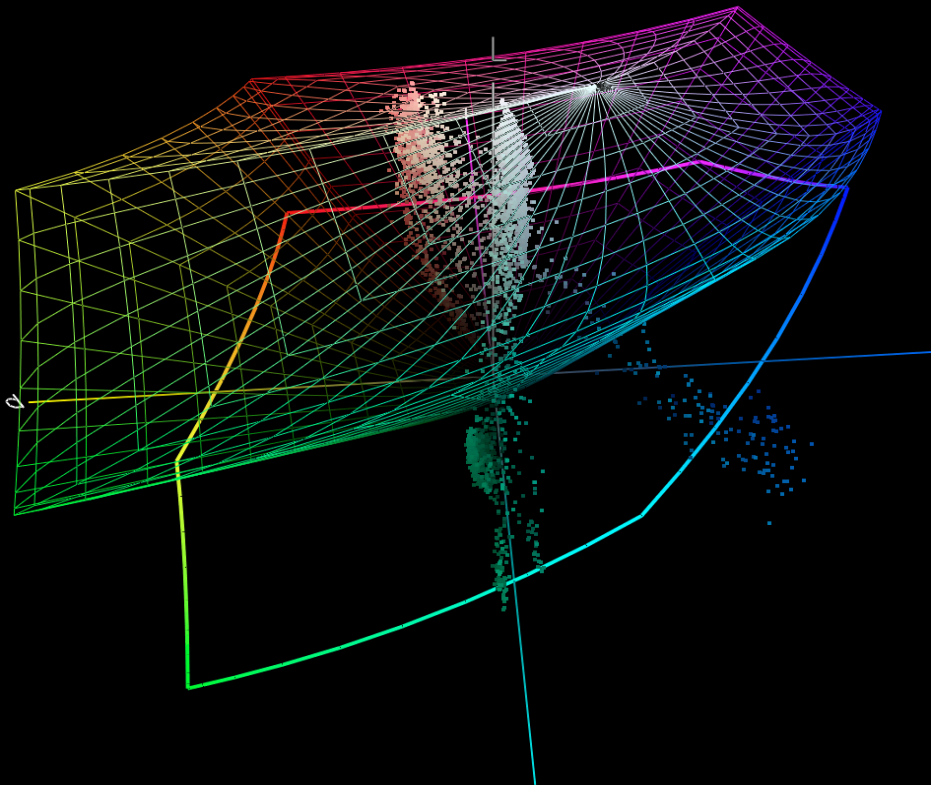


Practical Colour Management for Photographers and Digital Image Makers

HOW TO GET ACCURATE COLOUR ON SCREEN




Michael Walker and Neil Barstow

How to use this e-book

USING PDF NAVIGATION FEATURES

This e-book has been designed to be read on-screen or printed out, as you prefer. A number of PDF navigation features have been included to enhance on-screen reading; they are explained below and you will need some version of the free Adobe (Acrobat) Reader to access them reliably. It's available at <http://get.adobe.com/reader/>. Other PDF viewers may not support all these features.

layout and view

By default, this document opens in single-page view, which should provide at least a recognisable view of the page's contents to aid in identification of relevant content; on higher-resolution displays, it should be comfortably readable at this magnification, but in addition to the standard Acrobat Reader zoom tool  you may find the following options helpful:


bookmarks

The text items appearing to the left of this page are clickable PDF bookmarks that will take you directly to the relevant section. They may be thought of as an interactive contents page (though there is one of those too, on page 4). By default, all levels of this hierarchy are visible; you may expand or collapse them for convenience by clicking the + and - (Windows) or triangular (Mac) icons.

