

RGB Color Managed Workflow Example

Overview

Today's abundance of RGB source art such as digital illustrations, photos, and digital art are routinely "repurposed" (redirected for different outputs). There is great need for a flexible workflow and a master image that can be used with many different output processes. RGB color encodings are well suited to these requirements, as they tend to be closer to the original source of the image.

In the following workflow example, a master RGB image is color corrected and archived in RGB form. From there, it may end up in various output forms such as a billboard, a piece of art for a website, or a newspaper advertisement. Regardless of the output medium, a single RGB file can be the source in the production of pleasing results for each medium.

The general principle is to keep as close as possible to the source encoding until as late as possible in the workflow, using ICC profiles to implement the necessary conversions. This workflow often referred to as 'late binding', facilitates repurposing of image content.

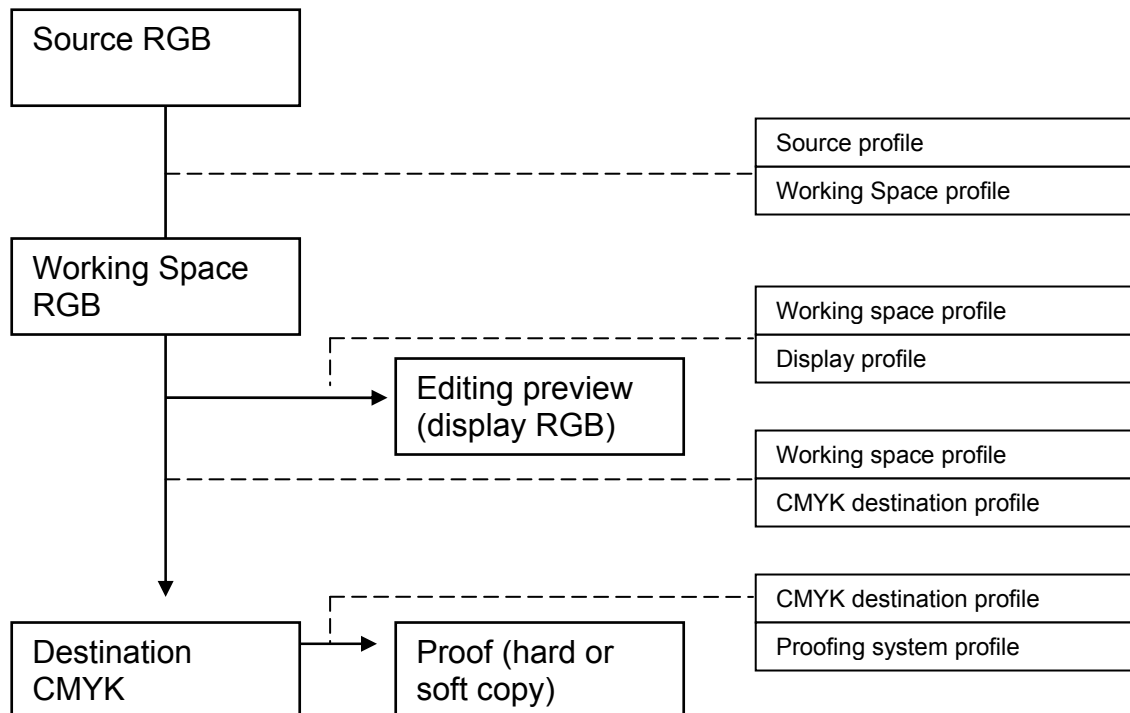


Figure 1. RGB workflow example

Prerequisites

To achieve an accurate and efficient RGB workflow, each color device in the workflow must be calibrated. This is a process by which a device is returned to known color conditions. Calibration is followed by characterization, which is the process of creating a profile that describes the color characteristics of that particular device. In a color management system (CMS) or workflow, a calibrated device is characterized by an ICC profile. The process of calibrating and characterizing may be slightly different for each type of device.

A standard Color Management Module (CMM), also called a Color Engine should be chosen for the workflow. A CMM is the software component in a CMS that transforms the specific color values in the source color encoding into specific color values for the destination color encoding using the corresponding source and destination ICC profiles. Color engines are part of an operating system or an application. Such engines are provided, for example, by Apple® in Mac OS, by Microsoft in Windows® and by vendors such as Adobe® and Heidelberg.

