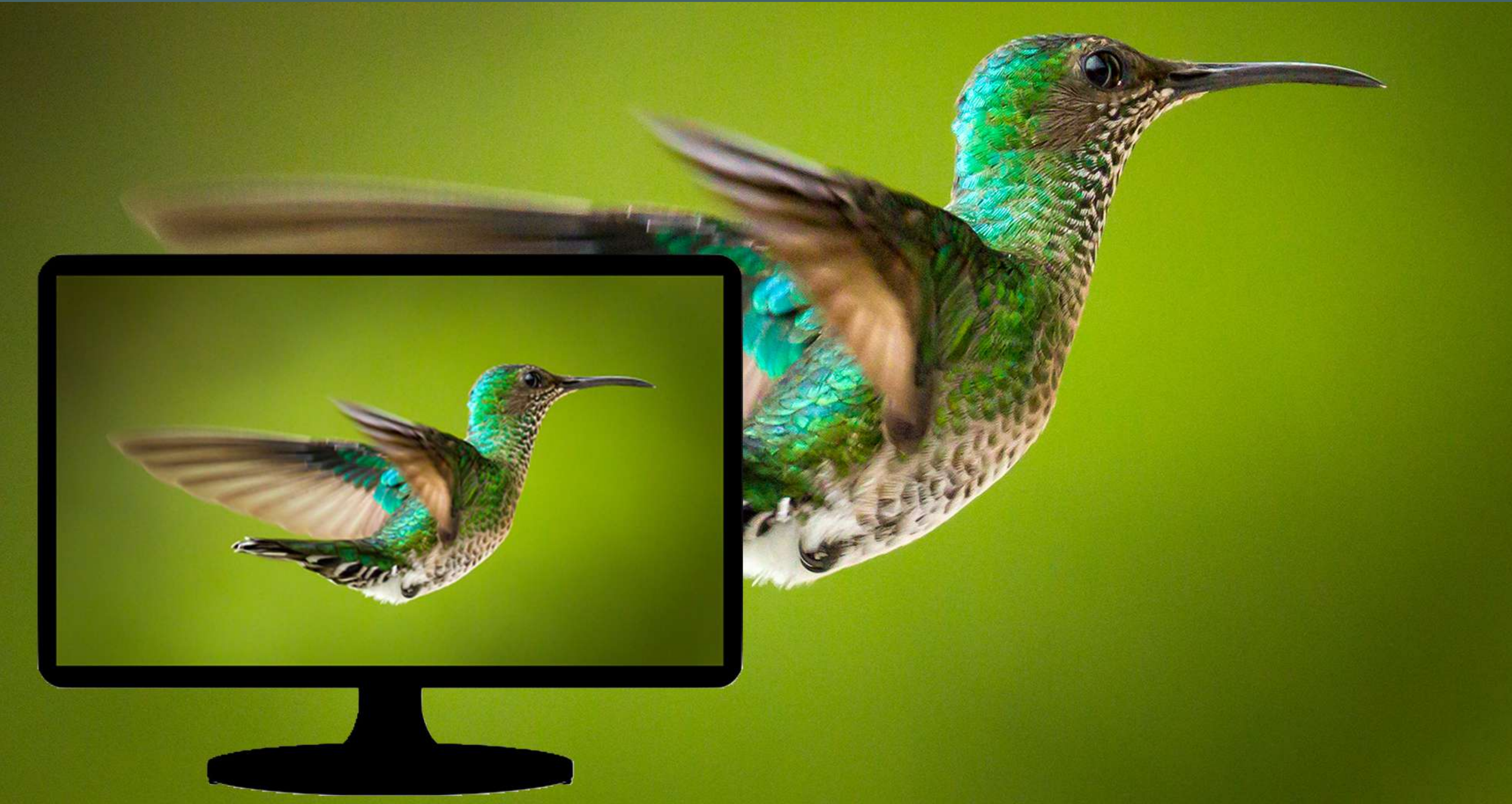
THE COLOR-MANAGED WORKFLOW PART TWO: COLOR SPACE AND MONITOR CALIBRATION

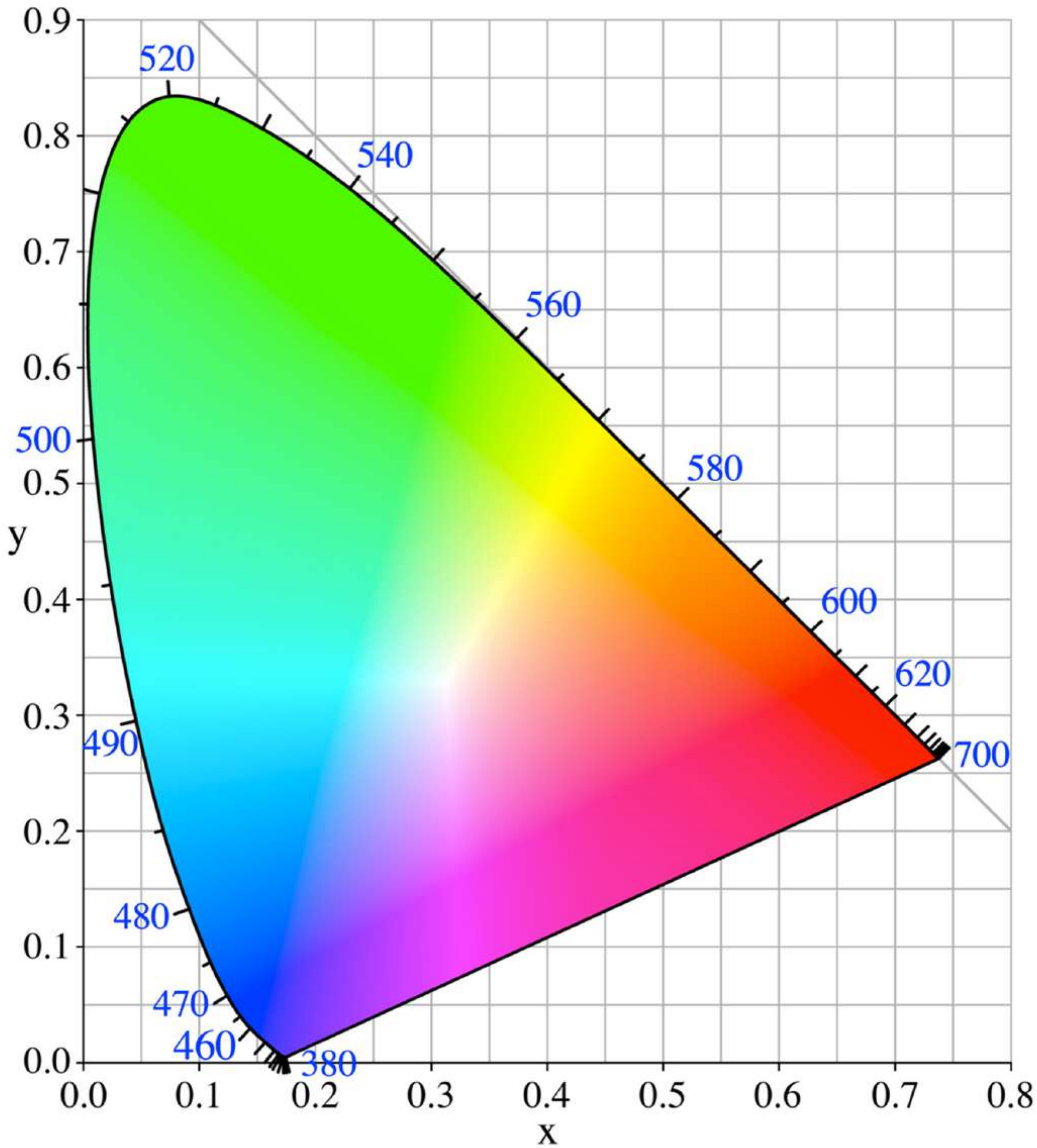
Quick Guide
Written by Rob Eyers



Part One of this series discussed the naked eye and whether it can be trusted in making objective measurements. It also detailed how color information is translated between devices using ICC profiles and the reference color chart for photography. This guide takes a look at color spaces and details monitor calibration.