links

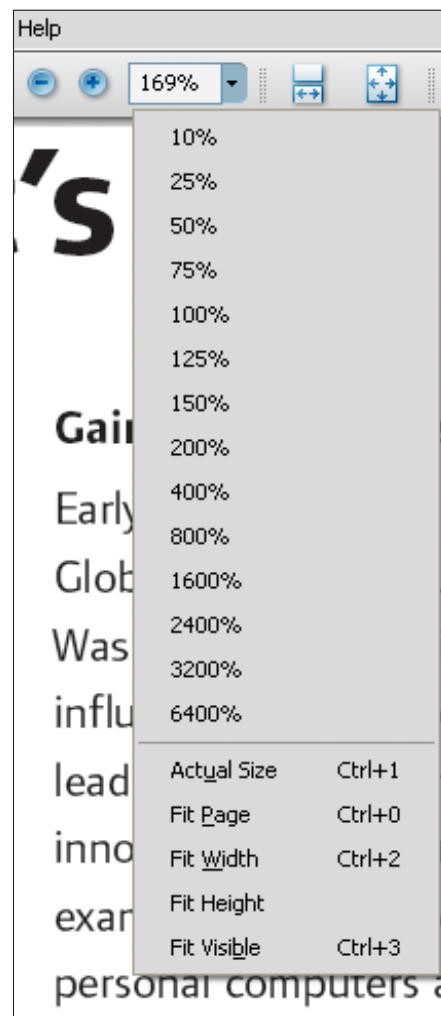
This PDF supports clickable links both within the document, as in the contents listing items on page 4 or any page reference in red, and external web links, denoted by URLs in bold type; these will open in your Web browser.

viewing screengrabs

With Acrobat's Hand tool (found under the Tools menu/Select & Zoom) you can click on screengrabs and captions to view them at a magnified size for easy reading. When this feature is available, the Hand tool changes to look like this: . After reading, click again to be taken back to your starting view.

index / search

Rather than include a conventional index, you can simply search this PDF for the word or phrase of interest using Acrobat's 'Find' function (Edit/Find or command-F on Macintosh, Ctrl-F on Windows systems).



Adobe Acrobat Reader's Zoom and 'Fit...' view options make it easier to read text comfortably on screen but we've also included various additional options to produce convenient magnifications, especially for the smaller screengrabs – just click anywhere in them to have them zoom to fill your viewer window.

