THE COLOR-MANAGED WORKFLOW PART ONE: THE BASICS

Quick Guide

Written by Rob Eyers

Producing images with fabulous color is something that many of us strive for in our photographic endeavors. Unfortunately digital cameras, computers, software, and printers are not simple plug-and-play devices when it comes to color. It can be frustrating to post-process a photo only to produce disappointing color results at the output stage. Images for the web may look off when viewed on different devices or prints may be color shifted, dull, and dark.

Capturing, processing, and outputting a photo that's accurate in its color representation may not be everyone's end goal. However, even if the objective is to create a surreal piece of art, it's helpful to begin with an accurate neutral starting point. The way to achieve this accurate neutral starting point is referred to as 'color management.' Implementing a color-managed workflow will facilitate predictable color output. That's what we're going to be discussing in this guide.

We're going to look at everything from the lens through to the printer paper to analyze what can be done to achieve color accuracy. Although there's a tremendous amount of highly technical engineering going on behind the scenes, we're going to stick to a broader understanding of the subject, with finer details on the specifics of implementation. There will be as little technical jargon as possible.

Because there are so many facets to this topic, this guide is broken into multiple installments. This first part will give you a broader understanding of how we perceive color, how it's communicated between devices, and what standards are used in assessing accurate color. Subsequent installments will detail the specifics of color spaces as well as the calibration of cameras, monitors, and output for print and the web.

Implementing a color-managed workflow will facilitate predictable color output.

After completing part one you will understand the following:

- If you can trust your eyes
- What color management is and why it's needed
- What the ICC standard is and what it does
- What color charts are and why they're used

Subsequent installments will discuss the following:

- The ins and outs of different color spaces
- Why computer monitors are not color accurate
- How to calibrate a monitor
- Why your expensive camera is not color accurate
- How to color-profile your camera
- Why the color from your printer is not accurate
- How to print with accurate colors and the effects different papers have
- How to prepare an image for viewing on the web
- How to color-calibrate your iOS or Android tablet or phone

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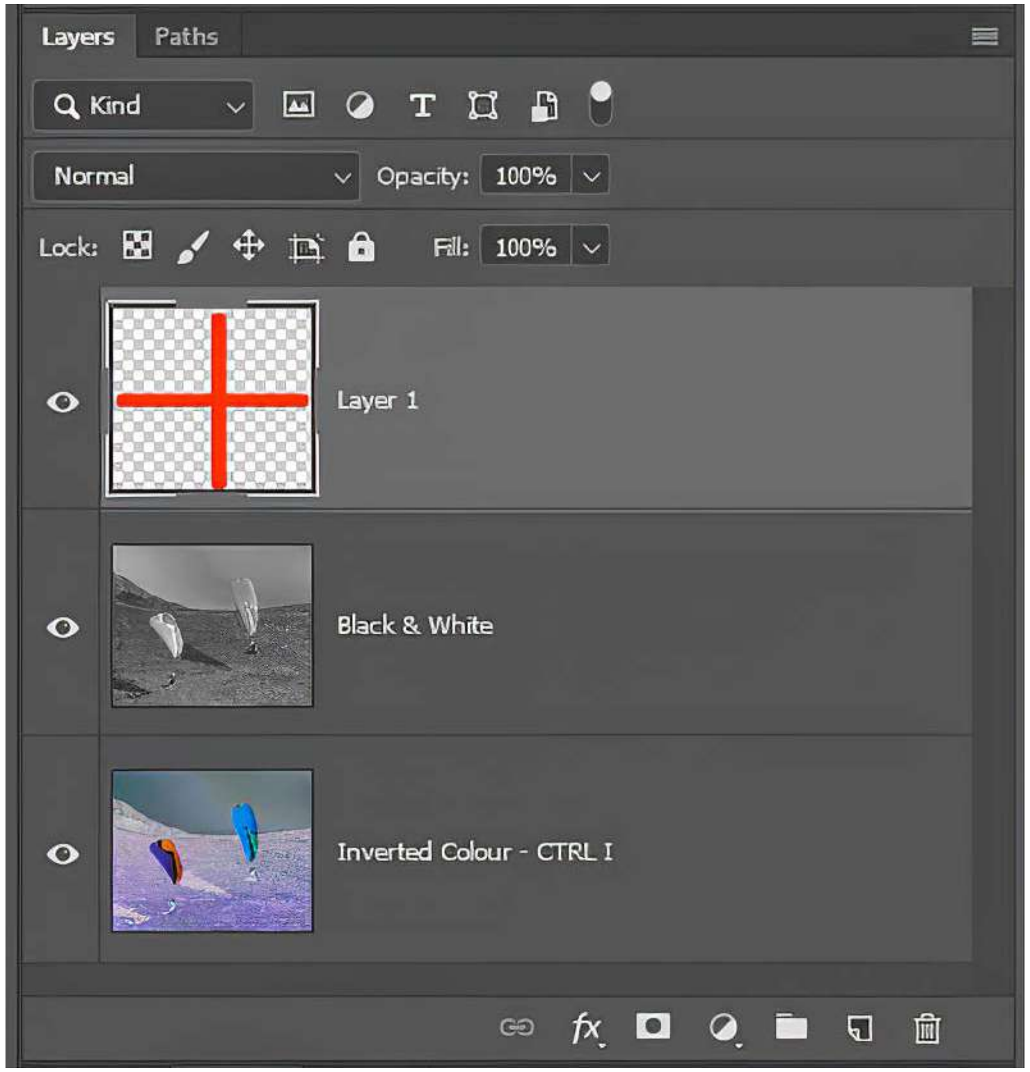
YOUR EYES ARE THE BEST JUDGE…RIGHT?

