Colour Management - A Practical Start

This advice is based on a talk given to Harrow Camera Club in August 2008 by Mark Buckley-Sharp ARPS CPAGB APAGB.

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Introduction

In this advice, I take the reader through from the theory of measurement, to the measurement of colour, and on to colour management, calibration and printing. It is intended for beginners. Many people make colour management too complicated before learning and using the basics properly. Do not try to go too far too fast with digital colour photography. You will just end up in confusion and you will waste a lot of money in poor quality results.

The manufacturers of cameras, image processing systems, screens and printers do go to quite a lot of trouble to test their products so that they work for the typical user. Only when you have enough experience, and only then if you understand how and why you need ultimate quality, should you experiment.

How Do We Measure Anything

Let's take length as an example. We use a ruler. The ruler has been calibrated against an international standard of length, but that rarely concerns us. The ruler is marked in known lengths. We lay it alongside the unknown length, and read off the result.

Besides understanding that the ruler measures length, we must also record the units of measurement on the ruler. For example, are the results in inches or in centimetres? Obviously the same length has a different value in each scale, although we do know that the scales can be inter-converted.

A measurement must include:

- What has been measured
- The scale of units used
- The result, usually a number,

For length, the scale could be inch, centimetre, mile, chain, furlong, or quite a variety of other options. For temperature, the scale could be fahrenheight, centigrade, or kelvin. And so on for other measurements.

How Do We Describe Colour Measurements

We can measure a quantity of light. If repeated at many points, this would make a monochrome image. Colour photography relies on the biology of the eye. By making image colour measurements in the red, green and blue, and by presenting the image mixed in those colours, the eye will see a fair colour representation of the image.

When measuring colour, we must say:

- What has been measured:
    - When we measure in each of red and green and blue, the 'Mode' is RGB, and the data has three 'Channels', one for each colour.
    - Photographers sometimes use other modes, including CMYK (cyan, magenta, yellow, black) as used for commercial printing, and Grayscale with one 'K' channel (black).
- What is the scale of units:
    - For colour modes like RGB, the scale is called the 'Colour Space'. It may also be called the 'Profile'. The colour space is a definition of the range of available colours, and how those colours are matched to the numbers in the result.
        - The sRGB colour space is an industry standard, matching the typical gamut of cameras and scanners for detection, and monitors for display.
        - The AdobeRGB colour space is a proprietary standard, defining a wider gamut than sRGB.
        - NOTE: Do not confuse RGB, which is a mode, and sRGB, which is one possible space used in the RGB mode. However, it is true that an image in the sRGB space must be in the RGB mode, and cannot for example be in Grayscale.
- What is the result:
    - The result for colour measurements is given as a number, most commonly as a whole number in the range 0-255.
        - The number range 0-255 requires storage of 8 computer bits, and this number 8 is called the 'Bit Depth'. JPG files always use 8-bit depth.
        - Other bit depths are available, with cameras typically recording RAW format data files in 12 bit depth, and with scanners recording in up to 16 bit depth per colour. TIF files can use these different bit depths.
        - Photoshop can import 12-bit files, which it expands to 16 bits, and some editing functions are available for 16-bit images.
        - NOTE: The bit depth may sometimes be described as the number of bits per pixel, which for three channels would be 24, 36 or 48 using the above examples.

To summarise: While the individual numbers are not usually examined by the user, each image file can only be properly interpreted by using its mode and colour space descriptions. Although it is nigh impossible for an image file to lose its mode description, loss of or misapplication of the colour space description means that the colours displayed or printed will not bear a correct relation to those captured or processed by the user.

What is Meant by Colour Management

Once we understand that the data in an image file can only be interpreted by reference to its mode and colour space, then colour management becomes much simpler. Colour management has just two requirements:

- We ensure that the correct mode and the correct colour space remain attached to every image file. If, for some reason, we decide to convert the mode or the colour space, then the new descriptions must replace the old one with the file.
- When a file is received, we examine the mode and colour space of the image file, and interpret the data correctly according to those descriptions.

Taken together, these two requirements ensure that every step in the chain between image capture and image display will maintain colours as correctly as possible.