Practical Colour Management for Photographers and Digital Image Makers

HOW TO GET ACCURATE COLOUR ON SCREEN

Michael Walker and Neil Barstow

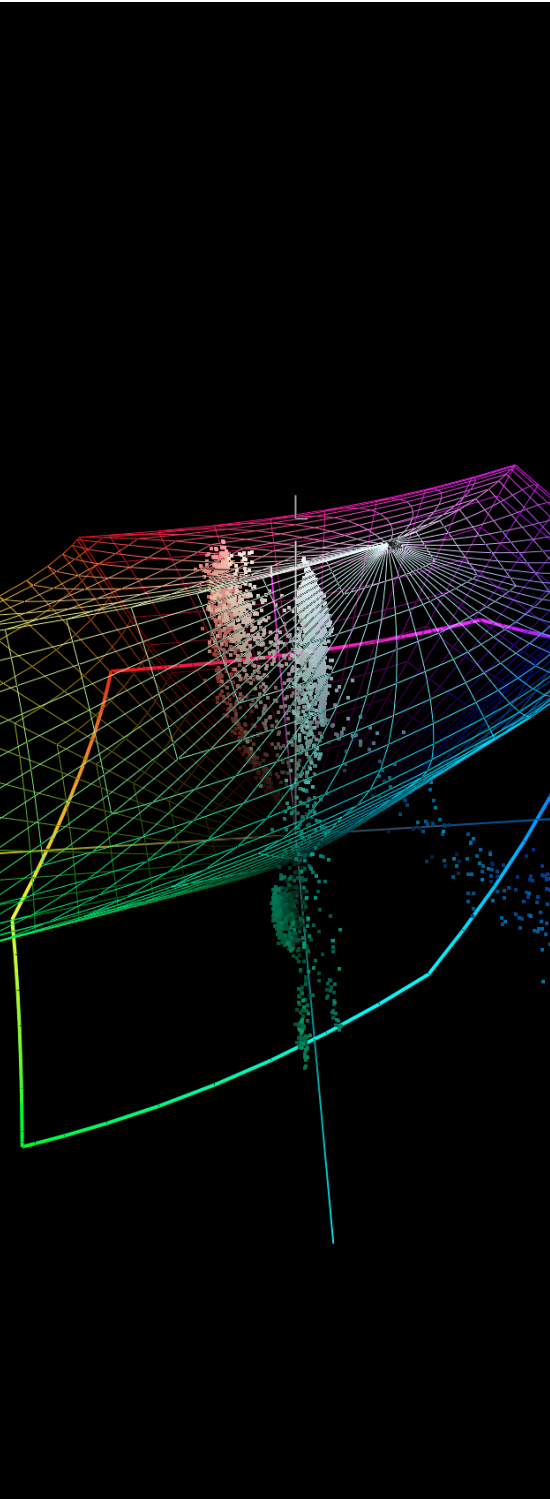
© 2015 Michael Walker and Neil Barstow

This e-book is only for the personal use of the original licensee as per our sales records. It may not be copied or distributed in part or whole by any means, electronic or mechanical. This copy is not licensed for educational use.

Contents

display calibration and profiling explained	6
working environment	7
calibration and profiling	7
<i>hardware and software calibration</i>	7
'visual' calibration tools	8
manual hardware calibration of luminance	9
calibration and profiling tools	10
calibration options	10
calibration and profiling tips	12
luminance	12
white point	13
gamma	14
verification	14
re-profiling	15
preparations for calibration and profiling	16
using display profiles	18
Mac OS X	19
<i>profile locations</i>	19
<i>changing profiles</i>	19
<i>multiple monitors</i>	20
Windows XP	21
<i>profile locations</i>	21
<i>changing profiles</i>	21
<i>LUT loader conflicts</i>	22
<i>multiple monitors</i>	22
<i>laptop mirror mode</i>	23
<i>extended desktop mode</i>	23
<i>application support</i>	24
<i>Color Control Panel applet</i>	24
Windows Vista and Windows 7, 8 and 10	26
<i>Windows Color System</i>	26
<i>LUT bug and Service Pack 1</i>	26
<i>profile locations</i>	27
<i>Color Management control panel</i>	27
<i>changing profiles</i>	28
<i>Windows 7, 8 and 10 LUT loader</i>	28
<i>multiple monitors</i>	29
<i>application support</i>	29
how to be sure that display profiles are being used correctly	30
choosing a display	32

Technical talk
 You'll notice grey panels like this scattered throughout this e-book. We've used them to separate some of the more advanced technical explanations and detailed procedures relating to colour management from the main body of the text. In most straightforward set-ups you probably won't need to refer to them, but if your situation is more complex or you just like understanding things in greater depth, be our guest.



Foreword

why colour management matters

Digital technology offers a range of creative options and productivity enhancements that photographers and image makers of previous generations could only dream about. In terms of duplication without loss of quality, flexible editing and endless experimentation at minimal cost, digital imaging beats its analogue predecessor hands-down.

But digital imaging, and more specifically, digital colour, bring their own problems. Instead of the master transparency that was the definitive version of an image, you now have an endless range of interpretations, where each screen or print might show you something different – and the possibility that none of them are actually showing you the true colours from the file.

Colour management addresses this, allowing images to be reproduced accurately and repeatably across a range of display and printing devices. It provides the means to make your decisions about editing colour and tone based on reliable display, as well as accurately to preview the output.

This e-book provides concise, practical information on how to ‘do’ colour management on real computers using a range of current commercial software. You won’t find extensive colour theory here, or explanations of how to achieve specific corrections, ‘looks’ or retouching techniques; if you’re interested in those, we recommend *Getting Colour Right*, Ilex Press 2004, by the same authors.

What you will find here is detailed information on exactly which settings to use and help in making the various choices that colour management presents as you bring your images – whether digital or scanned from film – onto the screen and begin working with them.

We’ve also included tips on choosing and using colour-critical equipment, from monitors to the tools that calibrate and profile them.

Together, these will give you a solid basis for achieving and maintaining accurate colour on-screen. This will let you see better what you’ve shot or created, how your edits will affect it, and properly predict printed output, bringing the promise of digital imaging closer to full fruition.

