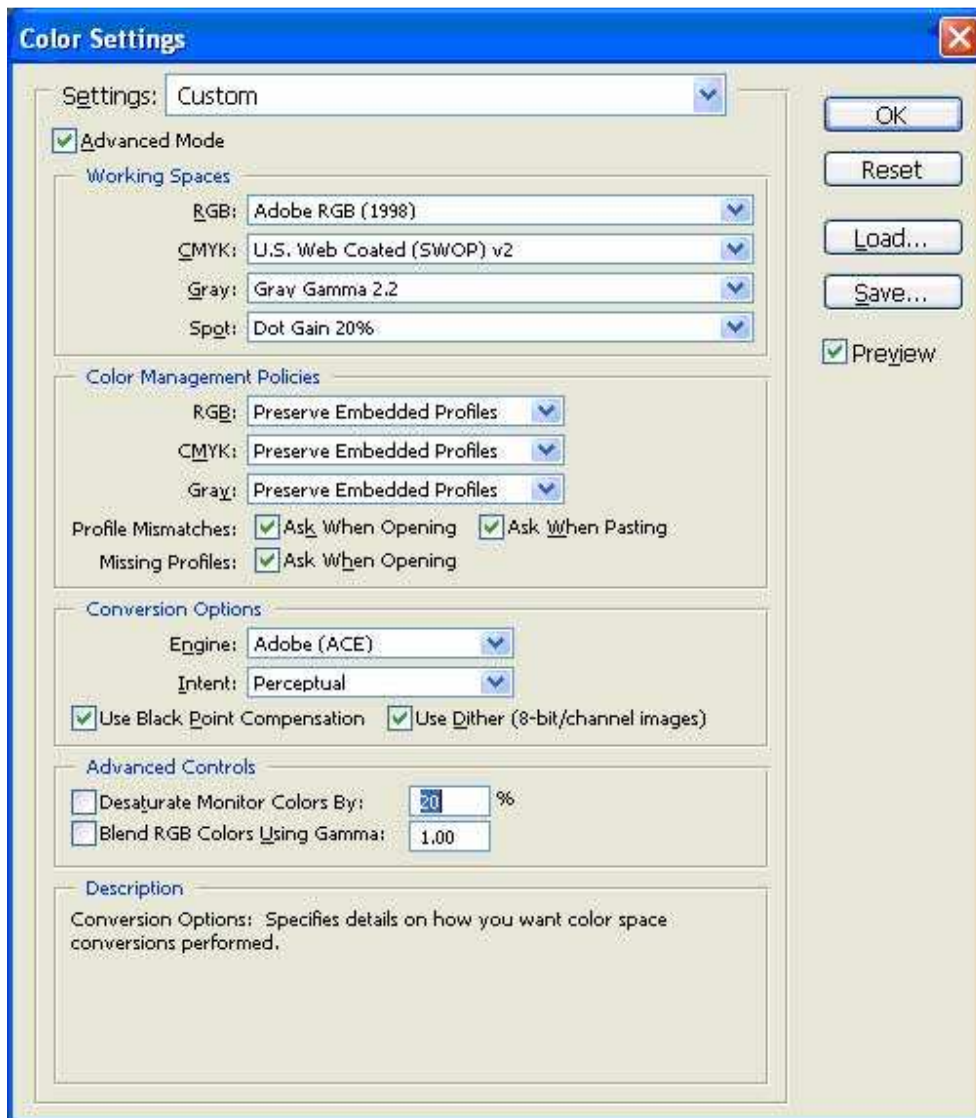
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View – Proof Setup dialog: Choose the profile for your printer, paper, and ink combination.

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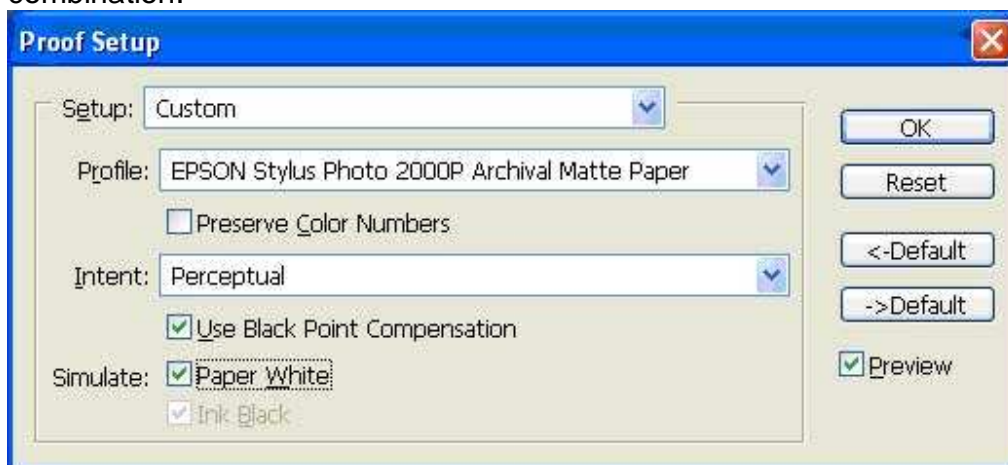
To print your image, choose File – Print with Preview… and set up the dialog as

follows, choosing the profile for your printer, paper, and ink combination for the Print Space Profile. Alternately, if proofing is already set up properly, you could choose Source Space = Proof and Print Space = Same as Source. When you click the "Print" button you will have an opportunity to set up your printer driver before actually printing. To do so, click the "Properties" button when the next dialog window appears.