The chain between capture and display may be very short, such as plugging a camera into a home printer. Or the chain may be very long and involve the author with multiple other users such as a processing laboratory or an exhibition organiser. Only if we know the colour management policies of all the links in the chain can we ensure correct colour processing from end to end.

There is a default policy to adopt in case of doubt. Because sRGB is the industry standard space for RGB mode files, we can assume that other users will at least implement sRGB processing. Therefore files being sent to other users are best left in the sRGB space, or if necessary first converted into the sRGB space. This particularly applies to all images put onto the internet. The policy for most browsers is to assume sRGB even if that is untrue. It is therefore usual to put any file for the internet into the sRGB colour space, and then remove the sRGB description, which reduces the file size and improves download time.

What Colour Space Should I Use?

All cameras can record in the sRGB colour space. That is, the camera creates numbers, as defined by sRGB, in the JPG image file, and tags the file to show that sRGB is used.

Some cameras have an option to record in the AdobeRGB colour space. Often this does not apply to all pictures, and the users ends up with a mixture of JPG files; some in sRGB and some in AdobeRGB. This can cause difficulty or confusion with image processing further down the chain. The advocates of using AdobeRGB say that the larger colour range must be a good thing. The detractors say that the extra colours defined by AdobeRGB rarely occur in typical photographs. Decide for yourself whether the complexity of working with files in a variety of spaces is worth the extra effort.

Camera RAW files do not have a colour space. The user chooses the colour space during RAW file processing.

Very advanced photographers aiming for fine art reproduction are likely to process their images extensively. In this case, it can be helpful to convert the captured image into a very large colour space, such as ProPhotoRGB, and use 16-bit depth editing. This is not because any extra colours magically appear in the image, but because

processing the image does not allow any colours to hit the end of the available range, and 16-bit data is less subject to serious arithmetic rounding during the calculations.

Photographers sometimes convert images into the Grayscale mode. For this it is best to set the space to Gamma 2.2 as this reproduces fairly closely to sRGB if the grayscale image is viewed with an unmanaged application such as an internet browser.

Converting between Colour Spaces

Interconversion is easily done, but is not exact and some image quality is lost for each conversion.

The main choice to be made when converting is the rendering intent, which manages any data from the source space which cannot fit into the destination space. For photographers, the choices are 'Relative Colorimetric' and 'Perceptual'. Again, there are different opinions. The differences are slight and most users can choose either.

Calibrating Your Screen

Although screens work quite well out of the box, any serious photographer needs to do better, and get their screen calibrated. Only a calibrated screen is good enough to judge critical colour adjustments in image files.

Laptop screens often give a different appearance as you move the screen forwards or backwards, or move your head from side to side. Any screen showing these effects is really not suitable for photographic work, and calibration is no solution.

Suitable calibration devices can be purchased eg, from the Spyder range. The Spyder3 Elite will calibrate projectors as well as screens: the Spyder3 Pro will calibrate screens only. Check the facilities for alternative makes and models. Alternatively, borrow from a friend, or use one of the call-out services now readily available.

The screen calibration process creates a profile. The profile is loaded into the video driver of the computer where it adjusts the colours sent from the application, such as Photoshop, so that they display correctly on screen.

Calibration should be repeated regularly, although not as often as some people suggest. A CRT monitor (if you have one) should be checked every 2-3 months. An LCD monitor should be checked every 6-12 months. A projector with little use can be checked annually. The amount of drift at these intervals is usually quite small.

Calibration does not make your screen perfect. No screen is capable of being perfect, and displaying every possible colour. Calibration adjusts the screen software so that the highlights, shadows, and colours in between are as good as possible. Some people spend enormous sums of money to buy screens which are reputedly better.

Printing Colour the Simple Way

Your printer is a display device just like your screen, and it needs colour control via a profile. But you don't need to do anything special to get good prints the simple way.

The printer manufacturers will not release a model onto the market until they have worked out how to spray all their many and various inks onto paper to get the right result from an image file. But, they will only do that development work for their own inks and for their own paper types.

