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Stephen Johnson on Digital Photography

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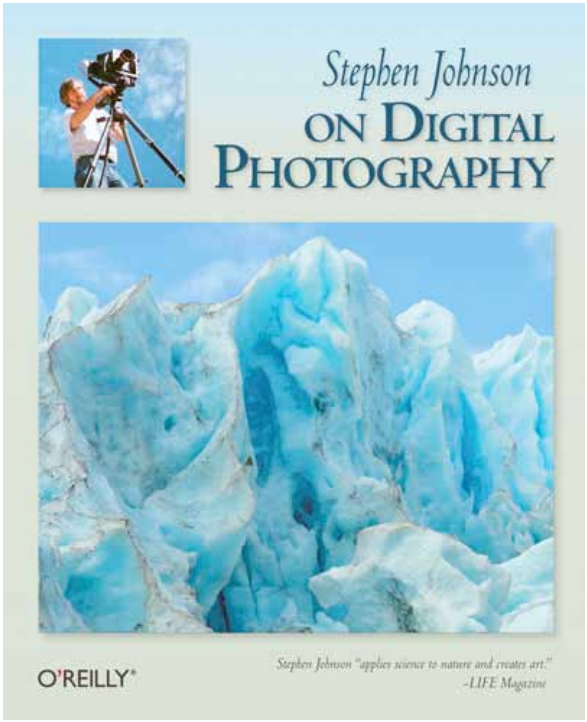

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Stephen Johnson ON DIGITAL PHOTOGRAPHY

Stephen Johnson "applies science to nature and creates art."
~LIFE Magazine

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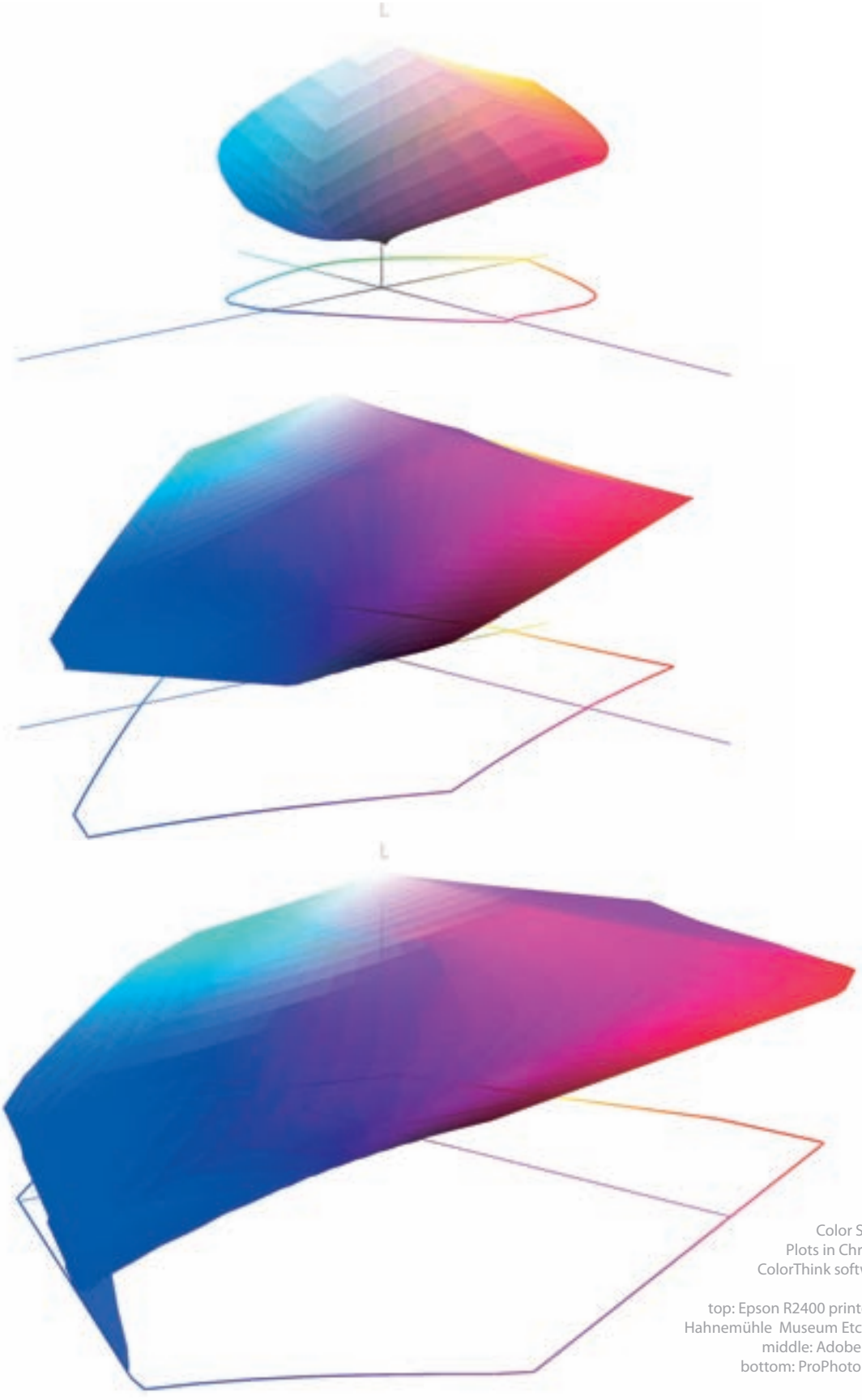


