COLOR MANAGEMENT – In A Digital Workflow Environment.

How can professional photo labs consistently deliver great-looking color prints in a high-volume digital workflow environment? By implementing a highly effective and productive color management strategy.

Elements of this strategy will be influenced by the nature of the lab. For example, labs that employ their own photographers who shoot on film have much greater control over the emulsion, lighting and exposure, etc. – that generally improves first-time yield. By contrast, labs serving independent portrait and wedding photographers can expect to receive a wider latitude of exposure and image-quality variables that make it significantly more challenging to achieve the desired consistent results. The same is true in both cases when the capture device is a digital camera.

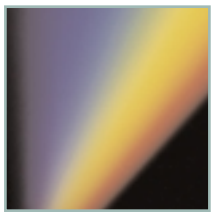
Keep in mind that many of the following recommendations are consistent with those that would be implemented to achieve optimal optical printing. In digital workflows, it's even more critical to faithfully execute the strategy. In the process, don't forget that the densitometer remains a key to consistency – make sure that it is routinely checked and calibrated. Likewise, always ensure that the film and paper processors are in tight control.

Color Has Three Perceptual Attributes:

- *Hue – the color property denoted by the wavelength (e.g. red, green, orange, etc.).*
- *Saturation – the amount of vividness of the color (e.g. red, and pink share the same hue but differ in saturation levels.).*
- *Lightness/Brightness – the amount of light the color reflects.*

It's important to caution that color management can not cure all photographic ills. Whether the lab is working with raw digital files or scans of color negatives, a normally exposed image is still required to provide the best results.

■ Color Management – A Simple Definition.



Broadly defined, color management is the art and science of controlling the color quality of photographic prints. In the digital world, color management encompasses a multitude of disciplines, including physics, chemistry, engineering, image science and computer science – each reinforced by an exhaustive understanding of the human visual system and a culturally-based appreciation for human color preferences.

After all, getting color right is what professional finishing is all about. The optimization of color values, contrast, and density in the finished print is central to making quality pictures.

To accomplish this, all workflows – optical or digital – incorporate a form of set-up and balance, analyzation, calibration, and maintenance. Automatic scene balance algorithms can replace film analyzers in a digital workflow.

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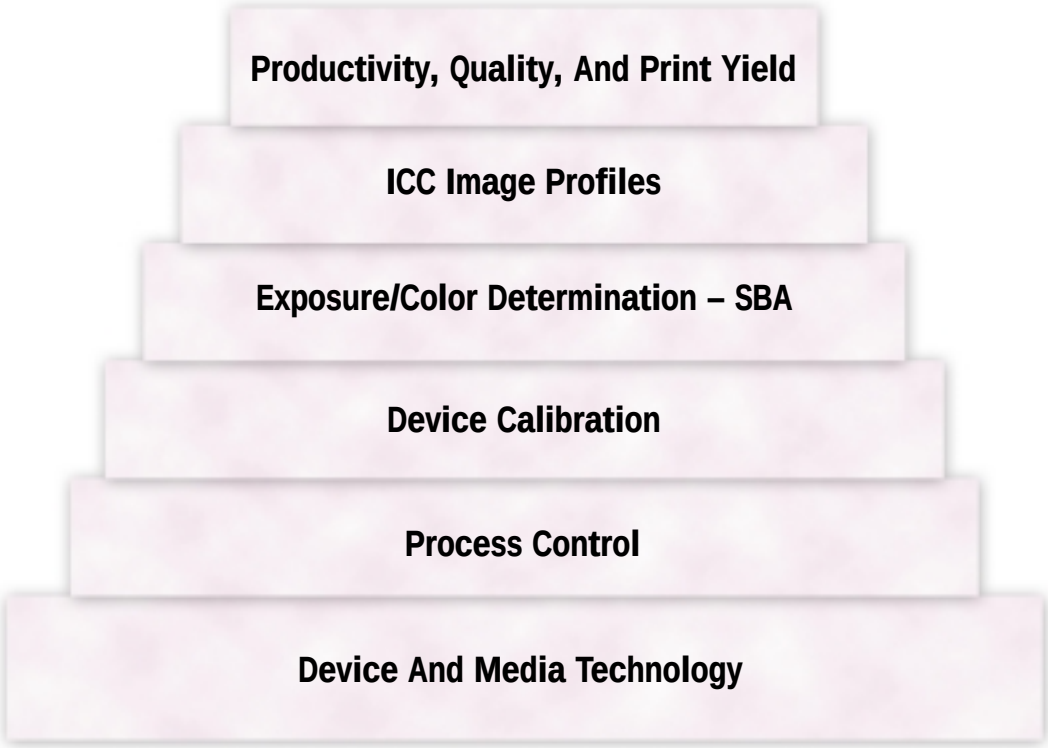
In traditional lab workflows, the properties that affect final print color fidelity – film brand and emulsion, film format, exposure, chemistry, and paper – are generally well understood. As a matter of control, the opportunity to adjust the eventual look and color of the image is confined to the lab, once the color negative film has been developed.

