

## ColorSync and ICC by Andrew Rodney, the Digital Dog

Getting predictable and repeatable color on the desktop is NOT an easy task! Today's work flows are quite different then they were years ago when color work was handled by proprietary hardware and software products known as Color Electronic Publishing Systems or CEPS. Usually these high end systems were operated by highly trained personal with all work done under one roof. Today it's not uncommon to find one user producing a scan, another user attempting to manipulate that file and several more users down the chain producing dye sub proofs, contract proofs and ultimately a printed 4 color piece. The task of getting great color output in this situation is daunting. For example, assuming that the RGB (Red/Green/Blue) scan and the manipulations to the file are all done correctly, the colorspace conversion, that is, the mode change to CMYK (Cyan, Magenta, Yellow and Black) is itself a critical step. If the RGB scan is intended for output to a 4 color press, the manner in which the conversion to CMYK is handled can make a huge impact on the quality and accuracy of the printing.

CMYK is known as "Device Dependent" which simply means, all output devices that require a CMYK file will require a slightly different mix of CMY and K in order to produce similar, accurate color. No two digital color devices handle color exactly the same way, just as no two film stocks from different manufacturers are the same.

Many desktop users incorrectly believe that all that is necessary to convert a file to CMYK is to simply go under the Mode Menu in Photoshop and pick "CMYK". Nothing could be further from the truth! One could fill pages on setting up Photoshop's various preferences for controlling how it converts to CMYK. Blanter and Fraser's "Real World Photoshop" published by Peach Pit is an excellent source for this information.

Even if one takes the time to create all the various preferences for Photoshop, another issue needs attention. By it's very nature, CMYK has far fewer printable colors then RGB. This range of colors is known as color gamut. If an output device has a narrower color gamut then the file it receives, some colors will not be correctly reproduced; the colors will be clipped. This explains why so many desktop users are disappointed when very saturated and vibrant colors they see on their monitors don't look the same when printed. In the best situations, the hue (the actual color) remains similar but the saturation is far lower, in the worst case, the color simply doesn't get close to matching. When vibrant blue skies print magenta, someone is going to be very unhappy.

So keep in mind that all output devices require different mixes of color to produce the expected output. Also keep in mind that all output devices will have different abilities to reproduce wider or narrower palettes of colors. This is true for RGB devices but far more so for CMYK devices. Furthermore, many of the devices used in the imaging chain can only output RGB data, such as a color monitor. Not only does a monitor need to be calibrated so it is set in a known state, software provisions are necessary so that when this monitor displays a CMYK file, it does so in an accurate fashion. In order to do this, the software must in essence convert CMYK data back to RGB in such a way that the data on screen is displaying what is truly representative of the file. Photoshop's monitor's preference is one area where this can be accomplished assuming the proper preferences are created and loaded.

In recent years, Color Management Systems, known as CMS's have helped desktop users in controlling many of the above variables in such a manner that excellent color can be produced. Both

Eastman Kodak and Agfa have CMS's on the market and we have had great success with Kodak's. Nearly all CMS's share a common work flow.

Profiles, small files of code that contain information about the characteristics of input, display and output devices are the key ingredient found in all CMS's. An example is the use of a hardware device to calibrate the monitor into a known state such as a color temperature of 5500K while producing a profile of the monitor for use in the CMS

Most CMS packages ship with a print and/or transparency that has a large number of known color patches often referred to as either a Q60 or IT8 color target. By scanning these targets and running the resulting scan through the CMS software, an evaluation can be made by the software to determine which colors are altered by the scanner compared to the known colors contained on the IT8 target. Once again, a software profile is created for that scanner for use in the CMS. The profile instructs the CMS as to how each color patch deviates from the norm and instructs and controls the CMS to alter the resulting file so that all colors shift correctly and thus remove the bias produced by the scanner.

In addition, many CMS's allow the user to simulate a soft proof on screen so that one can see how the file will output (within reason) to various devices. What colors will actually be clipped when the CMS alters the color gamut for the intended output device? How will this scan appear if output to multiple color devices? By simply using different output profiles in combination with the monitor profile, the user can see the expected results and attempt to adjust the file prior to producing an expensive color proof.