Color Space
Plots in Chromix
ColorThink software.

top: Epson R2400 printer on
Hahnemühle Museum Etching.
middle: Adobe RGB.
bottom: ProPhoto RGB.

Chapter 13: Color Management

Color is my day-long obsession, joy and torment.

—Claude Monet

Color management could also be known as color confusion, marketing hyperbole, or the black hole. There has been much oversimplification and much over-complication of this subject. In fact, done carefully and with reasonable expectations, managing your digital color workflow can make a tremendous positive difference in the overall usability of a digital photography system.

An Overview of Color Management

Color management is mostly about describing the color capabilities of different devices and linking them together with a language of color that translates from one to another. This is a critical translation; otherwise, the color capabilities of one device will simply send undefined colors to other devices, which will in turn print or display however it happens to print or display, without any control other than the manufacturer's assumptions and current device conditions. That is often the case when you have no color management in play, and the color is understandably out of control.

Color Spaces

A color space is a range of color definitions modeling human color perception, and color space can be interchanged, displayed, and printed with some predictability. These ranges of color can be modeled, plotted in various ways, and compared. Color spaces are defined in the Lab colorspace, a model of color definitions that maps human color perception into measurable form.

Color Profiles

Profiles are descriptions of the color capabilities of a real-world device such as a camera, display, scanner, or printer. The Lab values in these descriptions are used by imaging software and provide the key for translating color information from one device to another. These are often referred to as ICC Profiles (a commonly accepted profile format), meaning they conform to the standards of the International Color Consortium, a group of imaging company representatives who work on color standards, such as defining the information in a profile.

Color Management Module (CMM)

The Color Management Module is the software engine that does the math translation from one profile to another. This translates image color from one set of color capabilities (color gamut) to another device's color capabilities.