In order to understand color management, it's necessary to have an understanding of color spaces. As discussed in Part One, the human eye can see approximately 10 million different colors. They all fall within what is called the visible light spectrum. Technically, this is the electromagnetic radiation spectrum that's visible to the human eye. Those visible colors and their wavelengths are as follows:

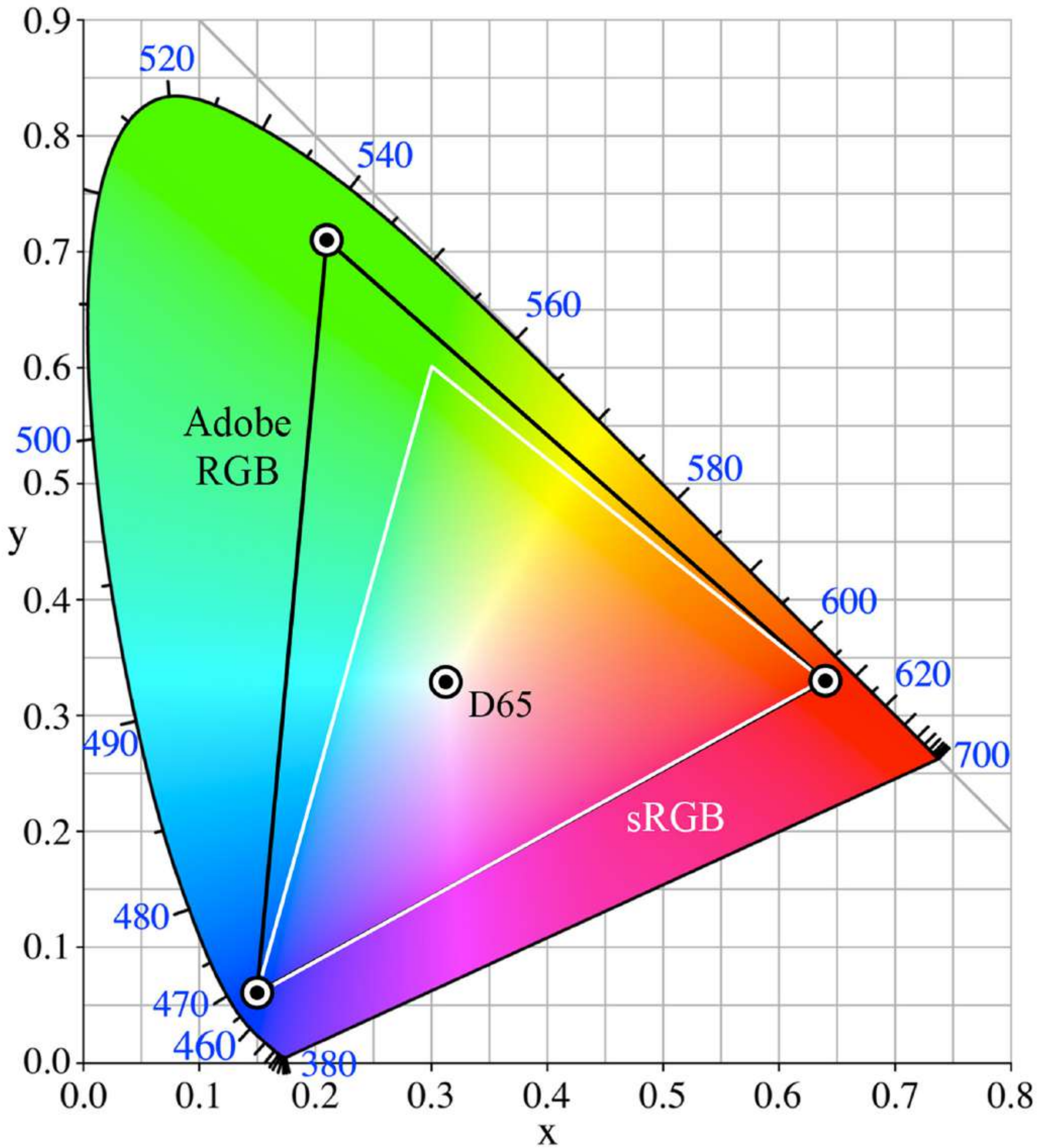
COLOR	WAVELENGTH (IN NANOMETERS, OR BILLIONTHS OF A METER)
Red	625 - 740
Orange	590 - 625
Yellow	565 - 590
Green	520 - 565
Cyan	500 - 520
Blue	435 - 500
Violet	380 - 435