An example RGB workflow is illustrated in Figure 1 above, and brief recommendations on profiling for an RGB color managed workflow are given below. Information on making profiles, and on tools for this purpose, can also be found on the ICC web site at <http://www.color.org/makingprofiles.html>

Source Profiling

Source profiles for workflow input devices such as scanners and digital cameras should be located, or created as needed. In many cases, the scanner or digital camera will create RGB values directly in some standard output-referred color encoding, such as sRGB, Adobe RGB (1998), or ROMM (ProPhoto) RGB. In this case a profile for the color encoding used should be selected as the source profile, and embedded in the image (if not already there).

In some cases the source color encoding will be a raw file. Scanners that produce raw data should be profiled using an appropriate characterization target, as specified in ISO 12641. Raw digital camera files should be processed to some standard color encoding using a camera raw processing application. This processing includes the white balancing and color rendering, and is where most of the editorial choices and tradeoffs are made.

[While rare at present, there may be some emerging interest in scene-referred color encodings, such as scRGB and RIMM RGB. (With scene-referred color encodings the white balancing has been performed, but not the color rendering.) It is also possible to create raw camera RGB files. If a raw camera RGB or scene-referred file contains an embedded ICC v4 profile, it should be used to convert to a standard output-referred color encoding before proceeding. Generally the perceptual rendering intent should be used.]

The source RGB color encoding should be chosen based on the anticipated destination media gamuts. sRGB is well-suited to typical display gamuts and is therefore the best choice for web content. It may also be a good choice for lower-end printed material. Adobe RGB (1998) is a common choice for content that will be presented on wide-gamut displays and for mainstream printing. sRGB and Adobe RGB (1998) are also used as

working spaces for image editing. ROMM RGB is the best choice for high-end printing on large gamut media, but only experts should use it as a working space as some code values are not allowed, and 16-bits per channel are recommended. RGB images should always contain an ICC profile describing the current color encoding the image is rendered to.

Display Profiles

Natively, different monitors often display color differently. To compensate, the signals sent to a monitor must be color managed using an ICC profile, either one provided by the manufacturer or one created using display profile creation tools.

Profiles for proofing and printing

Print destination profiles are available for standard printing conditions (defined in ISO 12647-2 and ISO 12647-3) on the ICC Profile Registry. These profiles are recommended for use when the actual printing condition corresponds to one of the conditions for which these profiles were generated. Printer profiles may also be provided by the manufacturers of digital printers, such as ink-jet printers and digital presses.

Where such a profile is not available, users may wish to generate a custom profile. Where the printing condition corresponds to one of the printing conditions in the ICC Characterization Data Registry, this data should be used in preference to preparing custom characterization data.

Where published characterization data does not exist for the target printing condition, users will first need to obtain such data by measurement of printed targets before generating the profile. The printing system should be linearized prior to characterization. CMYK output devices can be characterized using a target such as ECI 2002 or IT8.7/4. Randomly-arranged (as opposed to visually-arranged) targets work best on most press types. Print two or more random targets, rotated at 90° to each other, close to the center of the page and not in-line with each other. Measure and average the results to provide the most accurate characterization data.

When generating a profile in an ICC profiling application, the appropriate amount of black generation and ink limiting should be used. In lithographic printing ink limiting may vary between 200 % and 350% Total Area Coverage (TAC), depending on the printing process and paper, In ink jet printing the TAC will typically need be at the lower end of this range unless ink limiting has been applied independently in the RIP. Default black generation settings for printing processes are provided by profiling applications, and recommendations on such settings are available from industry bodies such as SWOP, fogra, ECI, SNAP and ifra.

In proofing, the aim is to match the output of the final reproduction process. The profile for the proofing system is generated from targets printed on the proofing stock, using the methods described above. The image will usually be converted to the print destination profile, using a Perceptual or Colorimetric rendering intent according to the goals of the reproduction, and then converted to the proofer profile using a Colorimetric intent.

Assigning Source Profiles

In a color-managed workflow it is very important that each image has an associated profile. Documents containing embedded profiles are referred to as tagged files (e.g., scanned art tagged with the scanner's profile, or digital camera files tagged with the sRGB or Adobe RGB (1998) profiles). Image files with the proper ICC profile embedded provide a computer's color management system with valuable information about how individual image and graphic objects should be displayed, processed and printed.

Conversion to an RGB Color Encoding

Prior to image editing, convert to an RGB color encoding or working space, as shown in Figure 1.. It's not wise to edit colors in an output-device-specific color space. Choose a working space based on the considerations noted above.

