GETTING YOUR MONITOR AND PRINTS TO MATCH

for the advanced amateur, wedding, and small studio photographer

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REVISION HISTORY

- *Revision 0a1:* Draft issued for initial review, January 11, 2010.

REFERENCES CONSULTED

Books

Color Confidence, Second Edition. The Digital Photographer's Guide to Color Management. Tim Gray.

Color Management in Digital Photography – Ten Steps to True Colors in Photoshop. Brad Hinkel.

Color Management for Photographers. Hands on Techniques for Photoshop Users. Andrew Rodney.

Color Pipeline – Revolutionary Paths to Controlling Digital Color. Ted Dillard.

Fine Art Printing for Photographers, Uwe Stenimueller and Juergen Gulbins.

Practical Color Management – On Digital Photography. Eddie Tapp.

Real World Color Management, Second Edition. Industrial Strength Production Techniques. Bruce Fraser, Chris Murphy, Fred Bunting.

The Photographer's Guide to Color Management. Professional Techniques for Consistent Results. Phil Nelson.

Understanding Color Management, Abhay Sharma.

REFERENCES CONSULTED

Documents

Digital Darkroom Lighting – Critical Element of Color Management, Frans Waterlander, http://www.solux.net/ies_files/Digital%20Darkroom%20Lighting.pdf

UPDIG (Universal Photographic Digital Imaging Guidelines) Photographers Guidelines. http://www.updig.org/pdfs/updig_photographers_guidelines_v40.pdf

REFERENCES CONSULTED

Web Sites

http://www.imaging-resource.com/ARTS/MONCAL/CALIBRATE.HTM

http://vimeo.com/2953893

http://www.gballard.net/psd/srgbforwww.html#

http://www.integrated-color.com/phpBB3/

http://www.normankoren.com/makingfineprints1A.html

http://www.drycreekphoto.com/Learn/color_management.htm

http://www.lagom.nl/lcd-test/

http://www.webstir.com/color_management/PDITestImage.html

http://lists.apple.com/archives/colorsync-users/2006/Jun/msg00156.html

http://www.dpbestflow.org/color/color-management-overview

http://www.cambridgeincolour.com/tutorials/color-management1.htm

http://www.brucelindbloom.com/ A great site for color geeks who want to know how color works.

www.digitaldog.net Andrew Rodney site for color information, articles, etc.

There are a HUGE number of these web sites – I won't list them all. Search for "color management" and you will see what is available.

Tools of the Trade

Monitors

- Eizo – http://www.eizo.com/na/index.html
- LaCie – http://www.lacie.com/us/products/range.htm?id=10016
- NEC – http://www.necdisplay.com/Products/SubClass/?subclass=bc36902c-b5d6-43a8-9a5a-ff637e7ca705

Monitor Hardware Calibrators

- DataColor – http://www.datacolor.com/
- X-Rite – http://www.xritephoto.com/

Monitor Calibration Software

- Integrated Color Corporation – http://www.integrated-color.com/
- basICColor – http://www.basiccolor.de/english/index_E.htm In North America, sold through B3K Digital – http://www.b3kdigital.com/

Light Booths

- Just Normlicht – http://www.just-normlicht.de/us/productgroup.html?maingroup=3
- X-Rite – http://www.xrite.com/product_overview.aspx?id=808&lang=en&region=94

Print Lighting

- Solux – www.solux.net

PIA/GATF RHEM Indicators

- See sources below

Partial Listing of Major US Color Management Equipment Sources

- Chromix – www.chromic.com
- ColorHQ – www.colorhq.com
- ColorMall – www.colormall.com
- ColorManagement.com – www.colormanagement.com

DOCUMENT COMMENTERS and CONTRIBUTORS

Helpful comments and information used to generate this document came from the following people:

INTENDED AUDIENCE

The intended audience for this document is amateur photographers, wedding photographers, and small studio photographers who care about the color of their images – and are not happy with their current results.

NOT THE INTENDED AUDIENCE

Equally important to identifying who *is* the intended audience is identifying who *is not* the intended audience. The following groups are *not* the intended audience for this document:

- Photographers who are happy with their current color management system and the results from that system.
- "Point and shoot" photographers and others to who color management is not particularly important.
- Commercial photographers and others for whom color is critical and an important aspect of their livelihood. The exactitude to which they require color management and control is not the focus of this document. For these people there are many resources and professional color management consultants available.
- People who want to learn the theoretical aspects of color management.

DOCUMENT PURPOSE

The purpose of this document is to give the reader assistance in getting their monitor and prints to match one another, regardless of if the prints are from a professional photo lab or via an inkjet printer.

If what you see on your monitor is not a close approximation, and more importantly a *consistent* approximation – of your prints, you will forever face challenges in meeting your goals. This document will help you to achieve your goals in this area.

TOPICS WE WON'T COVER

This document is *not* intended to cover the following topics:

- Camera exposure
- Camera calibration
- Color correction – how to correct colors in your images

Although these topics are important to obtaining satisfying images, they are not central to the purpose of this document. Many references are available both in print and on the Internet on these above-listed topics.

We also won't talk about shooting with a color card – for a few reasons. First, I don't believe many photographers in the target audience do this. Second, the X-Rite *Passport* is an excellent device to do this with and X-Rite has excellent training available on the use of this tool.

This document does not intend to go into the theoretical aspects of color management. For that a list of recommended readings is included.

Table of Contents

1. Goals and Expectations

As with any task, you should start out with reasonable goals and expectations.

If your goal is to achieve a *perfect* match between your monitor and a print – well, that is simply an unrealistic and unachievable goal.

Such a perfect match is theoretically impossible because a monitor is an RGB (red-green-blue) additive (all the colors together equal *white*) emissive device, whereas photo paper is generally printed in CMYK (cyan, magenta, yellow, black – or similar colors) and is a subtractive (all the colors together equal *black*) reflective object.

Attempting to achieve as close a match as possible given these conditions requires a substantial outlay of money (thousands of dollars for the best grade photo monitor, many hundreds of dollars or more for an adjustable light booth, etc.) – which is generally beyond what is affordable for the amateur or small studio photographer.

If your goal is to have the relationship between your monitor and print be repeatable and consistent (so that you always know what to expect) and as good as possible within your constraints of time and money – that *is* achievable and *is* a realistic goal. Through this document we attempt to show you how to achieve that goal.

I understand the reader's desire is to have an extremely simple, step-by-step process that results in that desired match. In this document we have attempted to do so, but recognize that color management is an exceptionally complex process with many variables involved. As much as we try – this simply cannot be written in a simple, cookbook approach.

In some places we might go into more detail than the reader is interested in. If so, please feel free to skip over that portion. We have included that detailed information because some of our readers have requested it.

Given the challenges and variables in the system, it is amazing (to me, at least) how close a color match *can* be achieved between a monitor and print – *if* sufficient effort is put into the process.

I consider the color match I get on my equipment to be "near-perfect" – so achieving a realistic goal for a reasonable outlay of time and money *is* possible.

My *process* to achieve a match is:

1. *Use a properly calibrated monitor*

2. *Soft proof the image in Photoshop CS*
   a. After the image is modified to my liking, I soft proof it in Photoshop CS, using the ICC printer profile provided by my print lab (WHCC). This is VERY easy to do.
   b. Depending on how the soft proof compares to the non-proofed image, I may adjust the soft-proofed image.

3. *Send the image to my print lab to have it printed*
   a. Here I need to make sure the color space I am sending the image in is what the print lab accepts – generally sRGB for commercial labs, sometimes AdobeRGB for fine art labs using high-quality inkjet printers. We will discuss this all in detail below.
   b. I make sure I *DO NOT* have my lab do any color correction. If the lab does color correction (either by computer or by a human) you have *NO CHANCE* of getting your monitor image and the print to match.

