Color Management

Introduction | **Calibration** | **Characterization** | **Conversion** | **Software** | **Scanners** | **Monitors** | **Output** | **Maintaining** |

Introduction

One of the greatest challenges in producing color for print projects is making sure that the colors the designer has chosen or created are the same colors that are printed. In creating a project, several devices are used and no two of them produce the same visual color from the same digital values. Images scanned as RGB (red, green, blue) can look different when viewed on different monitors. Colors viewed on a monitor can look different than the same colors output from an inkjet printer or printing press, which both use CMYK (cyan, magenta, yellow, black) for color reproduction. With monitors, printers and presses all using different varieties of color, keeping the color consistent throughout the production of a job is very challenging. You must have a basic understanding of the **additive** and **subtractive** color processes and use a Color Management System (CMS) in order to get consistent and reliable color.

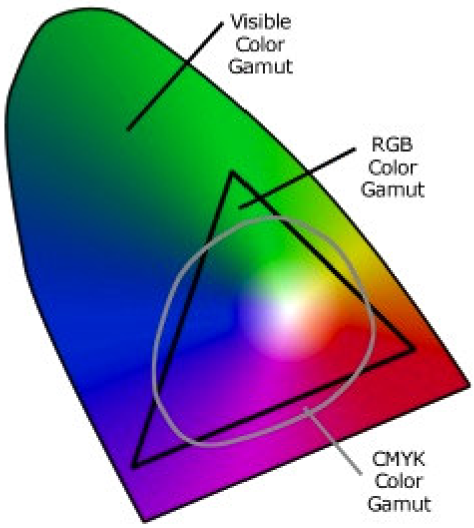
The graphics industry is developing standards for color management that will provide a set of rules to be followed by all those involved in the production process. By following the standards, hardware and software vendors are able to build cross-platform, device profile formats which characterize color devices. The two standard committees addressing the issue of developing color management standards are the Image Technology Committee and the International Color Consortium (ICC).

The ICC was started in 1993 by several of the leaders in the prepress industry including Apple, Microsoft, Adobe, and Kodak. They created a standard device profile format to characterize devices using the CIELab color space to define colors. The standard device profile format is called the ICC profiles. A properly built ICC profile accurately translates any set of RGB or CMYK values into CIELab values. Before there were ICC profiles, many vendors had their own unique systems which were incompatible with other systems.

Note: CIE L*a*b* is theoretical color space developed by the Commission Internationale de L'Eclairage (CIE), which is an organization for setting standards for color measurement. It is a color model based on L* = lightness, a* = red-green axis of the space, b* = blue-yellow axis of the space.

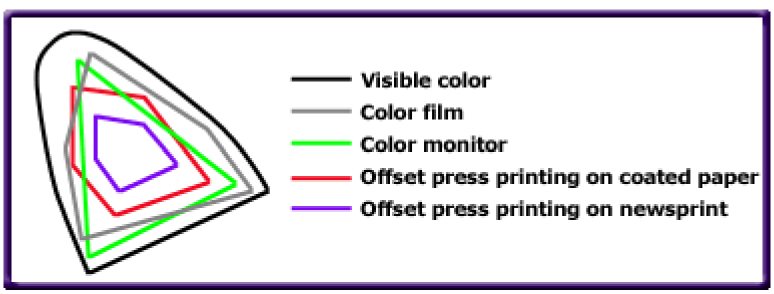
Successful color management requires:

- device-independent color space (CIELab) that transforms colors from one color space to another (e.g., RGB to CMYK)
- accurate profiling to describe a color behavior of a digital color device
- a good gamut mapping technology that maps colors between devices that have different gamuts (e.g., scanners and monitors)



Different devices (scanners, monitors, printers) use different color spaces (RGB or CMYK) and each of those has a different range of colors that each device can display or produce, which is known as its color "gamut", or "color range". Some devices have limited gamuts and others have very large gamuts, but none can produce the range of colors our eyes can detect. The color range can even vary among similar devices, such as different brands of monitors. Printers vary drastically in their gamuts, especially if they use different technologies. Changing the ink or paper will also make a difference. A color management system converts the device-specific colors into a common visual language that can be used throughout the process to assure predictable color. When colors in an image cannot be displayed or printed because they are not in a device's gamut, they are called "out-of-gamut colors".

When an image is scanned into the computer, only the colors within the scanner's gamut are saved. When an image is viewed on a monitor, or output to a printer, the colors that are produced are the colors within its gamut. Devices that use different gamuts cannot reproduce each other's colors exactly. A Color Matching Module (CMM) is then used to perform gamut mapping, which selects the next closest reproducible color.



A color management system can be broken down into three categories: calibration, characterization, and conversion.

Calibration

Calibration is the first step in obtaining color management. It is the process of tuning a device (scanner, monitor, printer, etc.) to a known or defined standard to ensure that it will meet the manufacturer's specifications predictably and accurately. It establishes a baseline of operation to ensure that the device does not vary from the standards.

Calibration should be performed quite often and some devices require it more often than others. For example, if you have a color copier, you should recalibrate it every eight hours or every 5000 prints. Since color copiers operate by static electricity, they are drastically affected by changes in the humidity and temperature.