For most of us, scientific data causes our eyes to glaze over. A more appealing way of looking at visible light is with a color graph.

The color graph on the left is how the visible light spectrum is normally depicted. The numbers around the outside of the chart are the colors' wavelengths in nanometers. It should be noted that there is a third dimension to this 2D chart. The third dimension expresses the level of brightness of any given color. We'll stay with 2D for now.

Wouldn't it be great if current photographic equipment could capture the whole visible light spectrum? The sad truth is, it can't. Even if it could, it would still be constrained by the standards that were defined using previous technologies. As past equipment was developed, it became necessary to define the portions of the visible light spectrum that the equipment was able to reproduce. These portions of the visible light spectrum are referred to as color spaces, and they are the current color standards. In some ways we are still restrained by these previous standards.



This image depicts two of the major color spaces that photographers need to pay attention to. These color spaces are sRGB (standard red green blue) and Adobe RGB.

SRGB

sRGB was proposed as a standard for display, internet, scanners, digital cameras, and printing systems by Microsoft and Hewlett Packard in 1996. Before that time, color was not managed between devices, which made it impossible to predict what color an image would be when viewed on any other device. It was total color chaos, so sRGB was proposed to make color and brightness consistent between devices.

The standard was based on the average performance of a consumer CRT (cathode ray tube) TV of the day, as they were the weakest link. Even though they were the weakest link, TVs were roughly similar due to the use of almost identical red, green, and blue phosphors and the broadcast standards of the day. Today's display panels would most assuredly dictate a different color space, but the sRGB standard persists due to its universal adoption, and its use for the world wide web.

Key Lesson: sRGB is the color standard for the internet.