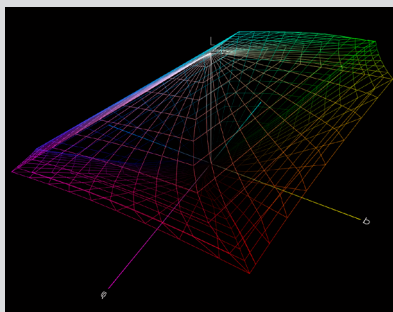
Getting screen colour right

display calibration and profiling

Colour by numbers – L*a*b*

A central component of colour management is an ‘absolute’ description of colour and tonal values that is related to human vision. The L*a*b* colour model fulfils this role in the ICC (International Color Consortium) profile specification. It describes colours using three axes: *L* (luminance), *a* (green – red) and *b* (yellow – blue).

ICC profiles can be represented as 3D shapes in which *L* is mapped to the vertical axis and *a* and *b* to the two horizontal ones. Black is at the bottom, white at the top. This example, plotted with Chromix ColorThink, shows an LED-backlit LCD display’s gamut.



Display calibration and profiling is one of the most important parts of colour management and is one of the easiest and cheapest to do. It is also especially easy to keep your screen up to spec now that relatively stable LCD flat panel displays have largely replaced the older and more variable CRT types, which required calibration every seven to 14 days and sometimes daily or even more frequently in critical applications. Don’t worry if you have a CRT monitor – you can still profile it and get excellent results (see ‘profiling tips’ on page 12).

Whether you use Windows XP, Vista, Windows 7/8/10 or Mac OS X, you can use custom-made screen profiles to ensure accurate display with colour management-aware applications; in the following pages we explain how the display profiling process works, suggest recommended settings and highlight the operating system-and application-specific issues that you need to be aware of.

Why we need to calibrate and profile our displays

Digital image files are normally made up of numerical RGB or CMYK pixel values which by themselves have no reference to the ‘real’ colours that we see. What’s more, digital devices are dissimilar: each digital output device is likely to need different RGB or CMYK values to display or print the same final colour, and in the case of image capture devices such as scanners and digital cameras, different numbers are often produced in response to the same original colour.

Without some mechanism to give unequivocal meaning to these pixel values, any display or printing of an image will rely upon assumptions in software as to the actual colours intended.

To determine an unambiguous colour and tonal value for each image pixel, the RGB or CMYK numbers in your files need to be referenced against ‘real’ colour values related to human vision, as described by the L*a*b* colour space (see panel ‘Colour by numbers’ at left). An ICC profile provides the link from the RGB or CMYK numbers in your files to ‘real’ L*a*b* colours.

An ICC profile may describe the characteristics of a camera or scanner, a working colour space, or the characteristics of an offset or digital press or an inkjet printer. Once referenced against L*a*b* via the profile, the pixels’ colours can then be calculated for accurate display on a calibrated monitor or printer.

Metamerism

Because the colour-sensitive cones in our retinas essentially respond to red, green, green and blue light, it's possible for objects with different physical properties to appear identical in colour to our eyes under some types of lighting but not under others. A frequently-encountered example is clothing items that appear to match under store lighting conditions but don't in daylight.

Metamerism is sometimes considered to be a problem and in some ways it is, but in another way it's useful because it allows physically dissimilar objects or materials to appear to be the same colour.

Metamerism is the basis of colour printing and screen display and the reason why we can print with just cyan and yellow inks yet see green, or illuminate red and green pixels on a screen and see yellow.

Working environment

Correct colour management extends beyond what is shown on your screen and includes what's around it or reflected in it too. For best results you need to work in a room with a constant luminance and colour temperature, as these affect your perception of white. Although daylight changes throughout the day, its spectral content is fairly constant, but artificial forms of lighting differ considerably, especially standard fluorescent tubes and domestic tungsten bulbs which can cause metamerism-related problems when viewing proofs or prints. Because of the way your vision adapts to your environment, you may not be aware of these effects but they can influence your editing decisions.

The colour of walls, ceilings and the light in the room can affect your perception of both screen and printed colour; ideally walls will be a neutral grey. You should also avoid wearing strongly-coloured clothes as they can be reflected in the screen, though this is less of an issue with matte-surfaced LCD panels than it was with glass CRTs. That said, glass-fronted LCD panels (iMac, for example) are even worse!

Similarly, non-neutral screen desktops can affect how you see the colour in the image windows so you should set the background to neutral greys only.