4. *View the print under controlled lighting.*
   a. I view my prints under an appropriate light. I happen to use a Solux 5000K light, but there are other options.

We will discuss all of the above in significantly greater detail.

For those of you printing to home inkjet printers or displaying images on the Internet the process is slightly different (and discussed in more detail later) but is similar in concept to that presented above.

Does this mean you need to do it the way I do? No Way! This document is all about helping *you* to get you the level *you* want, in a step-by step manner.

2. Experiment…

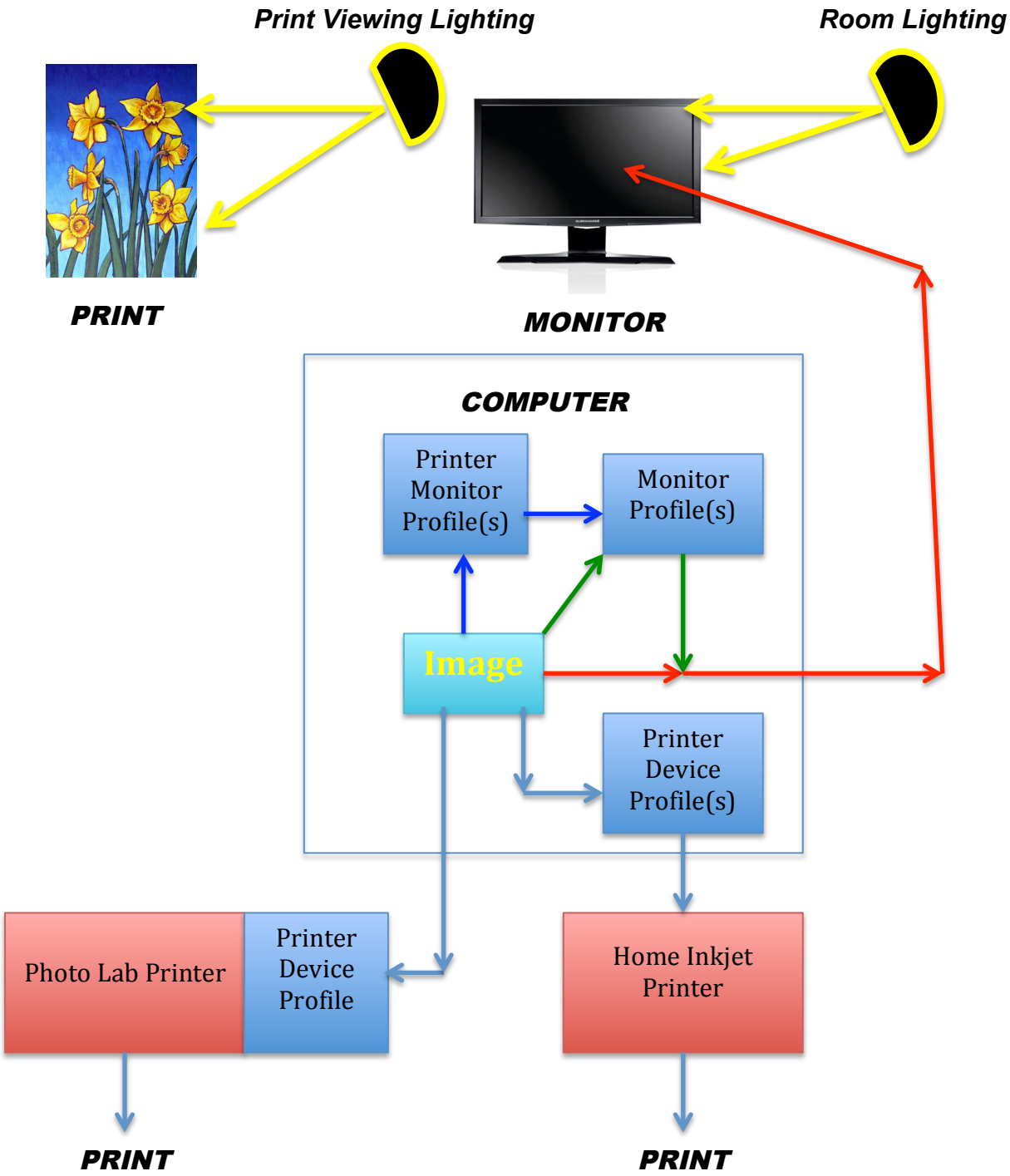
I am NOT an expert in color management. This document is a synthesis of what I have read and what I have learned through my experiences.

Having read dozens of books, papers and web sites written by the various color management experts I have learned there are many aspects of color management that even the experts don't agree on. There certainly are some significant points of color management that need to be adhered to. But details such as what are the best color temperature, luminance and other settings for a properly calibrated monitor – well, that is a subject of much disagreement.

In this document I have tried my best to present all sides of topics where such disagreement exists, and I will also try to present my opinion where I think it may be worthwhile. But please do not take my (or the expert's) word for it. Experiment, try out various options – see what works best for you. After all – your hardware, software, eyes and expectations are different than those of anyone else's – so you should not expect the recommendations of others always to work the best for you.

3. System Overview

Below is an overview of how color management works from a photographer' s perspective. It is not technically correct and certainly does not include all the details, but it may help the photographer visualize the overall color management system.



If your eyes are glazing over here – feel free to skip this section.

This sketch starts with the **Image** of the photograph in the **Computer**.

Initially the **Image** is sent directly (via the not-shown video card) to the **Monitor** (red lines).

One of the tasks we will be doing is to calibrate the monitor and create a **Monitor Profile** so that the image on the monitor is accurate. Once this is done, the signal from the **Image** will travel in the computer to the **Monitor Profile** (green lines) and then on to the **Monitor**.

Via various means we can obtain ICC printer profiles, in this sketch identified as **Printer Monitor Profiles** (ideally one for each type of printer that is used). These printer profiles help ensure that the image displayed on the monitor represents as closely as possible the image the printer delivers. These profiles can be selected and turned on and off in Photoshop CS in a process referred to as "soft proofing." When soft proofing is used the signal in the computer goes from the **Image** to the **Printer Monitor Profile** (blue lines), then to the **Monitor Profile**, then on to the **Monitor** for display.

A signal from the **Image** in the computer can be sent out of the computer to be printed. In one case this signal can be sent to a **Photo Lab Printer**, which initially interprets this signal through their **Printer Device Profile**. The end result of this is a **Print** that is delivered to you.

Alternately the **Image** can be sent to a **Home Inkjet Printer** that you own. In this case the **Printer Device Profile** for that inkjet printer resides in your **Computer**.

Once you receive the **Print** (top left of sketch) you evaluate it while looking at it under some form of **Print Viewing Lighting**. You may compare this image to that on the **Monitor**, which in addition to its output light is illuminated by the ambient **Room Lighting**.

In addition to this (and not shown) your eyes are affected by ambient room lighting as you are viewing either the **Print** or the **Monitor**.

Don't worry if this all does not make sense to you now. You may want to refer back to this sketch as you proceed through this document. It will help you to better understand what is happening from an overall perspective.

I find that having such a visual understanding of the overall process helps one grasp the details better.

Note: For those really interested in the details, the printer input and output profiles are stored in Photoshop, the monitor profiles are stored in the computer operating system.

4. Vision Test

How good is you color matching ability? If your ability to match colors is very poor, *you* may be the problem, not the monitor-to-print match.

