COLOR MANAGEMENT PRIMER

RGB and CMYK are device dependent color spaces. Digital cameras, scanners, printers and monitors are also device dependent. Each device has its own influence on the color files it interacts with.

From scanner... to computer... to monitor... to printer

In 1993 a group including Apple Computer, Adobe, Agfa, Eastman Kodak, Linotype-Hell, and others created a cross platform standard for device profiling. This group became known as ICC (International Color Consortium).

Devices such as scanners, digital cameras, monitors, and output devices, could be characterized and the creation of profiles, small files containing numeric data, which describes the characteristics of these devices, could be used throughout a color management system.

GLOSSARY

Characterization

The process of creating an ICC profile that describes the unique color characteristics of a particular device, such as a monitor, scanner, color printer, or printing press. ICC profiles define the gamut (range of colors), of a device in the context of a device independent color space, so that the colors can be mapped to or from the device gamut.

ICC Profile

ICC Profile is a file that describes how a particular device reproduces color. The profile defines device gamut (range of color) in the context of a device- independent color space. Profiles can be either generic or custom. The device manufacturer, who examines the color characteristics of a group of the same devices, under controlled conditions, and then uses the information to create a profile, creates generic profiles. Custom profiles are for an individual device, using a color measuring instrument, and a device profiling software.

Device- Independent Color Space

A color model not related to any device, but instead based on human visual perception as defined by C.I.E. experiments begun in 1931. Device independent color spaces contain all colors that may be perceived by the human eye. They are used as the intermediary space known as the profile connection space (PCS), in ICC color conversions.

Calibration

The process of setting a device to known color conditions. Calibration must be performed externally for devices whose color characteristics change frequently. For example, calibration must be performed on monitors because phosphors lose brightness over time and on printers because proofers and other digital printing devices can change output when colorant or paper stock is changed.

Adobe Gamma

The utility created by Adobe Systems incorporating calibrating and characterizing your monitor, resulting in the creation of an ICC profile, for use in Photoshop, Illustrator, and all other ICC aware applications.

Gamma

The values produced by a monitor from black to white are non-linear. If you map the values they form a curve, not a straight line. Gamma describes the slope of that curve at halfway between black and white. Gamma adjustment compensates for the non-linear tonal reproduction of output devices such as monitor tubes. The gamma setting of your monitor defines the brightness of the mid-tones.

Gray gamma 1.8 matches the default grayscale display of Mac OS computers.

Gray gamma 2.2 matches the grayscale display of Windows computers.

Color Space

Color space is a particular variant of a Color Model with a specific gamut (range of color).

For example, in the RGB Color Model there are a number of color spaces:

Apple RGB

Adobe RGB (1998)

sRGB

ColorMatch

Pro Photo

Adobe RGB (1998)

Adobe RGB (1998) is the RGB working space created by Adobe Systems. This space provides a large gamut of colors well suited for documents that will be converted to CMYK. This is a good choice for photographers.

Srgb

This space has a smaller color gamut. Typically Srgb will be confined to those users solely interested in web design.

ColorMatch RGB

This working space is the native color space of Radius Pressview Monitors. ColorMatch is the favorite choice of many Mac users. This space provides a slightly smaller gamut alternative to Adobe RGB1 998 for print production work.

Monitor RGB

Monitor RGB is the RGB working space that reflects the current profile of your monitor.

Apple RGB

Apple RGB is used for Mac web design.

Engine

Engine is the method that will be used for color space conversions.

Ace (Adobe's color engine)

Ace is the best engine to use for all color space conversions.

ColorSync (Apple's color engine)

The color management system used by Apple Computer for Mac OS computers.

ICM (Windows color engine)

The color management system used by windows based computers.

Rendering Intent

The method a color management model uses for mapping color from one device to another. Rendering intent is specified for different types of data to insure the best color reproduction (images, illustrations, or business graphics). There are four methods:

Perceptual, Saturation, Relative Calorimetric. Absolute Calorimetric

Perceptual (also known as image intent)

Aims to preserve the visual relationship between colors in a way that is natural to the human eye. This intent is most suited for photographic images.