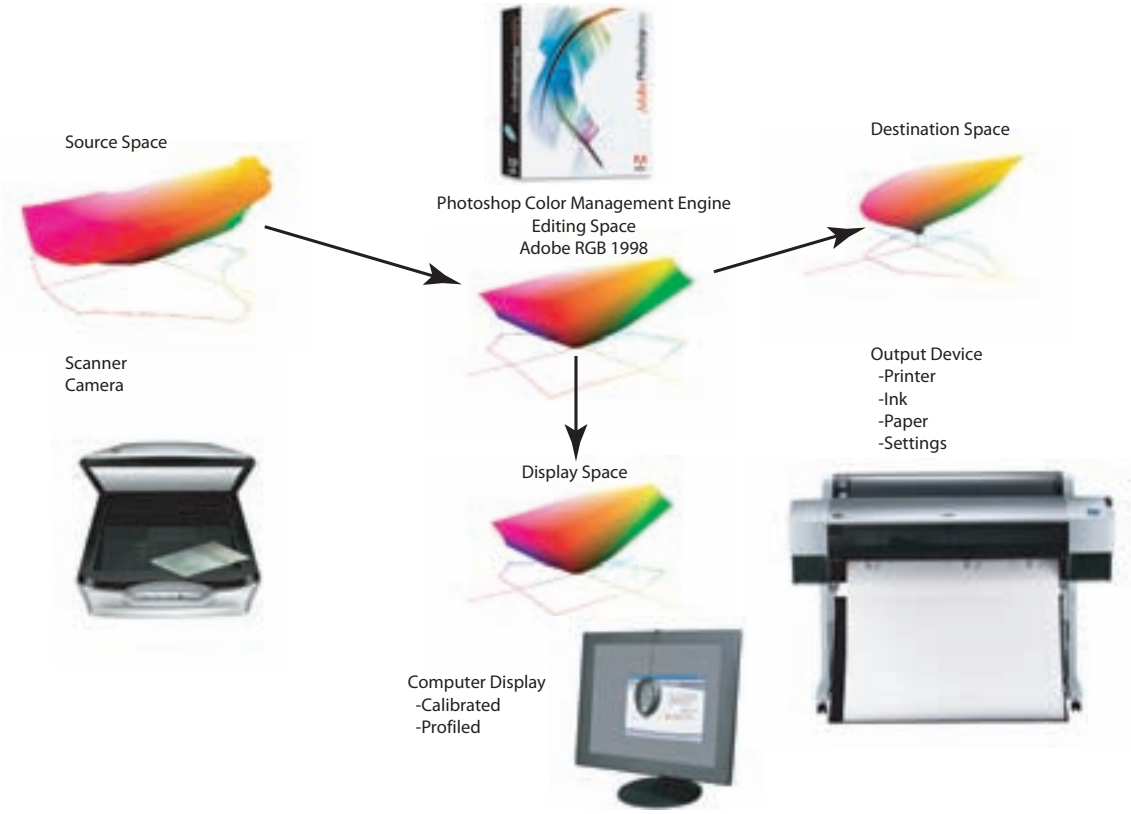
Displays

Your portal into your digital photo world is the computer display on which you view your image. It needs to be at least in a known state (characterized), and preferably a calibrated state so that the colors it displays provide a good representation of the digital file.

Many displays are simply in whatever state they happen to be, or have been adjusted to look "good" without any external reference as to how that relates to the signal being sent by the computer. Looking good may not be a correct representation of the file, and therefore using that skewed screen as a source of visual information for photo editing and printing can be very problematic.

Many printer companies complain that their single most common customer support call is the fact that prints don't look like the screen. The printer will print the data, in whatever state it's in, and without color management. No other part of the system knows what the viewer is seeing on the computer screen. A calibrated display and a good display profile addresses this issue.

Color Managment Workflow



Editing Spaces

Editing spaces refers to the set of color definitions used by Photoshop to define precise spectral meaning of the colors within the image. They are not definitions of a device, but rather a set of color definition parameters within which to operate. Editing profiles need to be well-behaved and well-suited for editing images, with uniform tone response for each channel, and also gray balanced, so that equal amounts of RGB make a neutral gray. Some of these spaces also have wider gamuts, so you aren't limited to the gamut of your display or a particular output device when editing your images. A common editing space that meets many needs is Adobe RGB (1998), and other such spaces include sRGB, ColorMatch RGB, ECI RGB, and ProPhoto RGB.

Device Profiles

Profiles that describe the behavior and capabilities of real devices are called device profiles. Although they have different roles, they can be cross-assigned, leading to flexibility and confusion.

Source Profile: a description of the color capabilities of the device that the image is coming from, such as a scanner or digital camera. Scanners can profile well, but digital cameras are difficult to profile because of the many variables involved in customizing the making of photographs.

Display Profile: a description of the color capabilities of the computer display in its current condition. This profile describes what color will look like to the users as they look at the screen. Our judgement of the display colors can be influenced by ambient lighting conditions, the color of the viewer's clothing, and colorful desktops that skew color perception.

Destination Profile: a description of the color capabilities of the device that the image is being printed to, such as an inkjet printer. This description is very specific, and it requires knowing the printer, paper, ink type, and settings.

Soft-Proof: an image processed by Photoshop or other application and displayed on the computer display that attempts to imitate how the print will look when finished. CMYK soft-proofing for prepress has been used effectively for many years. RGB soft-proofing to simulate desktop printer requiring RGB data has proven more challenging.

Picture to Print with Color Management

Granite & Brush, Acadia National Park, Maine, 1995.

This image's colors don't fit within the printer's capabilities—therefore, they must be transformed into colors the printer can produce. That is largely the task of printer color management.

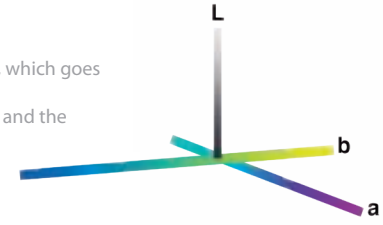
These three graphics show:
1. The photograph's color plotted in the Adobe RGB color space.