By contrast, in a digital workflow, new and constantly evolving input, display and output technologies have added additional layers of complexity to the color management challenge. At the same time, photographers have the ability to alter color and manipulate a digitally captured image even before it's sent to the lab for final output.

The rules of the game have changed. It's not necessary to be an expert in color science to understand the opportunities and consequences for shooters and professional labs.

For example, one of the defining features of a pure digital workflow is the technician's ability to preview an image on a computer monitor as a soft proof prior to printing. For many, this is a mixed blessing. Monitor quality and operation will vary greatly among manufacturers, models and technologies. Even two identical monitors can be set up to deliver quite different visual results. Available calibration software can minimize – but not totally eliminate – the potential for color variances between the soft-copy proof and the finished print.

The Color Management System

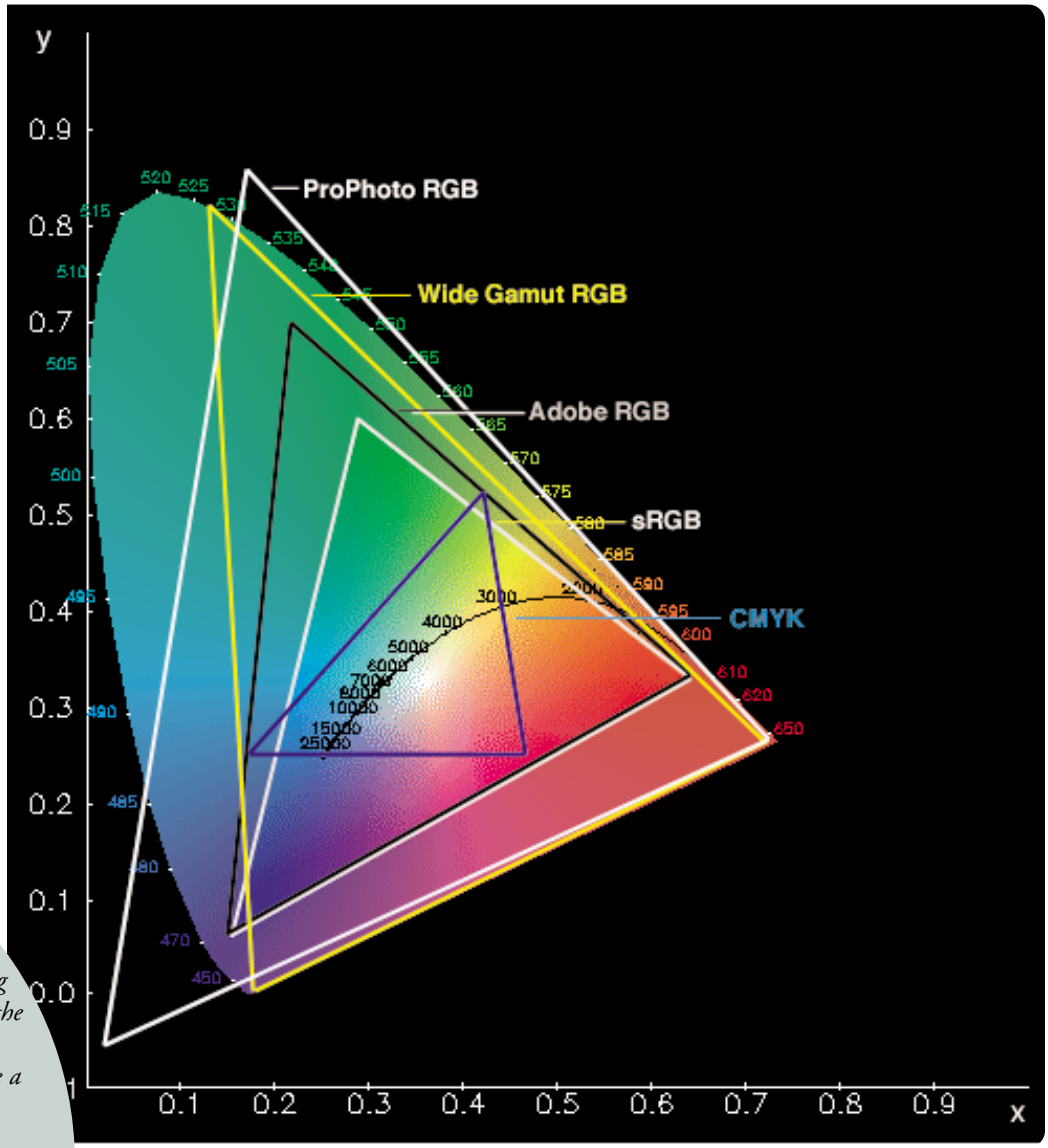


Color management isn't one task that gets performed –
it is comprised of many functions and disciplines which work together in harmony.