Photo labs administer sophisticated color matching tests to their prospective lab technicians before they begin training, so they can weed out those with inadequate visual ability. Unfortunately you are only one person – and do not have the luxury of weeding out the poor performers.

A simple color-matching test is called the "Munsell Hue Test." A link to that test is: http://www.xrite.com/custom_page.aspx?PageID=77&Lang=en If the link is broken Google the test name.

A weakness of this simple test is that it is not timed. I got a 100% on the test, but I took my time doing it. I bet if there were a time limit placed on the test my results would not be so good.

5. Color Temperature of Light

A few words about light and color temperature are required here to allow the reader to best follow this document.

In simple terms you can think of color temperature as being "how hot the light filament is." The color temperature of a light has a significant impact on how an image looks in a photograph. We all know that, if unadjusted, an image taken outdoors in the shade will look blue; one taken at night indoors under incandescent tungsten room lighting will look yellow. This is an effect of the color temperature of the light source, and this basic concept is an important one for photographers to understand.

Basic information for photographers:

- Color temperatures are reported in *degrees Kelvin* (similar to degrees Fahrenheit or degrees Celsius). This is generally abbreviated simply using the letter *K.*
- Higher color temperatures are called "cool" and tend to be more blue
- Lower color temperatures are called "warm" and tend to be more yellow (sounds backwards, but that is the way it is!)

For your reference, below are the color temperatures of various light sources:

Artificial Light

Light Source	***Color Temperature – degrees K***
Match Flame	1700
Candle Flame	1850
High Pressure Sodium Light	2000
40-Watt Incandescent Tungsten Filament Bulb	2650
75-Watt Incandescent Tungsten Filament Bulb	2820
100-Watt Incandescent Tungsten Filament Bulb	2865
200-Watt Incandescent Tungsten Filament Bulb	2960
500-Watt Incandescent Tungsten Filament Bulb	2980
1000-Watt Incandescent Tungsten Filament Bulb	2990
100-Watt Tungsten Halogen	3000
3200-Degree Kelvin Tungsten Lamp	3200
"C.P."(Color Photography) Studio Tungsten Lamp	3350
Photo Flood or Reflector Flood Lamp	3400
Bright White Deluxe Mercury Lamp	4000
Daylight Blue Photo Flood Lamp	4800
White Flame Carbon Arc Lamp	5000
Xenon Arc Lamp	6420

Daylight

Light Source	***Color Temp – degrees K***
Horizon Daylight: 2300K	2300
Sunrise or Sunset	2000
One Hour After Sunrise	3500
Early Morning, Late Afternoon	4300
D50 Noon Sky Daylight, Equivalent of daylight	5000
Average Summer Sunlight at Noon (Washington DC)	5400
Average daylight, Noon daylight, Daylight	5500
Direct Mid-summer Sunlight	5800
Overcast Sky	6000
D65 Average North Sky Daylight, Daylight, Standard Daylight	6500
Average Summer Sunlight (plus blue skylight)	6500
Light Summer Shade	7100
D75 North Sky Daylight	7500
Average Summer Shade	8000
Summer Skylight (blue sky)	9500 to 30,000

Fluorescent light sources are complex and cannot be simply converted to or referred to using this degree K system. However, a general approximation is:

- *Deluxe Warm White Fluorescent:* 2950K
- *Cool White Fluorescent:* 3400K
- *Daylight Fluorescent:* 6300K

Although photographic images record these differences in lighting color temperature, human vision is relatively insensitive to them because human vision has the ability to instantaneously adapt to images under different lighting. If you look at the face of your best friend under various lighting conditions it all looks the same. If only cameras had this ability!

For those interested, additional information on color temperature is available at many web sites, including http://en.wikipedia.org/wiki/Color_temperature

6. Testing Your System – How Do You Know What Is an Acceptable Match?

We need to know if we are achieving our goal, or at least moving in the right direction or not. For this we need some sort of metric.

The metric I use is a test image – there are many available on the Internet. The one I use was created by PhotoDisc, Inc. and is shown below. I have found it to be more sensitive to showing subtle colors than others. I print it out as a 12 inch by 18 inch image.

This image is available at various web sites, including:
http://www.webstir.com/color_management/PDITestImage.html

There are many other test images available – feel free to use whatever you want.

Noted below is how I use this test image. Realize I print with a professional photo lab. If you print to your home inkjet printer the process is more complicated – because the printer is another device for which you need to manage the calibration (more on this later).

a. I have my lab print the image above. I make sure I send it to them as an sRGB image (this is what most photo labs require) and make sure I DO NOT allow the lab to do any color correction to the print. I have them print this as a 12 by 18 inch image (this is about $6.30 at WHCC – prices vary depending on the lab).

b. I compare this print to what I have on my monitor.
    a. I view the print under my standard print lighting, with controlled room illumination (more on this later)
    b. I have obtained from WHCC their ICC profiles for their printers. In Photoshop CS. I "soft proof" the image using the appropriate ICC profile for the printer used by WHCC.

I particularly pay attention to the skin tones at the bottom of the image. I find they often are the most difficult to deal with (particularly the lightest colored Caucasian) partially because of the particular blend of light tones, partially because skin tones are "memory" colors that we all are very familiar with.

By careful comparison of the test print to the image on the monitor will be able to find any discrepancies. It is up to you to determine what "good enough for my purpose" is.

We will describe this entire process in more detail later.

7. The Basics – Explained in a Video

X-Rite is a leader in color management. Fortunately for us they have posted numerous presentations on the subject of color management.

A good place to start is by viewing their excellent presentation "Beyond Monitor Calibration – Getting Prints that Match your Monitor Display."

This presentation can be found at the X-Rite photo webinar archive
http://www.xritephoto.com/ph_learning.aspx?action=webinarsarchive

If by viewing this presentation you find you can achieve an acceptable print to monitor match you are done – that is it! You are done and do not need to proceed any farther in this document.

If you find this does not meet your needs we will delve into the following two areas in more detail:

- Additional aspects of getting a print to monitor match
- Hardware and software suggestions

Another video on the topic is *Screen to Print Match* by Will Crocket ($50 at SmartShooter.com). Once I have a chance to view this I will include a report on it.

8. Priorities

If you have not achieved a match between your monitor and prints that is acceptable too you, it is helpful to know what parts of the color management process or system are more significant than others. Working on the various aspects randomly, or working on a subtle detail of color management before you have addressed one of the more basic issues would be a waste of your time.

How do you know what issues are more significant? I have attempted to prioritize the various aspects of color management for you below.

a. Make sure your monitor and computer video card are working properly
b. Make sure you are using a proper color space for your method of printing
c. Use a monitor of acceptable quality
d. Hardware calibrate your monitor
e. Tweak the monitor profile
f. Use a printer or print lab of acceptable quality
g. View the print under appropriate lighting
h. Soft proof the image in Photoshop CS
i. Ensure your room lighting is appropriate

One can argue with the exact order of the elements listed above (and realize that a *combination* of elements can play an important role) BUT working on a detail such as room lighting, when the monitor is not working properly, will be an exercise in futility.

9. Make Sure Your Monitor and Computer Video System are Operating Properly

Generally this is not an issue, but if it is it will prevent you from ever getting close to the results you desire. I worked many hours with one person via e-mail trying to calibrate their monitor. We were getting nowhere fast. What I did not realize (because I had not seen the monitor in person) is that their colors were not a little off – they were *way* off. This was because the video card in their computer was failing. No amount of calibration of the system was going to solve that problem.

How do you know if your monitor or video card is failing? Largely by your experience in viewing the images presented on the monitor. If the colors you see on your monitor literally change in front of your eyes or flicker, more than likely your hardware is failing. If from day to day, or from one turn-on to another your images look different, more than likely you have a hardware problem.