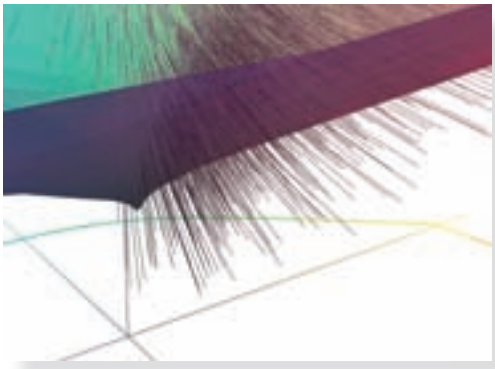
2. Those same points shown with the Epson 2200 printer space.

3. The movement needed to transform the image color outside the gamut of colors into color that can be printed by this printer, with this paper.

This gamut mapping is the challenge, purpose, and opportunity of color management.

The Lab color space graphics:
The L axis is luminance, or brightness, which goes from black at bottom to white at top;
the B axis ranges from yellow to blue; and the
A axis from magenta to cyan.

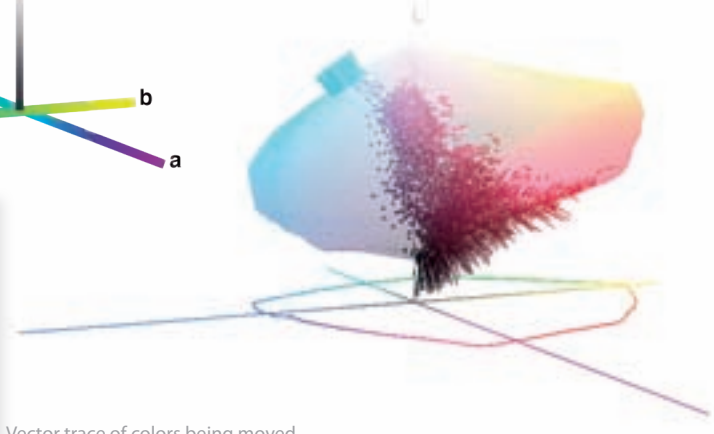




Vector trace of colors being moved into the printer space from Adobe RGB. Perceptual Rendering Intent. Color Space Plots in Chromix ColorThink™ software.

1. Acadia photograph plotted in the Adobe RGB color space.

2. Epson 2200 print space.



3. Epson 2200 print space.

Color Management in Practice

Color management can get pretty dense and theoretical quickly. All of this effort is simply trying to describe what these devices can do, and how to transform color between them. A profile of any real-world machine is a device profile, but I find it useful to break them down to distinguish how they are used.

Kodak IT8 Test Target on color photographic paper. This is designed to profile how scanners render color.

Source Profiles

The *Source Profile* refers to a profile describing the color capabilities of the device which produced the file.

- Scanners: good scanner makers provide a basic profile of their scanner. These profiles take into account the lens, lamp, and software producing the scan. Custom profiles of scanners can be made with color calibration targets like the IT8 printed on color paper, transparency, and negative film. These targets are scanned in a raw mode on the scanner. Color profile–making software is then used to read the file, determine how it is different from what it knows is on the target, and create a new source profile. This has the potential to be a more accurate profile than a more generic profile supplied by the manufacturer.
- Cameras: cameras are hard to profile. There are many variables in play, such as light conditions, optics, and huge contrast range differences between photographs and the user's taste. Many cameras are now tagging their pictures with a display profile like sRGB or a color working space like Adobe RGB. Neither of these are camera profiles and should not be used as such. Some cameras use internal source profiles, and then translate them into standard color spaces.

Apple's Display Calibrator Assistant. This is designed as a careful visual feedback loop to create an approximate display profile.

Display Profiles

Display profile refers to a description of the capabilities and current condition of your display.

- Visual characterization with software: Apple Display Calibrator and Adobe Gamma are visual calibration software tools that use your eyes and judgment to adjust the display and create a profile. They should be used if there is no hardware solution available.
- Display calibration with hardware and software: packages with sensor and software are available from a variety of makers.
- Integrated display/calibration: the ultimate hardware/software solution is a package with software and sensor integrated into the display by the maker.
- The Internet: the sRGB color space was created in an attempt to find a colorspace that would describe generic uncalibrated displays on a PC. It is a reasonable assumption for web page viewing conditions; therefore, files transformed into that space with an sRGB profile embedded should look reasonable on most web browsers and screens that match the assumption.

far left: X-Rite's Monaco OPTIX^{XR} display calibrator.
above: GretagMacbeth's Eye-One Display calibrator on an Apple LCD display.

Printer Profiles

A printer profile is a description of how your printer prints color with the current ink, settings, and paper. These can come from various sources, or you can make your own with the proper hardware and software.