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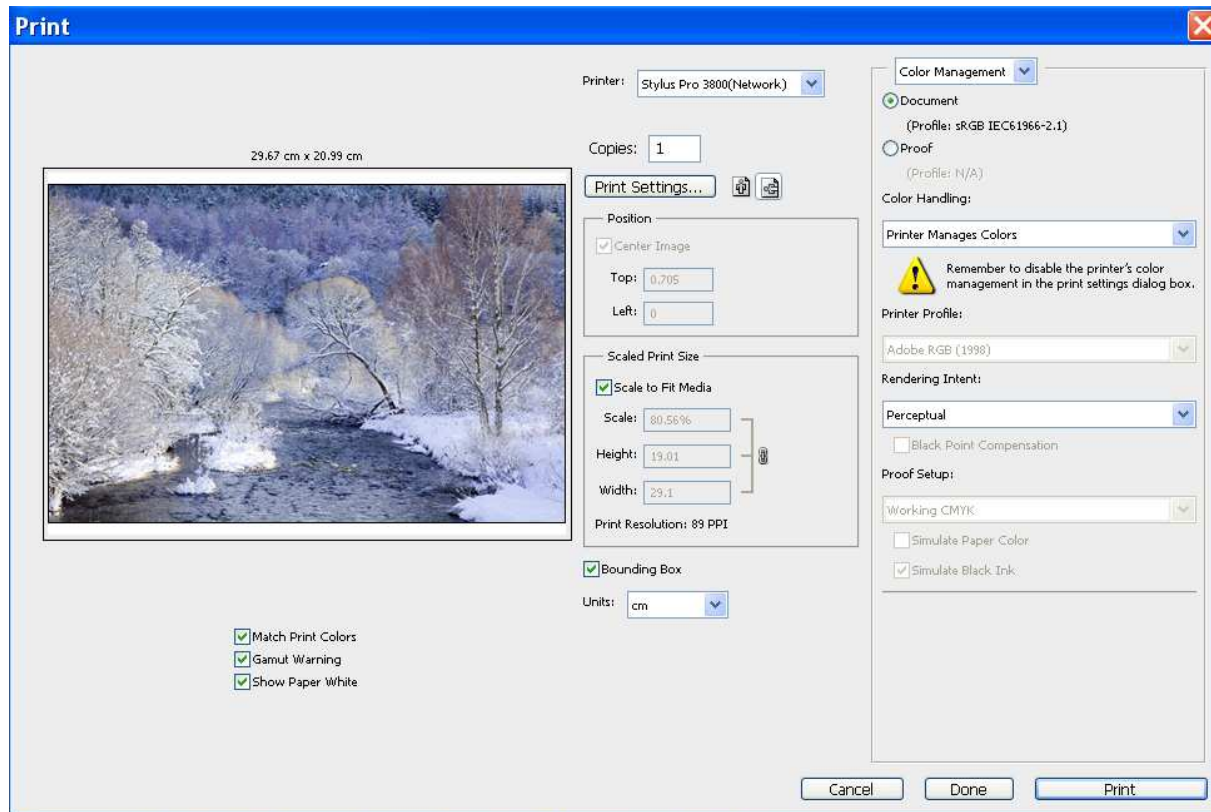
Experiment with rendering intent. You can quickly switch between rendering intents in the Soft Proof dialog — just have the Preview option checked. Relative Colorimetric often gives the best results. Perceptual or Saturation can be better if your image contains many out-of-gamut colors. Absolute Colorimetric rendering is often used for mid-stage print proofing; if you are familiar with this, you don't need this document.

For most images, Relative Colorimetric rendering produces superior results. For others, Perceptual will be far better. These cases include images with significant shadow details where a slight lightening of the print is acceptable to open up the shadows. Also images with areas of highly saturated color can benefit from Perceptual rendering. If you see color banding in the soft proof with Rel. Color. selected, try Perceptual. With experience you will get a feel for which images best pair with each rendering intent.

Only the Basics

This article has presented only the most basic concepts of color management. Although a lot more can be learned about this topic, a good implementation of these basic concepts is enough for excellent print making. Obtaining accurate equipment profiles and using them properly will save plenty of ink, paper, and frustration.