How can you determine if it is the video card in your computer or your monitor that is failing? Connect your monitor to different computer, or use a monitor from a different computer on your computer. Through this process of elimination you should be able to tell which component is going bad.

An interesting monitor test that may help in this process be found at:

http://www.lagom.nl/lcd-test/

Some video card vendors provide test software on their web site to test their card. If you are comfortable with computers you should be able to find this and run the test yourself. Otherwise ask your friendly computer geek for help.

CRT monitors are getting pretty old in the tooth now, and CRT phosphors do age over time. If you are still using a CRT – and you find it impossible to hardware calibrate the CRT – it may be time for a new monitor!

Windows Vista has some very peculiar aspects that can, under certain conditions, cause the monitor calibration profile to disappear each time Windows is started. If you thing you are experiencing this issue see the information on this topic in the last chapter in this document.

10. Use a Monitor of Reasonable Quality

a. General Information

If you are happy with your monitor, or simply don't want to invest the money in a new one at this time – that is fine. You may want to skip over this chapter for now.

If you cannot achieve a match that is acceptable to you, there is a chance that your monitor is simply not up to the task.

The monitor is the heart of the color management system. If your monitor is of low quality you may never be able to achieve acceptable color management.

If you are using a $99 dollar Best Buy monitor you may find yourself not too successful in getting a good match. Not that you need to spend $3000 on a top of the line Eizo monitor, but cheep is cheep.

Selecting a good quality monitor for photography at a moderate price can be very challenging, in my opinion partly because it is difficult to find unbiased, helpful comparative information on the subject.

It is my perspective that if you are interested in color management and want the image displayed on your monitor to come somewhat close to matching your prints, the monitor on a laptop is NOT adequate. Others may have different experiences, but that is my perspective. If you have a laptop and want good color management – I would suggest connecting the laptop to a good quality external monitor.

b. Monitor Recommendations

The monitor is the heart of the color management system. If you are considering a new monitor I suggest you carefully and thoroughly consider your selection. More than likely you will keep your monitor for many years – and you want to make sure it meets your needs.

There are many web sites dedicated to monitors; unfortunately few of them address the specific needs of photographers. Some of the photography web sites have discussions of monitors. Joe says his Vaxo 123 monitor yields "perfect" colors and only costs $129. Mary claims the same thing for her Mplax monitor. Your eyes and your criteria most likely are different than Joe's or Mary's – do you really want to trust their judgment on such an important topic?

There are a lot of reviews of monitors on the Internet. Unfortunately most of them are oriented to gamers and others with very different requirements than photographers.

A few Internet sites that discuss monitors for the photographer include:

- http://www.flatpanelshd.com/focus.php?subaction=showfull&id=1229341472 Scroll down to "Monitor recommendations – Graphics monitors"
- http://mansurovs.com/best-monitor-for-photography
- http://macperformanceguide.com/RecommendedDisplays.html
- www.shootsmarter.com (You will need to sign up to be a free member). Search for "Best and Budget Recommended Monitors List."
- http://www.prad.de/en/index.html

AnandTech has an interesting article at: http://www.anandtech.com/show/2922/3

Shutterbug Magazine tends to have more, and more in-depth reviews on monitors than the other photography magazines. See http://www.shutterbug.com/equipmentreviews/software_computers/

If you know of other worthwhile sites that discuss and make recommendations on photography monitors please let me know and I will incorporate them.

One of the web sites states "brands don't matter." This is a very broad statement, and one that I don't totally agree with. My perspective is that you generally get what you pay for, and that the best brands typically (but certainly not always) deliver the best quality.

If you go into a top photo-retouching studio in New Your, you will find Eizo CG monitors. They are widely recognized as the "Rolls Royce" of monitors for photography. The only problem with Eizo monitors is that most of us can't afford them. My perspective of the hierarchy for photography monitors is below.

- Eizo CG. Generally regarded as the best, with a price to go along with it.
  - The Eizo CG243W, at $2400, is widely used in many of the top studios. The Eizo CG245W, with a built-in calibrator and running $2900, appears to be even better.

- LaCie and NEC are widely considered to be the "Lexus and Infinity" of photography monitors
  - NEC has a very wide range of monitors. Their best monitors for photography are in the MultiSync series, specifically the PA, 90, and SpectraView II). A currently popular NEC monitor for photography is the PA241W, at $1100 without a calibrator, $1300 with a calibrator.
  - The LaCie 324 monitor is currently a popular monitor for photography, and goes for about $850. Various places on the Internet have noted that LaCie monitors are re-badged NECs. I have no way to confirm or refute that.

The real problem comes in for those of us looking for a more affordable monitor than those listed above – a Ford or Chevy monitor that still meets the needs of photographers. I have seen various Dells, HPs, Samsung, lower-end NECs, Apple and other monitors listed in this group. Some would place Apple monitors above the others. If you feel that way – that's fine by me.

One of the problems is that some of these companies (Dell, most notably) may change LCD panels (the part of the LCD that your eyes see) in a particular LCD model during the life of that model. So you may read a glowing report on a particular monitor, only to find out the version you purchased is substantially different that the one the reviewer tested. This has become so common with Dell that it has its own name – the "Dell panel lottery."

Also – it is widely known that monitors in this range can see a wide unit-to-unit variation. Joe's may be close to perfect; Mary's may be a dog.

Beware of postings that are older than one or two years, as this technology changes rapidly. If a posting discusses CRTs skip it – the posting is VERY old. How many CRT displays can you find currently at your local computer store? Generally the number is ZERO.

The *type of panel* (the part of the monitor display that you look at) is important in the selection process. A good discussion of the various panel types can be found at http://www.tftcentral.co.uk/articles/panel_technologies.htm

http://en.wikipedia.org/wiki/TFT_LCD

http://www.pchardwarehelp.com/guides/s-ips-lcd-list.php

I personally believe monitors using IPS panels are superior for photographic work. To see which monitors use IPS panels go to:
http://www.flatpanelshd.com/panels.php and type *IPS* into the search panel.

There are sub-types of IPS panels, some of which are less attractive to photographers than others. The links above have some discussions of this topic.

Are two different monitors, both using the same IPS panel the same? Absolutely NOT. In addition to the panel, the monitor manufacturer includes a lot of their custom electronics. So for two monitors both using the same IPS display, where one costs $500 and the other costs $1800 – you can pretty much believe the image quality will be different. Is the difference worth it to you? That is a different question – and one that I cannot answer for you.

There are some criteria that you can use in selecting a monitor for photography work. Following are some thoughts in this area

- The bit depth of the LCD monitor is important to the photographer. Monitors with a smaller bit depth tend to show banding – those with a larger bit depth will show smoother graduations from light to dark.
    - Some of the less expensive monitors use 6-bit electronics, which has been shown to produce substantially poorer images than the traditional 8-bit electronics. For an interesting article on this subject see http://www.maximumpc.com/article/6_bit_vs_8_bit_lcds
    - Better monitors have 10 and even 14 bit depths.

- As noted above, I believe in monitors that use IPS panels. IPS panels generally produce truer colors than do other panel types, and IPS panels offer better color over a wider range of viewing angles than do other panel types. However there are some newer variants of IPS panels tat do not appear to be as good as others.

- The best monitors use an internal "look-up table" (LUT) to adjust and calibrate colors, rather than making adjustments via the computer video system. This results in better colors and certainly less banding. A good monitor has a 10-bit LUT, better still are the few monitors that use 12 bit or even 14-bit LUTs. This data may be difficult to find – you will need to search through the specifications on the monitor vendor's web site.