Let's first look briefly at how the human eye operates. We have three different color-sensitive cones in the eye that can detect 10 million different colors. These colors are electromagnetic radiation waves in the 380 to 740 nanometer range. We also have rods that detect brightness. There's some disagreement over how many shades we can see with our 120 million cones, but the arguments suggest it's somewhere between 30 and 50 shades of gray. There are only 7 million of the color cones reading those 10 million colors. As you might guess, we're more sensitive to brightness differences than color differences. However, about 8% of males are color blind, with females having a lower percentage, so we're not all created equal when it comes to our eyesight.

With all of our sensing power it seems logical that we could judge color and light pretty accurately. There's just one small problem, and that's the mind. Our brain is tabulating all of that data, and unfortunately it can be tricked. Let me explain.

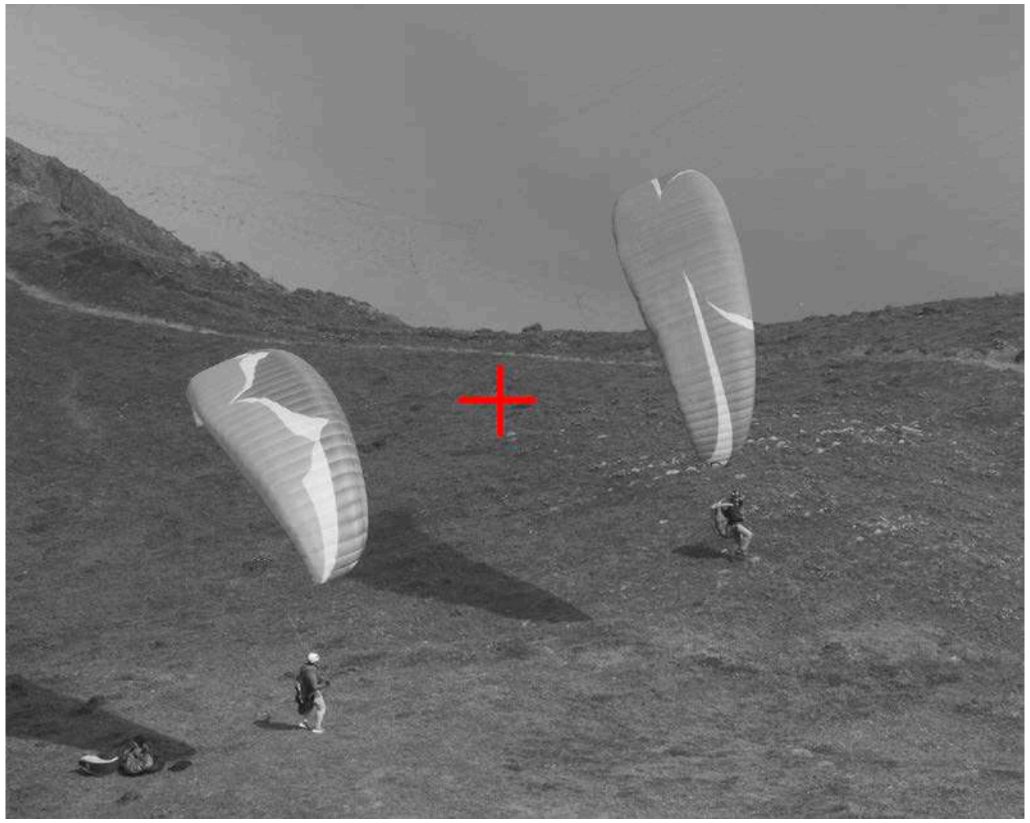
We all know that movies are just a series of single pictures. They're flashed in front of us quickly enough to take advantage of our persistence of vision. What we perceive is a moving image. There is one other quirky thing about our persistence of vision, but you'll have to test this for yourself as there's no way to show you in this guide.

Here's how it works. Open any color image in Photoshop and create a second layer of the image in black and white. Invert the color of the first layer so you have a color negative as your base layer (Ctrl I on PC; Cmd I on Mac). Open a new layer and place a red X on it.



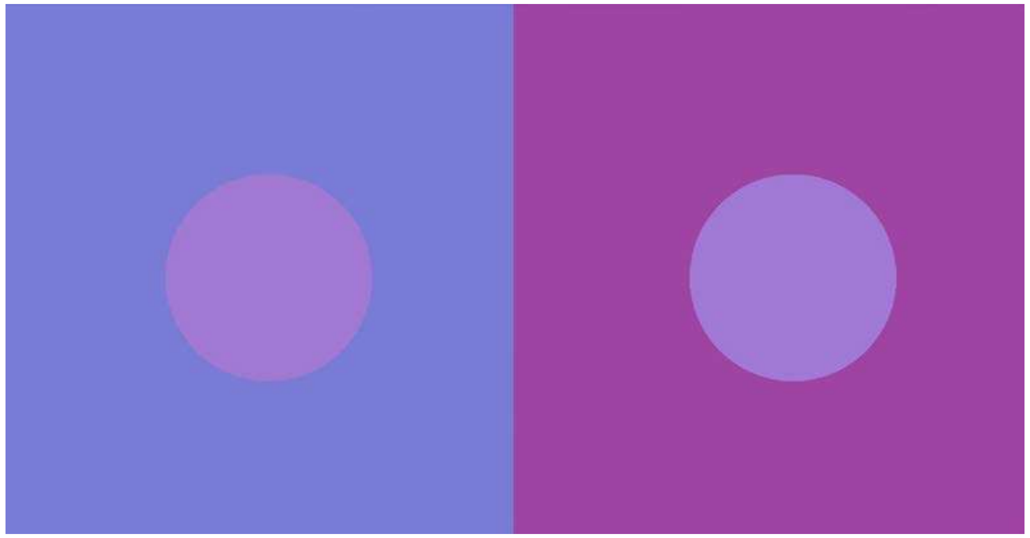
Screen capture by Rob Eyers

Your layers panel should look something like the left image above. The right image above shows my photo with the X in place.