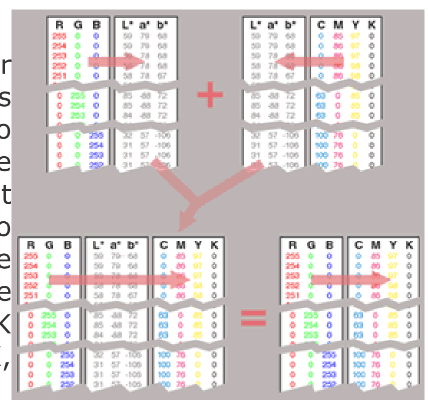
An industry standard color reference tool used to calibrate input and output devices is the IT-8 color reference target.

Characterization

Another term for characterization is profiling, which is a process that defines the color gamut of a specific device. A device profile is simply a translation table between the standard color space and device-specific RGB or CMYK. The device profiles are used to convert from one device to another. They measure how the device differs from an industry standard, such as the IT-8 standard target. Determining how the device differs is accomplished by sending a target to a device, measuring the device's reproduction, and comparing the measured values against the target values. This process is the same for creating profiles for monitors, scanners, and output devices.

The most accurate method for communicating color is spectral data. Spectral data describes what a color is, not just how it appears or is reproduced. A spectrophotometer is used to capture spectral data by measuring a color sample such as a proof, print, paint chip, ink sample, etc. The spectral data information is then used to create the color profiles.

Conversion



The conversion function charts or maps the color gamut of one device to that of another and makes the required changes in order for both devices to display or produce a similar color range. The conversion process is also known as gamut mapping. For example, to convert an RGB image to CMYK, the CMM (e.g. ColorSync) looks up the CIELab value for the RGB and then looks up the resulting CIELab value to get the equivalent CMYK value. This converts directly from RGB to CMYK, resulting in both having the same color range.

Custom profiles are important for every device in your workflow. A profile for each type of paper that will be used in a printing device are also necessary.

Software

One option to assist you with color management is with the use of Apple's ColorSync software. Applications such as Adobe PageMaker®, Photoshop®, and Illustrator®; QuarkXPress™, Macromedia Freehand™, and more than 90 other products, all support ColorSync. ColorSync is supplied with every copy of the Macintosh Operating System and is available at no charge.

ColorSync is a standard for managing color in cross-platform workflows. Microsoft Windows (Versions 98 and later) contain ICM2, which is Microsoft's first capable color management implementation. The system uses the same Color Management Module (CMM) used by default in ColorSync.

Adobe products have a gamma corrector and calibrator. Use either Adobe calibrator or ColorSync, but do not use both. The Adobe calibrator will change your ColorSync settings and override the lookup table. When an Adobe program is launched, it checks for the ColorSync settings in the system. Some systems may use other programs such as the Kodak Color Workflow.

Note: Generic profiles are available free for many monitors, printers, and scanners, but the profiles are seldom of any real value. Serious users should profile their own devices using hardware and software available from several vendors.

Scanners

Scanners are easy to profile, but you need a different ICC profile for each type of original, such as one for reflective copy, transparencies, slides, etc. Generally, a reflective and/or transparent IT8 target is scanned and compared to the target values. A corrective profile is then created. Then when an image is scanned, the driver can access the profile information and correct the color on the fly.

If you have your scanning outsourced, your vendor must characterize and calibrate their scanners as well.

Generally, scanner profiles are in RGB, although there are ways to to create CMYK profiles.

Monitors

Monitors are generally the least stable in the prepress workflow. Regular calibration and consistent viewing conditions are very important. To optimize the monitor, make sure you are creating the ICC profile in the ambient lighting conditions in which you will be using the monitor. White point is a critical issue here. The appropriate white point and gamma used for printing and graphics is the D50 standard and the gamma of 1.8.

If the brightness and contrast are adjusted after the profile has been created, the profile will be completely worthless and a new profile must be made.

There are software-only solutions available such as the default calibrator included with ColorSync and the Adobe Gamma Control Panel included with Photoshop 5.

There are limitations in using the software-only solutions, such as with the ambient conditions. For those who want the most control over their monitors, it's best to have an external calibrator, such as a colorimeter, used with the software.

Currently, all monitor profiles are RGB profiles.

Output

The RIP (Raster Imaging Processor) that films will be run through needs to be linear so that the films represent what has been asked for. The calibration of the proofing process should be checked often to make sure that exposures and chemistry are maintained at the proper levels. The plating process, the ink set, and the paper stock on which the profile is printed or proofed also contribute to the accuracy of the profile.

Using color management with a printer or press is very challenging because the different substrates used affect the outcome of the color. Different paper stock with different colors and different finishes all influence the way color appears.

Output device profiles can either be RGB or CMYK, depending on the device. It is important to determine before the profiling process begins whether a device is RGB or CMYK. Considerations must also be made for the total ink limit (TIL), black generation (UCR/GCR), and rendering intent. These measurements are usually taken with a spectrophotometer, which is usually driven by the profiling package.

Maintaining

Maintaining color management is the key. Your profiles must be checked often as several variables can change affecting your color.

Color management is not magic and does not happen by itself. As with any color reproduction method, the stability of each device in a color-managed chain can dramatically affect the whole system and good quality control is essential. Color management will squeeze the best out of your equipment, but it cannot improve a device's color gamut. It also does not eliminate the need for skill or learning from experience. The more you know, the better the results will be.