- An included calibrator, where the calibration software was designed for that specific monitor by the monitor vendor, may provide better accuracy that that of a generic monitor calibrator. If you are buying a monitor that provides this option and you do not own a monitor calibrator, it would be a good idea to purchase the monitor with its calibrator.

Some other things that should be considered in selecting a monitor:

Glossy or non-glare screen– an interesting article by Eizo can be found at http://www.eizo.com/global/support/wp/pdf/wp_07-001.pdf Personally I strongly prefer non-glare, as the glare from even subtle room lighting bothers me.

Wide gamut versus normal gamut. This is a rather complex topic when it comes to monitors for photography – so I will leave the research on this topic up to the reader. One article of interest is published by Eizo and can be found at: http://www.eizo.com/global/support/wp/pdf/wp_08-002.pdf

CCFL (cold-cathode fluorescent lighting) versus LED backlighting. With cold-cathode fluorescent lighting (CCFL), one or more tubes span the width of the panel, providing backlighting for the entire surface. This can result in uneven light distribution and therefore non-uniform color reproduction. LED panels have a grid of LEDs at the rear of the panel, so there is a more uniform distribution of light across the entire surface. What's more, the LEDs turn on and off as needed to illuminate the corresponding pixels on the screen, thereby allowing for true black – the complete absence of light – something LCDs have never been capable of with their always-on CCFL backlights. You can find monitors that use LEDs for backlighting by using the Flatpanels search tool.

A couple of really nice papers that describes features found on more advanced monitors designed for photographic work can be found at http://www.eizo.com/global/support/wp/pdf/wp_04-006A.pdf

http://www.eizo.com/global/support/wp/pdf/wp_03-003.pdf

I really am not trying to push Eizo monitors. I don't have one (would if I could afford it!). It is just that Eizo is the industry leader, and as such has a lot of technical knowledge in this field and do a good job trying to present it.

c. iMac

In reference to systems that have monitors essentially built-in to the system, carefully consider what you are getting before you purchase. One example of this is the iMac system. I know some people who find the iMac monitor works fine for them, others who cannot achieve acceptable results and end up purchasing an external monitor for the system.

11. Make Sure You are Using the Right Color Space

You don't really need to know what color spaces are all about; you just need to make sure you are using the correct one for your purpose.

Images printed, where the images are supposed to be in sRGB but are actually in AdobeRGB, will appear faded and washed-out. So if you see this faded, washed-out problem it could be a color space issue.

The X-Rite video mentioned at earlier does a good job discussing color spaces and how to convert them in Photoshop. If you have forgotten it, you may want to review the video again, it is "Beyond Monitor Calibration – Getting Prints that Match your Monitor Display."

This presentation can be found at the X-Rite photo webinar archive
http://www.xritephoto.com/ph_learning.aspx?action=webinarsarchive

For Viewing on the Web

For display on the Internet, you should make sure your images are in sRGB. Different browsers react differently to images that are not in and properly tagged as sRGB.

To get a better idea of what happens see:
http://www.gballard.net/psd/srgbforwww.html#

When Sending to a Lab Printer

When you have a lab do your printing they almost always require prints to be in the sRGB color space.

If your image is in the AdobeRGB color space you will need to *convert* it to the sRGB color space. If you simply *assign* it to sRGB it still actually will still be in AdobeRGB, but will have a (incorrect) tag of sRGB. This will result in the before-noted washed-out prints.

If none of this makes any sense to you, or you do not remember how to convert an image to sRGB watch the X-Rite video again.

For Printing to an Inkjet Printer

AdobeRGB is the generally used color space for inkjet prints.

12. Use a Good Quality Monitor Hardware Calibrator

a. General Information

Calibration of a monitor is critical to getting one's monitor to match prints. Visual calibration methods have been shown time and again to *not* be up to the task.

This means we need to use a *hardware calibrator* to accomplish the task of monitor calibration. There are two general categories of hardware calibrators:

- Those capable of calibrating only monitors (and sometimes LCD projectors)
- Those capable of calibrating *both* monitors *and* printers

b. Hardware Calibrator Recommendations

If you don't own a hardware calibrator, and can't borrow one from a friend, following is what I recommend. If you already have one you may want to just skip over this chapter for now.

For standard gamut monitors *(if you don't know what gamut your monitor is, most likely you have a standard gamut monitor)*

The EyeOne *Display2* (about $200) is a common hardware calibrator. Don't buy the less-expensive LT version – the hardware calibrator is the same but the software does not allow for the adjustments required for a photographer. The LaCie *Blue Eye Pro* (about $380) is the same hardware rebranded – abet using different software.

The DataColor *Spyder3 ELITE* (about $190) is another common hardware calibrator. If you get the Spyder3, get the *ELITE*. The hardware for all Spyder3's is the same, but only the ELITE has software that allows all the adjustments the photographer wants. The Spyder3 can also calibrate LCD projectors.

The X-Rite / Monaco *OPTIX DTP94B* is excellent and has somewhat of a cult following but is only available in limited quantities from Integrated Color and requires separate (at an additional cost) software.

The *Spyder2* is pretty old technology, and has been shown to not give the best calibration profiles. If you are happy with it fine, otherwise you might want to upgrade to one on the newer devices.

Most reviewers consider the Pantone *Huey* to a lower-end device and not suitable for critical color work.

For wide gamut monitors

The *Spyder3 ELITE* (about $190) is generally the recommendation. Some people using the EyeOne Display2 on wide gamut monitors have reported success, while others have not been satisfied – with no apparent rhyme or reason. The Display2 is an older calibrator, and there is a chance that it gel color filters were not optimized for wide-gamut monitors.

If you get the Spyder3, get the *ELITE*. The hardware for all Spyder3's is the same, but only the ELITE has software that allows all the adjustments the photographer wants.

If You Do In-House Printing

If you also have a home inkjet printer and want to calibrate both your monitor *and printer,* the following are recommended:

- DataColor *Spyder3 StudioSR* (about $430)
- X-Rite *ColorMunki Photo* (about $450)

Keith Cooper reviews various calibrators at http://www.northlight-images.co.uk/reviews.html#Monitor_profiling

Another source for reviews of monitor calibrators can be found at www.photographyblog.com

c. Do Hardware Calibrators Wear Out or Go Out of Calibration?

Calibrators contain gel-type color filters that can change over time, especially if subject to direct sunlight or high temperatures.

How do you know if your calibrator is in calibration? Basically, you don't – unless you own very sophisticated equipment or send it to a calibration lab.

So I try to keep my calibrators away from sunlight and high temperatures when stored.

d. Special Calibration Software

Hardware calibrators come with software that allows them to run on most computers. If you are really into monitor calibration you may want to purchase special aftermarket software for your monitor calibration.

The two primary sources of such software are:

- *ColorEyes Display Pro* from Integrated Color, http://www.integrated-color.com/ (about $175)

- *basICColor Display 4* from basICColor (http://www.basiccolor.de/english/index_E.htm). In North America this can be purchased from http://www.b3kdigital.com/ This product can be somewhat challenging to purchase and install, but works well once installed.

These software products do essentially the same thing as the software provided with your hardware calibrator, but produce better results in creating profiles. These differences are more noticeable on higher-end monitors that provide subtle highlight and shadow details. People doing a lot of black and white print work often find these software products useful as they produce very linear, neutral monitor profiles on the better quality monitors.

Both of these products began from a common lineage, but they diverted several years ago. There are advantages and disadvantages to each (certainly including licensing for multiple computers). If you are considering either of these I would suggest you try the free download of each. This helped convinced me to decide which one to use.