Lastly and perhaps most importantly, most of these CMS's ship with profiles that optimize the digital file for output to a device based on it's biases and color gamut, even converting from one colorspace to another if necessary. All three devices; the scanner, monitor and output device are characterized. The resulting software profiles are used to alter the color data so that the output matches the soft proof on the monitor and the original scanned art within the confines of each device's color gamut. Don't get the idea that these CMS's are magic bullets for producing perfect color. They are tools that when used intelligently can overcome many limitations of the desktop imaging chain. There are many times when one simply doesn't want to match the original! Should a transparency have an objectionable color cast, there's no way we would want to use the scanner input profile with the intent of matching that original. Far better to work with a calibrated display and the info palette in the scanning software and do corrections on the file, then use the rest of the CMS to insure a color match.

The biggest problem with these CMS products on the market, such as those by Kodak and Agfa was that each was proprietary. Portions of one CMS couldn't be used with another. Profiles could not be shared between CMS packages and in fact, one could not create custom output profiles; they were all supplied by the manufacturer of the CMS. This problem was solved in 1993 when a group of vendors including Apple Computer, Adobe, Agfa, Eastman Kodak Linotype Hell and others created a standard for device profiling. This group became known as ICC, which stood for International Color Consortium. A standard format was ironed out. ColorSync is Apple's system level CMS engine which works with the ICC standard. Not until version 2.0 of ColorSync was released by Apple were 3rd party developers ready to supply the tools, both software and hardware necessary to start this CMS engine rolling.

The ColorSync “system” is very similar to existing CMS’s in theory. Various profiles are created and used throughout the production process to affect the scanner, the display (which allows accurate soft proof on screen), and eventual output to a particular device. Unlike existing proprietary CMS’s, one ICC compliant profile could work with another compliant ICC product even across platforms. ColorSync 2.0 had many improvements over the original version. It provided a default Color-Matching Method or CMM which transforms images between Colorspaces and can be used with CMM’s from other companies. Because the profiles created for ColorSync 2.0 conformed to the ICC standard, these profiles would be open to other applications and even other operating systems that were also ICC compliant. ColorSync 2.0 was also able to operate with the Apple LaserWriter 8.3 driver and thus any Postscript device that could use this driver could take advantage of an ICC profile.

The single biggest improvement that ICC compliant software brought to the end user was the ability to create custom output ICC profiles for virtually any output device. No longer was a user limited to the “canned” output profiles created in a lab elsewhere that was limited by a specific software product. With a profile building ICC software product, one can create the necessary profile for virtually any device and any idiosyncrasies that device may have.

One rather interesting and useful capability of ColorSync ICC profiles is that one can control what is known as an intent rendering style. There are 4 ColorSync rendering Intents. For example, with Perceptual intent, all the colors of a given color gamut are scaled to fit within another color gamut thus maintaining the relationship off all colors. This rendering is best for scanned images. With Relative Colorimetric intent, colors that fit within the gamut of both the original and the output are untouched but colors that fall outside the color gamut of the output are converted to the closest in gamut colors possible. This rendering allows all colors that fill within the gamut of the output device to remain unchanged. Out of gamut colors affected in such a manner that hue and lightness of the colors are maintained at the expense of saturation. With Absolute Colorimetric in gamut colors are unchanged but out of gamut colors are clipped, a very similar intent to Relative Colorimetric but in this case out of gamut colors are maintained at the expense of some density of other colors. Colorimetric matching is commonly used for reproducing colors where exactness is important such as a company logo. The idea here is that different intent rendering styles will attempt to remap out of gamut colors in different fashions based on the kind of image being processed. There’s a give and take as to how these out of gamut colors will be remapped. There are other Intent rendering styles as well and the end user should be aware of which rendering is most appropriate for a given task.

Once a series of ColorSync profiles has been created, how does the ColorSync system work? All profiles are stored in the preferences folder in the Mac’s System folder for access to ColorSync. The ColorSync System Profile Control Panel allows the user to pick a ColorSync system profile. This information is used for software like Photoshop to display RGB information. ColorSync comes with the Mac’s system software and a great deal of “canned” profiles are included. We will see next month a hardware product that calibrates a monitor and creates a custom ColorSync monitor profile which will be loaded from the ColorSync Control panel. From here on out, software that is ColorSync Savvy like Photoshop, Live Picture, PageMaker, xRes, Freehand 7 etc. will have access to ColorSync from a system level and each software package will utilize ColorSync in different fashions.