- Supplied profiles: supplied by the manufacturer for their printer, paper, ink, or software. These are generic to model, and they vary in quality. Free.
- Custom generic profiles: supplied by third-party profile producers for specific printer types. These are generic to model and they vary in quality.
- Custom profiles: a profile of your specific printer made by a service. These are specific to your printer. If you follow procedures carefully, they can be quite good.
- Your own custom profiles: your own custom-made profiles with your hardware and software. If done correctly, these are likely to be the highest quality profiles. *(See "To Profile a Printer" in Chapter 14.)*

ECI2002r CMYK 1485 patch Profiling Testchart.

Rendering Intents

When color has to be translated between two different devices with different color capabilities, the CMM (color management module) has to make decisions as to how to map color into the different space. Some color from the source may fit easily within the color gamut of the output device, but others may not. The control of how this mapping is done is called rendering intent. There are many strategies for rendering out-of-gamut color, but the two most commonly used variations are these:

- *Perceptual rendering*: attempts to preserve color relationships so that visual relationships remain. For example, suppose there are two close reds that are noticeably different, but one is in the gamut of the printer and one is not. With perceptual rendering both would likely be changed, moving the out-of-gamut color into the space, while moving the red that was in-gamut so as to maintain a visual difference between the two.
- *Relative Colormetric* rendering: attempts move only the colors that are out-of-gamut into the color capabilities of the device. Color that is in-gamut should, in theory, be left alone.

In Practice

Implementing a color-managed workflow requires integrated use of these capabilities. Education is required for the people (usually us) responsible for managing the color, together with a vigorous calibration enforcement.

1. Your display must be calibrated regularly, preferably with hardware.
2. You should know where the file came from and transform the file from its source space to your Photoshop working space.
3. Print to your printer's profile, either by having Photoshop manage the color (preferred), or by using the manufacturer's color workflow. Be very careful not to do both. *(See "Printing Software" in Chapter 14.)*

GretagMacbeth's Automated I/O Stage for the Eye-One Spectrophotometer.

Stephen Johnson on Digital Photography

Stonehenge at Dawn. 1996.

Perspectives & Techniques from a Digital Photography Pioneer Exploring the Intersection of Art & Technology

This practical guide from master photographer Stephen Johnson chronicles his own expedition on the bleeding edge of digital photography's evolving frontier. He explores a wide range of subjects, from basic camera techniques, to the ethical issues of digital imaging, to technological innovations for the future. What sets this book apart is its approach and execution. This isn't a Photoshop book, although Photoshop is part of the story. It's a book that reflects a master teacher and photographer's lifetime of showing others how to understand and take great photographs.

Stephen Johnson on Digital Photography brings a unique, passionate, and holistic method of teaching to students of photography. Johnson conveys a master's understanding of how any level of "taking pictures" involves a balance of science, craft, and artistic expression. No other book offers the knowledge and background of its author with this breadth of coverage, all in a concise and highly accessible format.

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- *Scanning*
- *Asserting control over the digital image*
- *Color correction & editing*
- *Restoration*
- *Duotones & photographic reproduction*
- *Color management*
- *Fine-Art printing*
- *Digital asset management*
- *The creative process*
- *Equipment considerations*
- *Photography as art*
- *The ethics of digital imaging*
- *The power of documentary photography*
- *Photography & social concerns*
- *Teaching photography*
- *The future of digital imaging*

photo by Steve Somers

Stephen Johnson is internationally recognized as a digital photography pioneer. His photographs are part of the collections of many institutions, including the J. Paul Getty Museum, the Oakland Museum, the City of New York, the U.S. State Department, and the National Park Service. *With a New Eye*, his digital national parks project, literally made photographic history.

His work in digital photography is renowned. His consulting has influenced products at the core of digital imaging for such clients as Adobe Systems, Apple Computer, Eastman Kodak, Epson, Foveon, and Hewlett-Packard. His work with Adobe includes consulting on the development of Photoshop since 1992 and the creation of Photoshop's Duotone feature.

In 1999, *Folio* magazine declared the publication of Johnson's digital photographs in *LIFE* magazine to be one of the "Top 15 Critical Events" in magazine publishing in the 20th century. He was named to the *Photoshop Hall of Fame* in 2003 for his achievements in Art.

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Johnson is "...the preeminent digital landscape photographer." He creates images "unlike anything possible on film...." His prints are "remarkably vibrant, and the details seem to jump out from the image."

—Photo Insider