13. Chose Your Calibration Settings

a. General Information

The most significant settings that must be decided on by the user for monitor hardware calibration are:

- *White Point*
- *Gamma*
- *Luminosity*

Many experts talk as if there were one "right" setting for at least the white point and gamma settings. The only problem I have with the expert's suggestions is that they vary all over the map. If you find one group of settings that work for you – fine, leave them as-is. Otherwise – experiment!

For *viewing images that you will post on the web,* I suggest you use the following:

- *White Point:* 6500K (or D65)
- *Gamma:* 2.2
- *Luminosity:* 120 CD/m^2 (or so)

These are pretty common and agreed to calibration settings for web viewing.

The most commonly noted *calibration settings for matching prints are:*

- *White Point:* 6500K (or D65)
- *Gamma:* 2.2
- *Luminosity:* 100 to 110 CD/m^2

First this means that if you really care about matching you will be using two different monitor settings and profiles: one for images posted to the web, one for images to be printed. Maybe even three if you use different settings for lab prints and inkjet prints.

Second, whereas I think the calibration settings noted above for use with prints are an excellent *starting point,* I tried them and they did not provide the *best* results *on my system.* After reading the excellent paper by Frans Waterlander (http://www.solux.net/ies_files/Digital%20Darkroom%20Lighting.pdf) I ended up using the following settings:

- *White Point:* 4750K
- *Gamma:* L* (requires the use of special calibration software)
- *Luminosity:* 130 CD/m^2

These settings give me *excellent* monitor to print match – with *my* monitor and *my* lighting. I know many of the experts would say these are very bad settings. I guess they have not worked with my system! I have worked with a number of people where we have arrived at very different settings.

The point is these adjustments are there for them to be adjusted, if and as required.

I have read and seen a number of reports where people have *sworn* that a white point of 6500K (or D65) *must* be selected. Some of the articles have gone into deep theory as to why this is true. Others have noted they have experience calibrating numerous monitors and have always found this to be true. I absolutely believe them – for their setups! For my setup I got different results. For yours – you might see something different still.

IF the settings you have used don't work for you – *experiment* with them. They won't harm your computer, and you can always go back to whatever settings you want.

Such experimentation is easiest to do if you have some idea of what the three variables noted above are and what changing them does. So we will attempt to give you an explanation of that below.

b. White Point

White point is the color temperature that the monitor is calibrated for.

This arguably the most important of the variables available to you. What is the correct white point to use*?* There is no shortage of opinions on this topic.

The following may help guide you.

- ***Basics:*** Higher white point numbers result in bluer (cooler) and brighter images on the monitor. Lower numbers result in yellower (warmer) and darker images on the monitor.

- For ***images that will be displayed on the Internet,*** use D65 (depending on the software, this may be called 6500K). I don't want to get into the differences between these two here (because they are somewhat complex and not particularly significant to our task at hand) but if you are given the choice between D50 or 5000K and D65 or 6500K – select the "D" version.

- For ***images that will be printed***, I calibrated my monitor to the white point of my viewing lamp, which for me is about 4750K (Solux 5000K light with lamp filter). This works for me and works for others I know of (again see Frans Waterlander and his excellent work on the subject). I know there are MANY who argue this should be 6500K (or D65) for various reasons. To me it is pretty simple. I get a better match to test prints viewed under my 5000K Solux lamp when my monitor is calibrated to 4750K than when it is calibrated to 6500K.

- LCD monitors have a native white point somewhere near 6500K. With some monitors, adjusting them to D50 or 5000K can result in a loss of color accuracy (this does not happen with my monitor, at least to a degree that it has bothered me). So experiment…

c. Native White Point

Native white point is the color temperature, or white point, that the LCD panel natively produces. The native white point for many LCD's is about, but not precisely 6500K.

Some argue for creating monitor profiles using native color temperature and native gamma, and let your eyes adjust to the difference between the monitor and the print or proof. They say that doing so will ensure you get the widest dynamic range the monitor can produce. They also say it will minimize artifacts, banding and posterization, which become more noticeable as you force a monitor (especially a standard, 8-bit monitor) farther from its native white point and gamma.

This method did not work for me, as the color difference between my monitor and my prints with this setup was something my eye did not get used to, unlike what many had said would happen.

I found that for me, minor banding was much less of an issue than failure to match print output. You may find different for yourself.

d. Gamma

Gamma is sometimes referred to as "Tonal Response Curve" – TRC. For those with an engineering background, gamma is a linearity adjustment.

The gamma correction can vary from 1.0 to 3.0, or be based on L* gamma. Adjust these settings based on viewing conditions. If comparing the monitor with proofs in a viewing booth, adjust to the best match.

A smaller gamma number decreases the contrast and lightens the image; a higher gamma number increases the contrast and darkens the image. If the gamma of a monitor is too low, images will appear very flat, whereas a high gamma setting may cause a harsh transition from dark to light. Start with 2.2, as this generally results in the smoothest display of gradients with a minimum of banding and posterization of the displayed image. Between 1.8 and 2.4 is typically an acceptable range.

Yes, there are more choices for gamma than 1.8 and 2.2. Some calibration software allows you to choose a custom gamma. Other software allows you to edit the gamma curve, and one product, Integrated Color's ColorEyes Display, has "L* gamma," which creates separate tonal curves for the shadow areas, midtones and highlights. It reportedly provides smoother transitions, and therefore more accurate color reproduction. The topic of L* is beyond the scope of what I want to cover here, but if you are really interested start here: http://lists.apple.com/archives/colorsync-users/2006/Jun/msg00156.html

Some have written that gamma changes things in Photoshop Windows, but has no impact on Photoshop Mac http://www.siggraph.org/education/materials/HyperGraph/color/gamma_correction/software/photoshop.html. They state that Photoshop Mac automatically corrects the gamma of the image as it is displayed on the monitor. If you are really interested you can test for the validity of this statement.

e. Luminance

This appears to be perhaps the most common problem reported – prints are too dark compared to the monitor. And what causes this? A monitor that is set too bright!

The brighter your monitor is adjusted to, the darker your prints will be. Makes sense – doesn't it! If you want to understand this a little more read David Brooks excellent article: http://www.shutterbug.com/techniques/digital_darkroom/0809prints/

Monitor vendors like their monitors to be bright – REAL bright. It works well in bright office environments, and looks nice on the store shelf. Unfortunately it plays havoc with monitor to print matching.

Below are my suggested monitor luminance settings:

- For images that will be viewed on the ***internet***: 120 CD/m^2 (for a start, adjust as desired)

- For images that will be made into ***prints***: start at 100 CD/m^2 – then adjust up or down to get a proper dark/light match to your monitor (remember, a darker monitor will drive toward lighter prints).

f. iMac

For those with an iMac, it is widely reported that even with the display turned down to its *minimum* brightness setting it is still two bright for photo matching. If you find this to be the case for you there are various options:

- Calibrate the system using a hardware calibrator and with the monitor set to minimum brightness. Then further dim the monitor using the freeware *Shades* - http://www.charcoaldesign.co.uk/shades
    - Realize that the use of Shades after monitor calibration *will* change the colors on the display. Some have commented this has not been a problem for them, even in use as a commercial photographer. Since this software is free, try it and find out for yourself.

- Use third-party calibration software that can deal with this issue. The most widely known calibration software is ColorEyes Display Pro. They have a free ten day trial on their website that you might want to try. They also have a lot of information available on this topic on their forum (which is free but requires registering in for). ColorEyes Display Pro works with most hardware calibrators, and is available for $175 in a software-only version, or packaged with various hardware calibrators for an additional fee. For an explanation of this see: http://blog.bretedge.com/2010/01/12/the-imac-calibration-conundrum/

- Lastly, as noted above you can purchase a separate monitor.