For this reason, labs are encouraged to create a series of reference images (matchprints) – prints of typical subject matter that can be compared to the corresponding images on the screen. In turn, color corrections can be made which can be automatically applied to subsequent images.

Cross platform color anomalies of this nature underscore the need to accurately translate color data created on one input, display or output device into another's native color space in a standardized way.

For this purpose, the ICC (International Color Consortium) device profile format was established to ensure images retain their color fidelity when moved among systems and applications. Visit www.color.org for a in-depth description of ICC profiles.



CIE Chromaticity Diagram:

- *A specification of a color stimulus indicating potential for evoking a color perception for the normal observer. A particular point on the chromaticity diagram DOES NOT indicate a particular perceived color.*
- *CIE colorimetric values provide a definition of matching or metameric color stimuli for the normal observer – provided that viewing conditions are constant. It does not mean that two stimuli with the same colorimetric values will appear the same under different viewing conditions.*

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■ Color Management – A Collaborative Effort.

Digital workflow is not just about technology change – it's about procedural change as well – especially the manner in which labs and photographers engage each other to ensure customer satisfaction.

Mutual expectations must be established at the outset in order to significantly minimize color management issues:

1. Will the lab be expected to make prints without altering the file, or attempt to make the best possible print from the digital file?

2. Will the lab provide its photographers with a digital reference image and print kit to help them calibrate to the lab?

3. Does the photographer have an overall personal color preference, requiring the lab to maintain flexible manual control over print color and density in its digital workflow?

4. Will the lab establish image resolution, file type and color specification parameters for its photographers?

5. How much flexibility will photographers have in submitting digital files for printing?

■ The Limitations Of Color Management Tools.

In practice, no single digital photographic system can be optimized for every possible application. Even the most advanced color management tools and protocols are limited by the color gamut and dynamic range of the input and output device. (The same can be said for the digital capture device.) Portrait/social and school labs, by their very nature, must be able to produce flesh tones of exceptional quality. However, color management tools can't produce colors and tones that don't exist in the captured file. This happens when the photographer doesn't correctly expose and balance the camera to capture the scene.

Ideally, algorithms that determine and automatically adjust color, in conjunction with the file compression and color encoding capabilities of the image processing software, will be optimized for the output of the lab.

With these broad concepts in mind, the following checklist can provide a strategic framework for professional labs to achieve effective color management tailored to their specific customer needs and expectations.

Color Gamut Range Of Colors That Can Be Reproduced With A Given Set Of Primaries:

- *Subtractive color systems generally have smaller color gamuts than additive systems.*
- *Subtractive systems generally have trouble with bright, highly saturated colors.*
- *Subtractive systems are sensitive to color temperature of viewing illuminant.*

Color Management Checklist

- ✓ Workflows must follow the business model
- ✓ Establish a plan for archiving finished work
- ✓ Establish guidelines for accepting digital file formats
- ✓ Develop a consistent procedure for dealing with exposure and color correction
- ✓ Provide customers with a reference file and print
- ✓ Develop digital expertise for lab and photographer support
- ✓ Establish a quality color standard
- ✓ Understand the keys to output consistency
- ✓ Install uniform lighting for print inspection
- ✓ Know what your output device can deliver
- ✓ Make sure equipment is properly set up
- ✓ Consider soft proofing
- ✓ It's important to make the right color monitor purchase decision
- ✓ Calibrate the monitor
- ✓ Don't forget about those ICC profiles
- ✓ Adjust monitors to closely match the print color

■ Workflows Must Follow The Business Model.

Labs must anticipate the nature of color printing services they wish to provide. *Will files be submitted and printed without customization (service bureau environment), or optimized on a file-by-file basis?*

The level of lab intervention to correct or modify files will help determine the tools and processes required to ensure the best possible results, while also establishing criteria for accepting digital files to print.

■ Know What Your Output Device Can Deliver.

Printers and media are not created equal in their abilities to deliver desired results. No color management strategy, by itself, can overcome the technical limitations of the chosen output device. For example, color gamut describes the differences between the maximum and minimum amount of color, ink or density that a printer can print. Color gamut, dynamic range of a printer, and print media will all greatly affect color quality.

Commercial labs often have to match Pantone colors. By contrast, photographs of people rarely contain very specific and highly saturated colors. Instead, flesh tone rendition is paramount. Professional labs have a different standard of color and quality requirements to produce pleasing results. (If a lab is uncertain about a printer's color gamut limitations, vendors should be asked to supply sample prints from a cross-section of the lab's digital files, prior to purchase.)