Soft Proofing

Using ICC profiles allows you to soft proof the printed results on your monitor. In Adobe applications, choose "Custom Proof Setup" from the View menu. Select the proper destination profile in the "Device to Simulate" menu. Use "Black Point Compensation" and choose either Perceptual or Relative Colorimetric as the Intent. Check "Simulate Black Ink and Paper Color" to preview shadow details and the overall effect of printing on the chosen stock. Soft proofing in this manner provides a reasonable viewing environment for image evaluation and editing. This setup does not necessarily provide an accurate appearance match between the monitor and the equivalent hard copy output.

Adjusting Color

Color management is not the same as color correction. Color management tries to maintain the artistic intent of the original image, with the degree of appearance matching depending on the rendering intent selected. The ICC-absolute colorimetric rendering intent attempts to produce an appearance match within the gamut of the destination medium, but clipping may result. The media-relative colorimetric rendering intent maps the colors relative to the source medium white to the destination medium white, avoiding both highlight clipping and muddy highlights. Black point compensation does the same thing to the shadows. Perceptual rendering intents aim for pleasing reproductions while preserving the original artistic intent and taking the capabilities of the printer into account, but in doing so may produce even larger differences in appearance. Also, there are issues with some profile perceptual transforms that result in poor combined results. Perceptual transforms should be checked prior to routine use. Finally, color adjustment may still be needed in order to achieve the desired appearance and/or creative goals.

Images that require extensive editing should be acquired and archived at higher bit depth, 16 bits vs. the standard 8 bits per channel, whenever possible. This minimizes the possibility of quantization errors (banding) being introduced during the editing or conversion processes.

When editing images, select the destination profile that represents the current destination device (i.e. Press, ISO standard proof, etc.) as the working space in the Color Settings (in the Edit meny) in Photoshop®. Selecting a destination profile allows

the operator to view the image and take readings in CMYK, reducing the learning curve for RGB color adjustments.

Images should be acquired as close to the size as they are to be used as possible, but if they require further resizing, it should be done at this time. Any edits in Lab color space should be done in 16 bits per channel., After editing is complete convert to 8-bit mode, if an 8 bit per channel file is to be archived.

Conversion to Destination Color Space

There are still image-dependent aspects of the color conversion process. Images whose colors all lie within the gamut of the destination profile can easily be converted using the relative colorimetric rendering intent and black point compensation. Images that have colors that are outside of the gamut of the destination profile may benefit from a color re-rendering; so the perceptual rendering intent may be selected to prevent clipping the out-of-gamut colors. Gamut clipping can be checked in Photoshop® by making sure the destination profile is selected in Adobe® Photoshop®'s Color Settings control panel, then select Gamut Warning from the View menu, to show any areas in the image that will be clipped when converting to the destination color space.

Even if all the source colors are inside the destination gamut a user might prefer the reproduction resulting from a perceptual rendering intent over a colorimetric reproduction as the perceptual re-rendering may produce a more pleasing result.

Color server software can also be used to convert pages on the fly. This is a highly desirable workflow but it can sometimes cause problems, if images are not normalized into a RGB color encoding where a tested rendering intent can be used for the final conversion to CMYK.

Sharpening

Sharpening should be process specific and is ideally performed after the image has been encoded in the final device space. Use the Un-sharp Mask filter or the Smart Sharpen filter in Adobe® Photoshop®, preferably in luminosity mode (not on the individual colour channels). Sharpening will be different for billboards, for example, than it will be for the Internet or newsprint. In an RGB workflow, the specific software solution will dictate whether sharpening can be done in CMYK immediately prior to proofing, or must be done earlier in the RGB stages of the workflow. Late binding sharpening is the most desirable solution and allows greater workflow flexibility.

Additional Editing

Black-only drop shadow creation can be done at this time. Additional spot colors or high GCR areas should be addressed and composited into the image file.

Legacy CMYK files can be converted to RGB with very little loss in color fidelity, by using ICC profiles with relative colorimetric rendering intent and black point compensation. Convert the data to the workflow's device independent color space (typically the current RGB working space). These files can now be repurposed just like the rest of the files in the RGB workflow.

Page files can be built from RGB archives and CMYK images, created as a first-generation conversions from the RGB parent files. Photoshop® provides excellent CMYK simulation, which helps with operator consistency of color evaluation and manipulation. Workflows using Spot Color or Grayscale can be built and previewed using plug-ins for Adobe® Photoshop®, such as X-Rite's Multi Color Plugin.