14. How to Select a Professional Photo Lab

Pick a good photo lab (or two) to work with, and stay with them unless you have a VERY good reason to leave. Jumping photo labs to find that "one perfect lab" is like changing spouses to find your "ideal sole mate." Zsa Zsa Gabor did not have too much luck at this (she was married nine times) – you won't either.

If you don't presently have a good lab, a few suggestions on finding one:

- Assuming you use Photoshop CS and are interested in the matching benefits that soft proofing could give you (more on this later) – pick a lab that provides *ICC printer profiles* for the various printers they use. Sometimes their ICC printer profiles are available on their web site. In some cases, you will need to ask for them. Some of the more popular national labs that provide ICC printer profiles include:

    - WHCC (White House Custom Color – the lab I use)
    - Collages Color
    - Mpix / Mpix Pro / Millers
    - Pro DPI
    - Myphotopipe
    - And many, many more

- Another thing that differentiates labs is the type of paper they print on, and the type of machine they use to print with. Some labs use Kodak *Supra Endura VC* paper (Kodak's best paper), some use the older Kodak *Endura,* some use Kodak *Royal* paper (a lower-level Kodak paper). Some labs use Fuji *Crystal Archive* paper, of which there are a multitude of types. There are a variety of machines that can print to the various types of paper. In addition to this, each lab has its own color calibration procedure. ***The point is*** – if you expect prints from any one company to match those from any other company *GOOD LUCK!*

A VERY IMPORTANT POINT! Don't have the lab do color corrections for you. If the photo lab (either automatically or via a computer color technician) color corrects your images they will be changing randomly from what you submitted. In that case there will be no consistency and you will *never* be able to develop a color workflow that meets the needs of any caring photographer.

15. What if You Print to an Inkjet Printer?

For those who do their own in-house inkjet printing, the following book is HIGHLY recommended: *Fine Art Printing for Photographers,* Uwe Steinmueller and Juergen Gulbins (about $30 from Amazon.com).

Printer quality

If you are printing to an inkjet printer you own, make sure the printer is a good "photo quality" printer. You will not be able to achieve acceptable results using a $59.99 Wal-Mart printer.

If you already own a printer and are happy with what you have – fine, use that. If you are interested in purchasing a new printer, one of the places you can find good printer reviews at is http://www.photo-i.co.uk/Reviews/printers_page.htm

Uwe's book has excellent suggestions on how to select an inkjet printer.

Paper quality

If you want good prints, use good paper – not the discount brands. The best thing I have seen on inkjet paper selection appears in *Fine Art Printing for Photographers* by Uwe Steinmueller, Appendix A – Papers for Fine Art Printing.

Ink quality

Ink quality is equally important. To use aftermarket ink sets to print a Word document – fine. Print a fine art photo using aftermarket inks – NEVER!

16. What is "Soft Proofing?"

Soft proofing is a task, generally accomplished in Photoshop CS, that allows the photographer to view the image on their monitor in a way that comes as close as possible to looking like the final print. The value of this is seeing *approximately* what the print will look like *before* you print. For those who use professional labs to do their printing, this saves time and money – same goes for those who do their own in-house printing on inkjet printers.

This happens through the use of ICC printer profiles, which allow Photoshop to mimic what the printer will produce.

ICC profiles are used with Photoshop CS (not with Photoshop Elements or Lightroom 3 – hopefully Lightroom 4 will have them). Apparently profiles can be used with Apple Aperture (http://www.oreillynet.com/digitalmedia/blog/2007/02/dont_forget_about_onscreen_pro.html) but I cannot vouch for the accuracy of their system.

Rather than trying to describe the process of soft proofing, Ian Lyons has done an excellent job of it in his article *Adobe Photoshop – Soft Proof Preview, A Technique for Fine Tuning RGB Images for Printing.* This fine work can be found at http://homepage.mac.com/ilyons/pdf/ps6_sp.pdf

How do you use profiles? See the Ian Lyon's article above. Some additional hints follow:

In Photoshop CS:

a. Increase the size of the image on the monitor so that it approximates that of the print.
b. Look at the image on the monitor in "Full Screen Mode." This will show the image with a solid black background – removing any distractions from the monitor. Full Screen Mode can be accessed by going to *View/Screen/Full Screen Mode.*

I can never remember all the steps required to properly setup Photoshop to allow me to efficiently make custom soft proofs. This information might appear somewhere on the Internet, but I just wrote up instructions for myself for my Mac. I have attached it below. Perhaps someone will revise it for Windows users.

To Install Custom Soft Proof Profiles.d

17. Where Do The ICC Profiles Go?

Where do you put the profiles?

- *Mac OS X:* System/Library/ColorSync/Profiles

- *Windows XP, Vista & Windows7 32 bit:* c:/windows/system32/spool/drivers/color

- Windows7, 64 bit: c:/windows/SysWOW64/spool/drivers/color

18. Control the Print Viewing Lighting

a. General Information

This is the single most overlooked element in color management for those not experienced in the technology.

In the task of matching your display to prints, most people understand the purpose and importance of calibrating your monitor. But what are you calibrating your monitor to do?

The answer in most cases is you are calibrating your monitor so that the prints you are viewing match as closely as possible to the monitor. Color theory says that the color temperature (and intensity) of the lighting we under view the print under significantly changes the colors of the print. We normally don't notice this because the human vision system readily adapts to such changes in lighting color temperatures. BUT if we are in an environment where we can compare an image in one color temperature lighting to that under different color temperature lighting we will readily notice the difference – at least I do.

So what is critical here is that our monitor be set up to mimic as closely as possible the lighting conditions under which we will be viewing the print. This brings us to the area of the lighting we view our prints under. What are those conditions you will be viewing your prints under? As you know, this really depends on your particular viewing environment. If your viewing environment is uncontrolled, that is, if the color temperature of the lighting varies greatly, it will be impossible to get a consistent match of colors between what the eye sees in the print and on the monitor.

The most important thing is for the lighting to be *consistent* over the various times we view prints. If we view a print under *different* lighting conditions at different times, the prints will not compare consistently to the display, and color management will be impossible.

b. Print Viewing Lighting

Low Cost Lighting Option

A low cost lighting option suitable for many general photographers, especially those who use professional labs to do their printing and do not print themselves, is a a halogen task lamp. This type of lighting is available from lighting stores, home centers, office supply stores and many other places. Generally these come with 35-watt or 50-watt halogen lamps, and are quite inexpensive.

They produce a light that is warmer that what we would prefer (they generally are about 3000 to 3200K or so) but their light output temperature is fairly constant, and they don't produce the spikes at various color wavelengths that fluorescent lighting does.

Mid-Range Cost Lighting Option

For a mid-range lighting option suitable for photographers who want to achieve a good match between their monitor and prints without spending a fortune, I would suggest a Solux *Original Task Lamp* with an accessory 5000K bulb, see https://www.solux.net/cgi-bin/tlistore/tasklamps.html

This is what I use. Such a set-up will cost about $150. This option would be good for those who do their own in-house printing but do not want to spend a fortune on a lighting system.

The Solux *Original Task Lamp* (available in desk, floor and mobile floor versions) is of very high quality. The 5000 degree K lamp match very closely to the settings I use for my monitor.

There are other lighting options claiming to be "full-spectrum" and suitable for use by photographers and others for color matching. GE *Reveal* is one such light. I have used the Reveal bulbs and the way they filter their light presents spikes and dips in the lighting that are readily viewable (to me, at least) when used in critical applications such as color matching. I won't use GE Reveal lights for this reason.