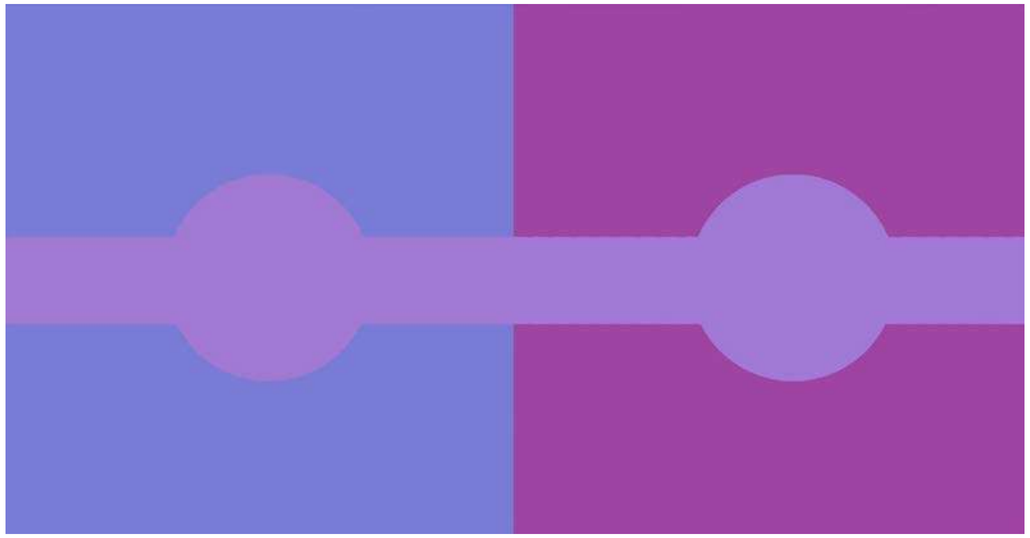


Screen capture by Rob Eyers

Turn off the black and white layer. Stare at the center of the red X for 10 seconds or more, and then turn on the black and white layer without moving your eyes away from the center of the X. What you see now is the image in color. As long as you don't move your eyes the color will remain. The moment you move your eyes you'll instantly see black and white. Once again, persistence of vision is at work.

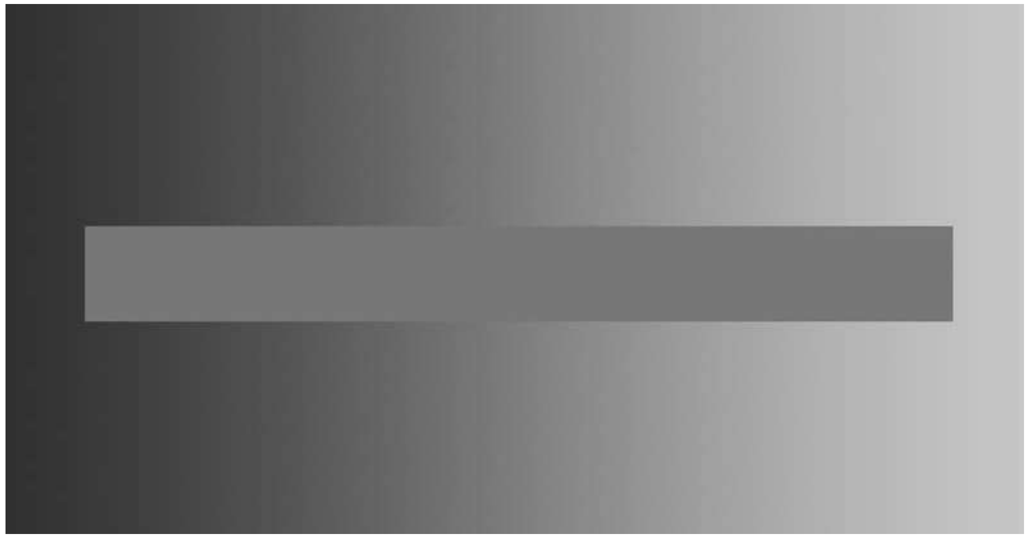


Another interesting aspect of our color perception is demonstrated by this image. The circle on the left appears to be more magenta.