Saturation
Saturation represents the amount of gray in proportion to the hue. Saturation is measured as a percentage. From 0% = gray to 1 00%= fully saturated.

Relative Calorimetric
Compares the white point (extreme highlight), of the source color space to that of the destination color space and shifts all the colors accordingly.

Absolute Calorimetric
Leaves colors that fall inside the destination gamut unchanged. Out of gamut colors are clipped. No scaling of colors to destination white point is performed. This intent aims to maintain color accuracy at the expense of preserving relationships between colors, and is useful for seeing how your output will look on a non-neutral substrate.

Clipping
Color shift caused by the inability of one color space to reproduce all the colors of another color space. Any colors in the source color space that are outside the gamut of the destination color space are forced into its gamut. Colors that are within the gamut of both spaces are left alone. The result is that two colors that used to be different may now show the same value, which results in a color shift.

Black Point
The point determined as absolute black on a color device, such as a color monitor, or printer.

Black Point Compensation
The setting on newer ICC enabled Adobe applications that adjusts for differences in black points when colors are converted between color spaces

Hard Proof
The printed proof of a document created to preview how colors will look when reproduced on a specific output device, usually a commercial printing press.

ABOUT COLOR MANAGEMENT

Because color-matching problems result from various devices and software using different color spaces, one solution is to have a system that interprets and translates color accurately between devices. A color management system (CMS) compares the color space in which a color was created to the color space in which the same color will be output, and makes the necessary adjustments to represent the color as consistently as possible among different devices.

Note: Don't confuse color management with color adjustment or color correction. A CMS won't correct an image that was saved with tonal or color balance problems. It provides an environment where you can evaluate images reliably in the context of your final output.

Photoshop follows a color management workflow based on conventions developed by the International Color Consortium (ICC). The following elements and concepts are integral to such a color-managed workflow. Color management engine Different companies have developed various ways to manage color. To provide you with a choice, a color management system lets you choose a color management engine that represents the approach you want to use. Sometimes called the color management module (CMM), the color management engine is the part of the CMS that does the work of reading and translating colors between different color spaces.

Color numbers
Each pixel in an image document has a set of color numbers that describe the pixel's location in a particular color mode--for example, red, green, and blue values for the RGB mode. However, the actual appearance of the pixel may vary when output or displayed on different devices, because each device has a particular way of translating the RAW numbers into visual color. When you apply color and tonal adjustments or convert a document to a different color space, you are changing the document's color numbers.

Color profiles
An ICC workflow uses color profiles to determine how color numbers in a document translate to actual color appearances. A profile

systematically describes how color numbers map to a particular color space, usually that of a device such as a scanner, printer, or monitor. By associating, or tagging, a document with a color profile, you provide a definition of actual color appearances in the document; changing the associated profile changes the color appearances. Documents without associated profiles are known as untagged and contain only RAW color numbers. When working with untagged documents, Photoshop uses the current working space profile to display and edit colors.

Obtaining, installing, and color profiles

Precise, consistent color management requires accurate ICC-compliant profiles of all of your color devices. For example, without an accurate scanner profile, a perfectly scanned image may appear incorrect in another program, simply due to any difference in color space between the scanner and the program displaying the image. This misleading representation may cause you to make unnecessary, time wasting, and potentially damaging "corrections" to an already satisfactory image. With an accurate profile, a program importing the image can correct for any gamut differences and display a scan's actual colors.

Once you obtain accurate profiles, they will work with all applications that are compatible with your color-management system. You can obtain profiles in the following ways, with the most precise methods listed first: Generate profiles customized for your specific devices using professional profiling equipment.

Use the settings in the Custom CMYK dialog box to describe your device, and then save the settings as a color profile.

Obtain a profile created by the manufacturer. Unfortunately, such profiles do not account for individual variations that naturally occur among machines (even identical modes from the same manufacturer) or from age. Substitute an available profile that may be appropriate for the device's color space. For example, many Mac OS scanners have been optimized for an Apple RGB monitor color space, so you might try using an Apple monitor profile for these devices; for a non-profiled Windows scanner, try substituting the Srgb color space. Be sure to proof images created with the profile before using the profile in production.