Calibration and profiling

Setting up a monitor to display accurate colour actually requires two distinct processes, calibration and profiling. The expression 'calibrating a monitor' is generally taken to mean performing both operations, though the distinction isn't always made clear, especially in entry-level products.

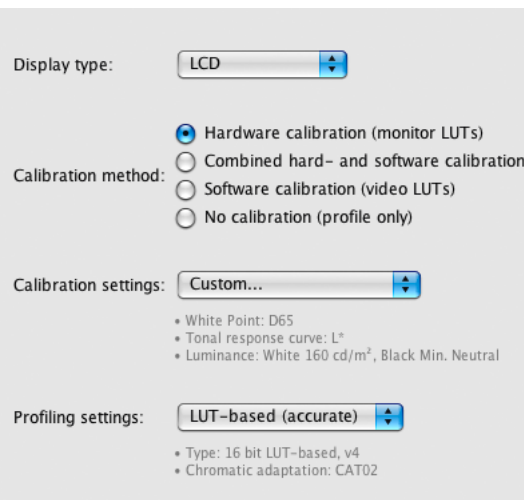
Calibration means measuring and adjusting the monitor to be as near as possible to a specified condition in terms of its white and black luminance, colour temperature and gamma (the relationship between input and output tonal levels).

Profiling then characterises (measures) the way it behaves in that calibrated state as a range of colours and tones are displayed and measured by an instrument. The ICC profile that is made maps this behaviour and allows the colour values sent to the screen to be adjusted on-the-fly by colour management-aware applications so that the correct colours will be displayed. The calibration data is also saved within the ICC profile.

The difference between 'hardware' and 'software' calibration

There's a further distinction that's important to understand, especially if you need to change monitors and profiles: that of 'software' and 'hardware' calibration.

Although both types use a measuring instrument, a 'software' calibration is one



*'Hardware calibration' displays usually ship with the manufacturer's own calibration software. Some third-party calibration software such as *basICColor Display* (above) supports both hardware and software calibration, enabling it to be used with a variety of displays from different manufacturers. Note that both types of calibration require a measuring instrument.*

in which all the changes necessary to meet your calibration requirements are made via a look-up table (LUT) loaded into the computer's video card from the display's ICC profile. The display is usually set to factory default values for brightness, contrast, colour temperature and so on, but if the necessary corrections are extreme, this can potentially lead to inferior display accuracy (see panel on page 9 for a discussion of how luminance correction can affect quality).

'Hardware' calibration strictly means making physical adjustments to the behaviour of the electronics inside the monitor itself to meet the target values. In CRT screens, that meant adjusting the respective strengths of the red, green and blue electron guns to achieve the desired white point and luminance. This could either be done manually, via an iterative process of adjustment and re-measurement, or in certain high-end models, it could be done automatically via calibration software and a digital link between computer and screen.

Some current LCD displays have controls which appear to offer individual adjustment of the red, green and blue channels, colour temperature, contrast, hue and saturation. However, you can't physically control the individual behaviour of the red, green and blue filters in an LCD panel. All you can vary is the brightness of the backlight; the rest is done in software within the display's electronics. With LCDs we don't recommend manually adjusting anything except the luminance (brightness), even if the calibration software suggests it. All the other controls are doing is inserting further layers of tonal and colour adjustment via the software controlling the LCD filters; the fewer of these the better.

In 'hardware calibration' LCD displays, luminance adjustment is made automatically by the calibration software. Adjustments to meet the target white point and tonal response are then implemented via 'high-bit' look-up tables within the displays' internal electronics. Displays that support this include Eizo ColorEdge, LaCie 500/700, NEC Spectraview, Quato IntelliProof and Samsung XL models.

'Visual' calibration tools

There are software tools that aim to provide some degree of monitor calibration purely by visual means, usually requiring you to make a series of judgements of tone or colour equivalence in on-screen graphics. From these, the software attempts to deduce the gamma and colour values of your monitor. Examples are Apple's Display Calibrator or Adobe Gamma that came with Photoshop up to CS2.

We don't recommend visual calibration utilities. Nothing is actually measured and different users tend to end up with different results. It is possible that a usable calibration could be achieved by trial-and-error, using a verification print viewed under controlled lighting as reference, but that could take a very long time.