There are various inexpensive fluorescent tubes that claim to be full-spectrum. Ott, Ultralux, Verilux, Paralite, Bell+ Howell, and Osram Sylvania "Daylight" are such fluorescents. When you look at their spectral charts you see many spikes and valleys that are not present in natural daylight or tungsten and tungsten halogen lighting.

High-End Lighting Options – Light Booths

A high-end solution, suitable for the larger professionals who do their own in-house printing would be to use a light booth. One popular vendor is *X-Rite (GTI),* another is *Just Normlicht.*

A problem for me with such light booths is their physical size – in my very small room I simply don't have space for them.

It is generally suggested to buy a light box that includes a dimmer to adjust the luminance to match your monitor (just adding a dimmer yourself won't work!).

Light booths range from $375 to many thousands. *ColorMall* and others have a good selection of light booths.

Since I have no personal experience with light booths I can give no further recommendations here. A very interesting article on high-end light boxes is "Light under control! How to evaluate and measure the quality of an illumination setup: a few examples" by Danny Pascale & Roger Breton, November 8, 2005. A Google search should bring up this PDF document that is located at www.babelcolor.com

c. Managing End-User Print Lighting

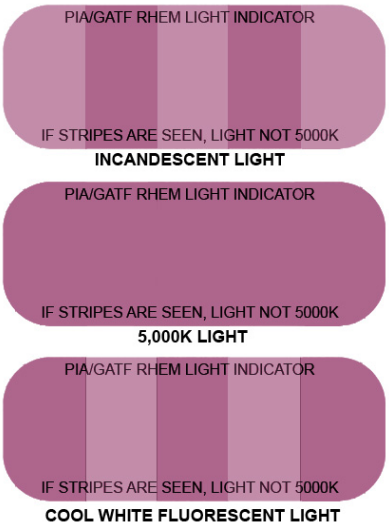
You are controlling *your* lighting – but what about the lighting that the *customer* will view the print under?

For most of us and our common applications and end-users – this simply is not an issue.

If you have an extremely color-critical end-user, you may want to consider the following. PIA/GATF RHEM *Light Indicator Strips* are a simple method of demonstrating where light is not proper for print viewing.

You simply include one light indicator with your prints. If the end-user has problems with the print color, have them check their lighting with the strip.

If the lighting is not proper, the strip will appear with obvious stripes rather than a solid color (see example below).



These RHEM light strips are about the size of a small Band-Aid® (smaller than shown above) and cost about $70 for a box of 50. They are available from *ColorMall* and other similar vendors.

If the client does not have access to D50 lighting sunlight does fine. Obviously standard fluorescent lights will be terrible.

Two caveats about the use of these strips:

- The target is designed to *invalidate* bad lighting conditions, not to *validate* good ones.

- Even good D50 lighting simulators create different color spectra, and may cause *slight* striping. This is normally not a cause for concern. But if obvious stripes are seen in the strips – similar to that shown above in the example, the lighting is not suitable for critical color viewing.

19. Control Room Lighting

Room Lighting Control

You have to view the prints under some sort of lighting, be it ambient lighting or artificial illumination. I hope I have made the point that such lighting needs to be consistent. The easiest way to get consistent lighting is to have a relatively dim viewing room with subdued lighting, and to provide task lighting to view the print under.

My viewing room has two windows that face south and west – not an ideal situation. I control the room lighting by doing two things. First I installed solar tint film on my windows. I used a 3M window tint with the lowest light and heat transmission I could find. I am very happy with this selection.

Then I installed mini-blinds. This lets me control the level of light that enters the room. I keep the blinds fully closed when matching prints.

There are many other options available such as heavy, lightproof drapes.

General Room Lighting

For general room lighting (I have a very small 10 by 12 foot room) I use a standard 25-watt tungsten incandescent light. This prevents the room from being a cave, while providing me with a somewhat consistent level of general lighting from day to evening.

In addition to this I have a 100-watt overhead tungsten halogen light for those times when I need additional general illumination. This could be anything you desire – as it does not impact our task (it is off any time I view the monitor).

The *color* of a room can impact the color of the image. My room has a white ceiling and neutral off-white walls and ceilings. If you are building your own room or are in a basement where you can paint whatever color you desire – something approximating 18% gray would be the best – in flat paint. And hopefully you are not married!

Other Reflections

Clothing, chairs, and other objects may reflect colors back to the monitor that are perceptible. Wearing a black or neutral gray shirt is best – but this is really getting into the minutia of this issue.

20. Monitor Hoods

More minutia perhaps, but some swear by them. Monitor hoods help minimize glare and room lighting from hitting the monitor.

An easy test to find out the difference a monitor hood makes for you is to fabricate on out of black foam board – at a cost of about $1.00.

Some of the more expensive monitor vendors provide optional custom fitted monitor hoods. Aftermarket monitor hoods are also available from various sources – just Google!

21. Need More Help?

If you have gotten this far and still have not achieved what you are looking for you may need to ask for help (you also may need to buy a better monitor or printer, but that was discussed already).

If your problem appears with a particular piece of hardware or software, often you are best off posing your question directly to that company. They are the experts on their products. Often the companies have FAQs or knowledge bases that cover the more common issues.

If your question is more general in nature, or crosses the boundaries of several company's products, there are many photography-related web sites that have forums that can be very helpful. I would suggest posting to a site in your geographical area first, as often viewing your setup in person is invaluable.

If no such local site is available, following are some of the major photography web sites:

- Dpreview http://www.dpreview.com/ Post in the "Printers and Printing" forum.
- LuminousLandscape http://www.luminous-landscape.com/index.shtml Post in the "Color Management" forum.
- FredMiranda http://www.fredmiranda.com/ Post in the "Post-processing and Printing" forum.

If you do post to such a web site please understand others are trying to help you, and are doing so for free. Don't take advantage of them. Clearly identify, as precisely as you can:

1. What the problem you are experiencing is.
    a. What are you seeing or not seeing that you don't like. Also describe what looks OK.
    b. Is with all colors, certain colors – etc.?
    c. Does the problem appear no matter where the image is on the monitor, or does it only occur in certain places on the monitor?
    d. I assume you are using test prints as discussed above, so note that in your posting.

2. When did the problem first occur?
    a. In calendar time.
    b. Is it consistent and constant, periodic, or random with time?
    c. Was it concurrent with any other changes?
    d. Ha it always been there, or something that worked fine once upon a time but not know?

3. State the equipment and operating system you are using.
    a. Computer operating system is important. Are you using Windows XP, Vista, Windows 7 (32 bit or 64 bit), Mac OS 10.6, or whatever?
    b. Monitor brand and model number.
    c. Where your print is from – inkjet (model number, paper type) or pro lab (which lab, their paper type)
    d. Are you sending the print in sRGB or AdobeRGB? Are you sure?
    e. How you illuminate your print.

4. Note *everything* you have done to date to try to remedy the problem, and the experiences you had at each step. The format of the information presented in this document can help you with this.

The people trying to help you unfortunately are not mind readers and do not have all the background data that you have – so please share it with them!

Saying "I am having problems getting my colors to match – can anyone help me?" is clearly inadequate and unfair to the others who truly do want to help you.

22. Windows Vista Calibration ICC Profiles Disappearing

There is a known bug in Windows Vista that under certain conditions (certain video cards, etc.) causes ICC profiles to disappear every time Windows is restarted.

More on this issue can be seen at http://neosmart.net/blog/2007/windows-vistas-gamma-table-bug/

As far as I know there is no known solution. Upgrading to Windows 7 may be the way to go if you are experiencing this issue.