Printing colour the simple way means using only the printer manufacturer's inks, and the printer manufacturer's paper. Make sure that all colour management is done by the printer driver, and not eg, by Photoshop. Choose the correct paper type in the printer control box, and you will get a very adequate result.

Where people start to go wrong is when they are persuaded to buy from a cheaper source of ink, or a cheaper source of paper, or both. The printer driver has no specific settings to use either the ink or the paper, and the results may be disappointing.

But, there are occasions when your printer manufacturer does not supply a particular type or surface of paper which you do want to use. In that case, you must use the method for advanced users.

Printing Colour for Advanced Users

Perhaps the commonest query raised with printing is 'Why doesn't my print look like my screen?'. You must understand that a print (reflective) and a screen (emissive) are completely different media, probably with different colour ranges. They are never going to look exactly the same. All that we can hope for in photography is that each representation of the image is as good as it can be. And, an important first step is to use a calibrated screen as described above.

Advanced users also understand that the printer, combined with a particular ink and a particular paper, needs calibrating to create a profile, just like a screen. The profile then adjusts the colours so that the printer can lay down the correct amounts of ink to produce the correct result.

Unlike a screen, making a profile for a printer is not really something you can do at home: or not without some very expensive equipment. What are the realistic options.

If your aim is mostly economy, and you have bought some cheap inks and cheap paper, then you want a cheap solution. The first and free option is to try all the different paper settings in your existing printer driver control box. One of them may give good results. Maybe your 'glossy' paper needs the 'plain paper' setting.

If your aim is to use a specialist paper, but you are still going to use the printer manufacturer's inks, then the paper manufacturer may have created a profile for your printer and ink, and with their paper. It helps them to sell their paper! These profiles are usually available as free downloads, and they will come with installation instructions. They will also come with instructions on exactly which settings to put in your printer driver control box when printing. For example, the entire range of Permajet papers, when printing on an Epson 1290 printer, requires the 'Glossy Film' setting and 1440dpi whatever the Permajet surface used. Those were the settings used when the profile was created, and that is what has to be repeated with every use of the profile to make a print.

If there is no free profile available for your combination of printer, ink and paper, then you can use a postal profiling service. The service sends you an image file of colour patches, with instructions on how to print it with no colour corrections. You post off the print; they measure it; and they create a profile for you. Again, the profile will come with instructions for installation and use.

A printing profile is not installed into the printer driver. To use a specific profile for printing, the colours are adjusted before the data gets to the driver. Colour control is turned on in the application eg, Photoshop > Print with Preview, and is turned off in the printer driver. The printer driver is given some standard settings as instructed by the profile supplier. A note of warning. Once you start using Print with Preview, it remembers your last settings, and those settings remain in use. Don't go back to using ordinary Print with colour control in the printer driver. The results may be unusual!

Sending Your Files to Someone Else

One of the great advantages of digital photography is that image files can be exchanged with others, and can be converted between media (view, print, slide) with ease. The time will come when you want to send one of your files to someone else.

Following the principles of colour management, you need to know what the recipient is able to do with your file.

Photobooth & Laboratory: Many shops have machines which will make a print from a file on your camera storage card. They are unlikely to tell you much about their colour management policies. You would be wise to assume they will think your file is in the sRGB colour space, and you should make sure that it is. The better laboratories publish their colour management policies, and maybe you can submit files to them either in sRGB or in some other colour spaces.

Competitions & Exhibitions: Reputable event organisers understand that they must give guidance to authors about colour management. Usually they will require files in the sRGB colour space.

E-mail & Internet: The are other issues such as file size which are not covered in this advice, but the main point about colour management on the internet is that you cannot assume anything. You must use the default policy for colour management, which is to ensure your file is in the sRGB colour space. You can then omit the colour space information from the file if you wish, especially as the smaller file is quicker to download.

Conclusion

You have probably noticed that I am very keen to recommend use of the sRGB colour space from capture through to ultimate use. I am, because it is much easier not to be making special choices in colour management, and it works perfectly adequately for all purposes. You should build up lots of experience before making your colour management any more complicated.