Over the course of the next few issues, I’ll look at several software and hardware products now on the market that are ColorSync 2.0 and ICC compliant, such as those that allow the creation of cus-

tom ICC profiles. As I will discuss in more detail , the manner in which one creates an output ICC profile take a similar approach among these products. The various ICC compliant software packages ship with files much like the IT8/Q60. That is, each product supplies a file with a number of color patches that the user sends to an output device. The user then measures each patch using a hardware device known as a spectrophotometer (like a ColorTron II) and the software reads the measured colors, compares them to the actual known colors in the file and in a nutshell creates a custom output ICC profile. Of course as we will see, there's a lot more to this process. Each software product we will examine has additional features such as the ability to open, examine and even tweak the ICC profile. The bottom line is that with a spectrophotometer and software that can create ICC profiles, the end user has the ability to create custom output profile that are able to be used with any other ColorSync/ICC compliant software product.

Note, this piece first ran several years ago in Photo Electronic Imaging magazine. I figured it was time to get a beginner's piece up on the web covering the basics of Color Management. Since this piece first appeared, ColorSync is now up to version 2.6 as shown in the one series of screen dumps below and Real World Photoshop is now at version 5.0 and better then ever.

Comments and corrections are welcome.

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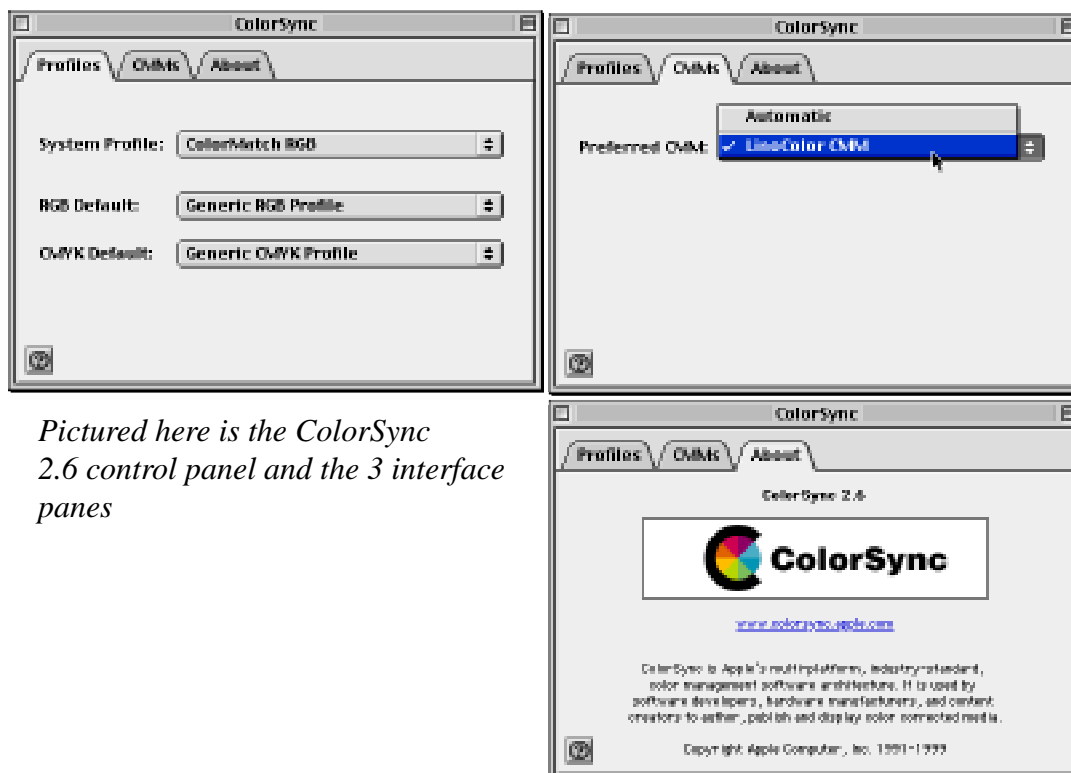
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*Pictured here is the ColorSync 2.6 control panel and the 3 interface panes*