Connecting the two circles with a bar of the same color shows that both circles are in fact the same color, as shown in this image. In this case, our perception of color is fooled by adjacent colors.

The rods in our eyes that sense brightness can also be tricked. If we take a gray bar and place it in the center of a lighter gray background then it appears to be the same shade, as shown in this image.



With the gray background replaced by a gray scale gradient, the center gray bar looks much different. Nothing about the bar has changed. It's exactly the same shade throughout and it does not ramp from lighter to darker gray. What has changed, though, is what your mind is telling you about the shade of that bar. In other words, your mind is deceiving you. This may seem like a trick, but it's not. It's easy to recreate it on your own if you're in doubt.

So it's pretty clear that our fantastic vision is not going to be up to the task of calibrating a color-managed workflow. What's needed is a reliable method of measurement. The methods will be different for the camera, the monitor, and the printer. We'll be discussing that fully when we get there, but first we need to have an understanding of the color-management standard and how it's conveyed between devices.

Key Lesson: Your eyes can be tricked and they can deceive you.

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ICC WHO?

We are lucky to live in the digital imaging age because we can achieve color accuracy much more easily than when the workflow was analogue. Much of the thanks for this goes to the International Color Consortium, also known as the ICC. A paragraph from their color.org website states the following:

> *"The International Color Consortium was established in 1993 by eight industry vendors for the purpose of creating, promoting, and encouraging the standardization and evolution of an open, vendor-neutral, cross-platform color-management system architecture and components. The outcome of this co-operation was the development of the ICC profile specification." (color.org)*

That's a lot to take in. What the ICC standard has achieved is a way for equipment, from cameras to printers, to talk to each other and convey color information with integrity. It's no small feat considering the multitude of manufacturers and devices. Adding to the complexity is the fact that some devices, like cameras and monitors, work in the sRGB additive light color space, and printers work in the CMYK subtractive ink/dye color space. We'll be discussing the differences in more detail later. For now, just understand that light and ink work differently.

So how is this accomplished if there are two separate languages, so to speak? The answer is a third language, or color space, referred to as Lab (pronounced EL AYE BEE). Lab is a scientific color space that covers all visible colors and lightness. The whole of sRGB and CMYK is covered by Lab. Because of this, it's possible to interpret any sRGB color in or out of Lab, and the same is true for CMYK. So your computer uses Lab as a sort of interpretive language to make accurate color communication possible between your photographic equipment. You could think of it as a language translator. The instructions of how to translate for each device, model, and brand are contained in an ICC profile. Each device's ICC profile is unique. The photo-processing software acts as the engine for all of that color translation. It makes sure that any given color is conveyed as accurately as possible between devices.

Graphic by Rob Eyers

Processing software such as Lightroom or Photoshop are the engines that connect the color profiles. The software interprets that ICC sRGB information from the camera into the Lab color space and then translates that information back out to the sRGB ICC profile of the monitor. It does the same for the printer by using the ICC profile that defines the printer's CMYK color space, including the paper's profile.

We'll be looking at these ICC profiles much more closely when we discuss calibration of your monitor, camera, and printer. For now, just know that it's the ICC profile that holds the key to an accurate color-managed workflow.

> **Key Lesson:** Lab is the scientific color space that is used to translate between different ICC color profiles.