CREATING AN ICC MONITOR PROFILE

Your monitor will display color more reliably if you use color management and accurate ICC profiles. The Adobe Gamma utility, which is automatically installed into your Control Panels folder, lets you calibrate and characterize your monitor to a standard and then save the settings as an ICC-compliant profile available to any program that uses your color management system. This calibration helps you eliminate any color cast in your monitor, make your monitor grays as neutral as possible, and standardize image display across different monitors.

Although Adobe Gamma is an effective calibration and profiling utility, hardware-based utilities are more precise. If you have a hardware-based utility that can generate an ICC-compliant profile, you should use that instead of Adobe Gamma. Also, be sure to use only one calibration utility to display your profile; using multiple utilities can result in incorrect color. Calibrating versus characterizing a monitor.

You can use profiling software such as Adobe Gamma to both characterize and calibrate your monitor. When you characterize your monitor, you create a profile that describes how the monitor is currently reproducing color. When you calibrate your monitor, you bring it into compliance with a predefined standard, for example, the graphics arts standard white point color temperature of 5000 Kelvin.

Determine in advance the standard to which you are calibrating so that you can enter the set of values for that standard. Coordinate calibration with your workgroup and prepress service provider to make sure you're all calibrating to the same standard. However, if you have implemented a good color management workflow, you need not calibrate all monitors to the same standard; you simply need to characterize each monitor to produce accurate profiles.

SOFT PROOFING

Soft Proofing is the ability to preview, or Soft Proof any output for which you have a profile. Choose View/ Proof Setup > Custom.
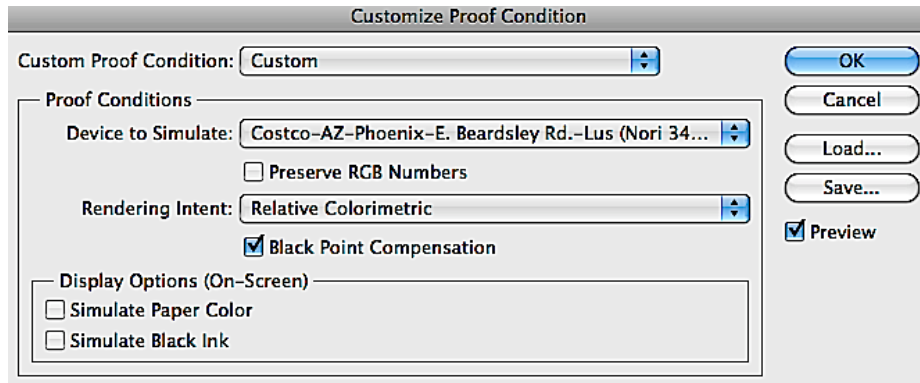
Device to Simulate: This is where you choose the profile for the output that you want to simulate on the screen. You can choose a profile for almost any device, but some scanner and digital camera profiles have the good sense to make themselves unavailable, given that soft proofing an input device doesn't make a lot of sense. You can choose a profile for an RGB, CMYK, Grayscale printer, monitor, or working space.

Printer profiles are specific to the paper stock you plan to use, because the same inks can behave very differently on a glossy paper, a matte paper, a transparency, and so on. Epson actually creates individual profiles for its different paper stocks. The only workaround is somehow to obtain the Mac paper-specific profiles and append the .Icc or .Icm extension.

Preserve RGB numbers: This box is designed to show you what would happen if you sent your unconverted document to the output specified by your choice of profile. It's only available when your document and your output profile share the same color mode... an RGB document and an RGB output profile.

Rendering Intent: The intent menu lets you choose the rendering intent you want to use in the conversion from document space to the proof space. It lets you see at a glance how different rendering intents will affect your image. The menu selection always defaults to the profile's default rendering intent (usually but not always "Perceptual"), so it pays to get in the habit of checking it each time you make a Custom Proof Setup.