■ Make Sure Equipment Is Properly Set Up.

It's imperative that all the manufacturer's guidelines for initial set up and calibration be precisely followed. To accommodate individual visual preferences, time should be allocated to complete any customization protocol beyond the manufacturer's standard configuration, and certify the results.

■ Don't Forget About Those ICC Profiles.

At a minimum, the equipment's default ICC profiles can help improve the display of digital image files on computer monitors. ICC profiles can also help improve color across various equipment and platforms.

■ Understand The Keys To Output Consistency.

It's imperative to understand and adhere to site requirements and calibration regimen for all input/output devices and media. Selected digital equipment is highly sensitive to temperature and humidity changes that can dramatically affect color quality and consistency.

■ Establish A Quality Color Standard.

Labs should always create a reference image representing both an objective and subjective example of "best printing" (as well as variations that are deemed acceptable) as visual guidelines for quality inspectors in the lab.

■ Establish Guidelines For Accepting Digital File Formats.

To help ensure optimal color quality, labs should establish firm guidelines and specifications for file type, source of file (film scanner, camera card, etc.), resolution, compression level and color encoding.

■ Develop A Consistent Procedure For Dealing With Exposure And Color Correction.

Photographers can not be expected to be perfect – even shooting digitally. Compensation and corrections for exposure errors introduced in-camera must be accommodated in the digital workflow as a standard operating procedure. A number of automated technologies and manual techniques exist to correct images for exposure errors. This does not mean a lab can make a good print if the image is not correctly captured. Digital camera capture does not increase the likelihood of correct exposure.

■ It's Important To Make The Right Color Monitor Purchase Decision.

Monitors greatly vary in color uniformity and color calibration capabilities. Critical evaluation of image files for color correction and retouching requires the selection of quality display technology.

■ Calibrate The Monitor.

External calibration equipment and software are available for most monitors. (Some monitors feature built-in devices and software.) Through either mean, it is important to analytically determine the monitor's calibration.

■ Adjust Monitors To Closely Match The Print Color.

To properly inspect and adjust digital files before printing, it's vital that the monitor image looks like the print that will be produced. The least complex way to achieve this is to calibrate the monitor to a white point that will more closely match the print result. (Color temperature between 5000 and 6500 Kelvin.) Monitor brightness and contrast will also need to be adjusted. Advanced calibration techniques and ICC profiles for both monitor and printer may be required to achieve extremely precise color parameters in the final output.

Chromatic Adaption:

- *The eyes adapt to different colors of "white."*
- *The eye sees white paper as white whether viewed in daylight, tungsten, or fluorescent light.*
- *Film and cameras do not chromatically adapt to different light sources.*
- *Can be a factor in judging print to monitor matching.*

Lateral Adaption:

- *Eyes adapt to different surroundings and can give erroneous results.*
- *Images viewed with dark surroundings generally have higher contrast when compared to light surroundings.*
- *Viewing prints with or without borders can influence perception of contrast.*
- *Can be a factor in judging print to monitor matching.*

Environmental conditions are important. Monitors should always be placed in slightly darkened room without lights reflecting off of the display.

■ Soft Proofing Can Save Labs Money.

Digital image workflows provide the opportunity to preview the digital file before it is printed to optimize color reproduction before final printing. Labs should always inspect and correct to minimize the need for remakes.

■ Install Uniform Lighting For Print Inspection.

Print media, inks and dyes react differently to various light sources. Often, visual perception of print color quality is influenced by the color quality of the light illuminating the print. High quality, uniform illumination is necessary to properly evaluate print color. Viewing lamps need to provide high quality, spectrally broad color output to simulate how prints will be viewed by the end user. It's suggested that print viewing rooms contain lamps with a color rendering index of 90 or above and a color temperature of 5,000 Kelvin. If current lighting in an optical workflow produces acceptable results for your photographers, output should also be satisfactory in a digital workflow as well.

■ Provide Customers With A Reference File And Print.

Labs that provide their customers with sample files and representative prints create opportunities to match the display of digital files on their computer monitors to the print color quality that the labs will produce.

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■ Establish A Plan For Archiving Finished Work.

Labs will need to decide if they will archive finished order files or send materials back to the photographers. Decisions will have to be made regarding type of storage media, file format and color representation of the finished digital files and any source elements.

■ Develop Digital Expertise For Lab And Photographer Support.

As labs adopt digital workflows, and more photographers embrace digital capture, the need exists for labs to hire/train "digital experts" who can provide technical and procedural support for internal and external "customers" while maintaining active working relationships with hardware and software vendors.