COLOR REFERENCE CHARTS

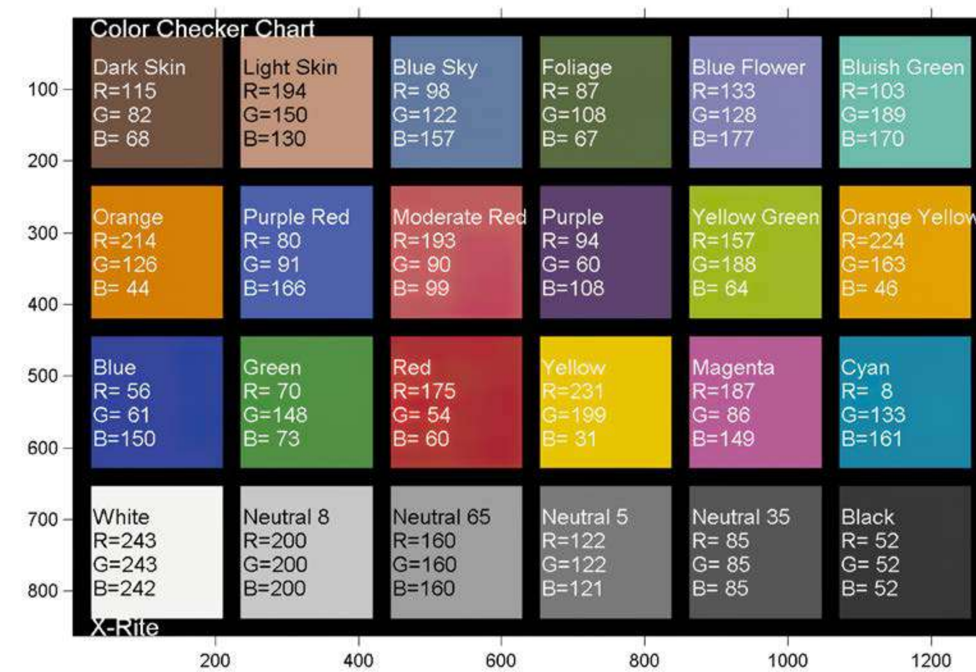
We now know the general layout of how color is interpreted between devices. One big question remains: What determines the correct red, green, blue, cyan, magenta, yellow, or any other color? What's needed is a reference color chart. That reference chart first appeared in the summer of 1976 in the Journal of Applied Photographic Engineering. A company called Macbeth first released the color chart, and so it became known as the Macbeth ColorChecker. The company was sold and subsequently purchased by Gretag. The chart then became the GretagMacbeth ColorChecker. Gretag eventually merged with X-Rite. Today the chart is called the X-Rite ColorChecker. There have been some tweaks to the chart over the years, but it now stands as the reference standard for photographic color.

Graphic by Rob Eyers

The original ColorChecker CLASSIC, as shown in this image, is 8.5 x 11 inches. It's now available in a smaller version.

Photograph by Rob Eyers

The X-Rite ColorChecker Passport, shown in the image on the left, is small enough to carry in your pocket. It has the same color patches as the original larger chart.



Graphic Rob Eyers

The image on the left shows the RGB values for the color patches. Along with the gray scale and RGB and CYMK patches, there are patches representing skin tone, blue sky, and foliage etc. It's this ColorChecker that's been used over the years to standardize color through the photographic workflow.

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Photograph by Rob Eyers

IN CLOSING

So far we've determined that the naked eye can't be trusted when it comes to objective measurement. We've also discussed how color information is translated between devices with ICC profiles and we know now that there's a reference color chart for photography.

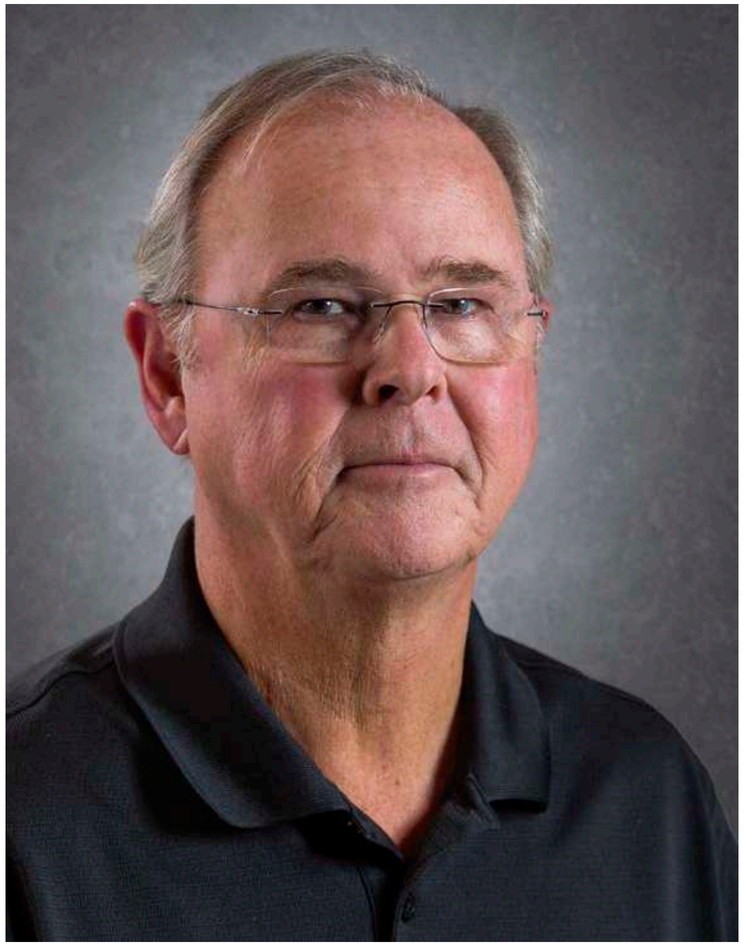
What we need to know next is how to technically apply that color standard to our workflow. In the color-managed workflow, the goal is to have the camera accurately output the colors of the ColorChecker. After that, the monitor and printer must faithfully reproduce those colors.

In part two we'll be discussing color spaces, and we'll begin the calibration process. It's important that we accurately see what we're doing, and since the monitor is our window we'll be calibrating it first. After that we'll be moving on to calibrating the camera and output devices.

Self-Check Quiz:

1) What devices are included in a color-managed workflow?
2) What is an ICC profile?
3) How are ICC profiles implemented?
4) When was a color standard for photography first introduced?
5) Is the eye an accurate judge of color?
6) Is the eye an accurate judge of brightness?
7) Why is a color-managed workflow required?

ABOUT THE AUTHOR



Rob Eyers is a retired Canadian business owner and musician. These days, photography, music, and travel keep him busy. His interest in photography began in the 1960s. Rob is certified by the Imaging Science Foundation and as such, he is highly interested in color accuracy for both video and photo processing.

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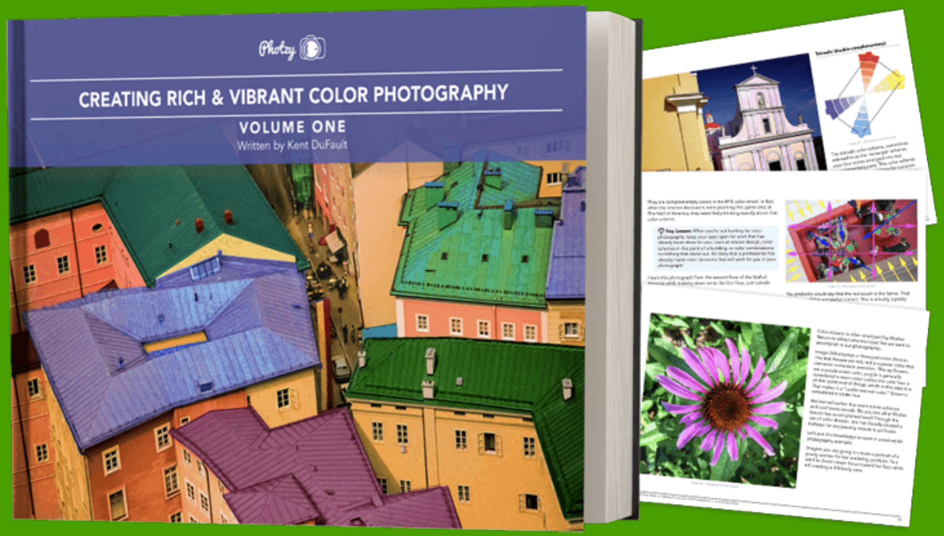

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