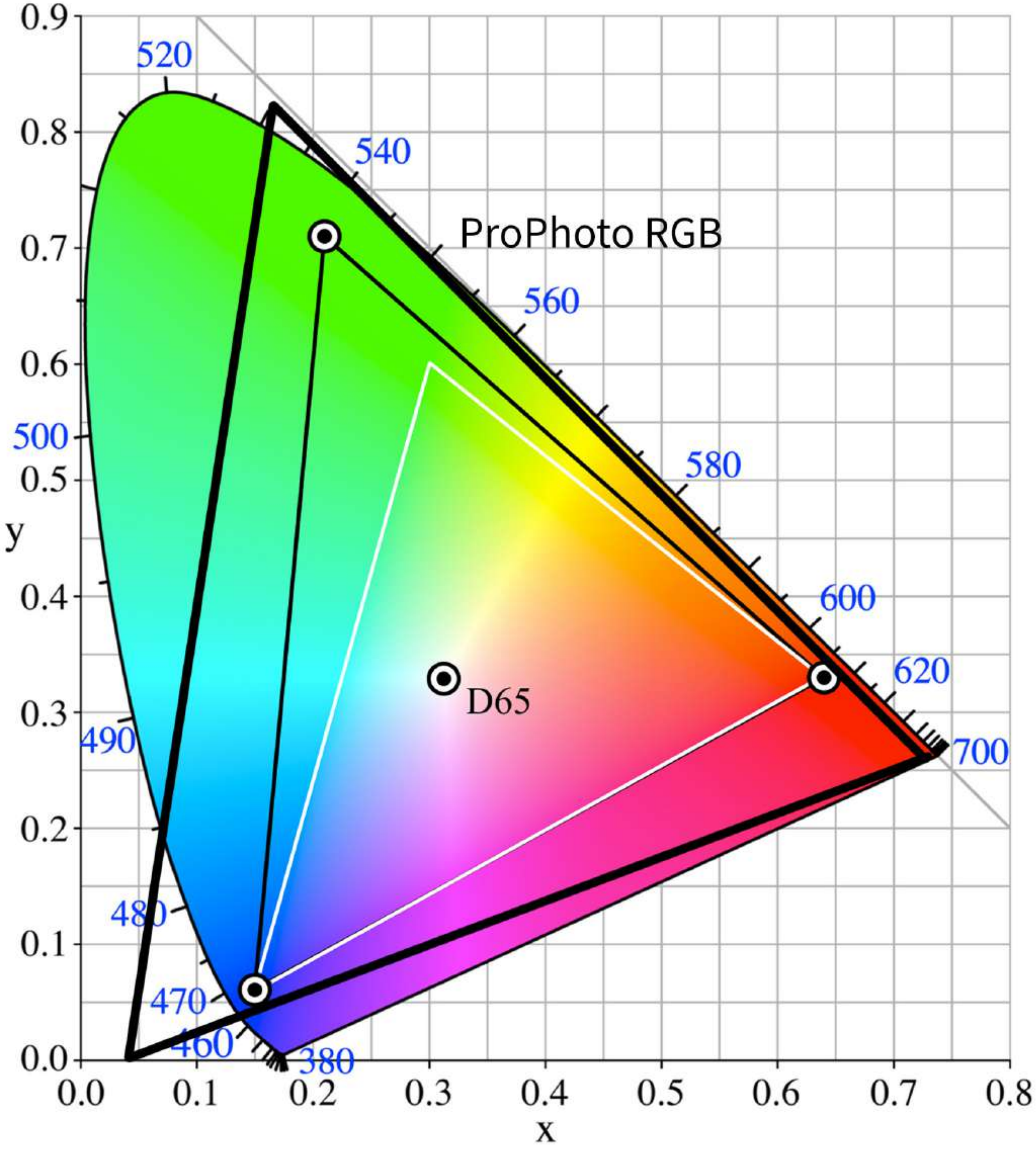
Recommended Reading: Want to create memorable, fascinating, and impressive color photographs? Grab a copy of Photzy's premium guide: Rich and Vibrant Color Photography Volume 1.

ADOBE RGB (1998)

Adobe RGB is a color space that Adobe Systems Inc. developed in 1998. Its purpose was to cover all of the ink/dye colors possible in CMYK (cyan, magenta, yellow, black). CMYK is the subtractive color model of color printers.

Adobe RGB included all of the colors in sRGB and about 50% of the colors available in Lab. Lab, as discussed in Part One, is the technical color space that includes all of the colors that the human eye can see. In comparison, sRGB only includes about 35% of Lab. The increased color coverage of Adobe RGB is primarily in the cyan/green range.

Adobe's first release of Photoshop in 1989 was not color managed. Color management only began in 1996 with the sRGB standard. Photoshop's first color-managed release was in 1998 with version 5.0, which included sRGB and Adobe RGB (1998).



PROPHOTO RGB

The third and largest color space is ProPhoto RGB. This space includes 90% of what we can see but also has some colors outside of our vision. Those colors are referred to as imaginary colors. Because this color space is so large, there are some special considerations to keep in mind. These will be discussed as we progress, but for now, just be aware that ProPhoto RGB exists.

THE MONITOR'S HISTORY

Why does a monitor require calibration? To understand that, it's helpful to understand how we got to where we are today.

Color TV was first incorporated into the 1943 National Television System Committee (NTSC) standard in 1953. Incredibly, the first version of the standard called for a spinning color wheel which was to be placed in front of the black and white TV set. A broadcast would sync the rotation of different colored wheel segments so that the viewer would perceive a color image. It was envisioned that the public would rush out to their local drug store to purchase these contraptions.

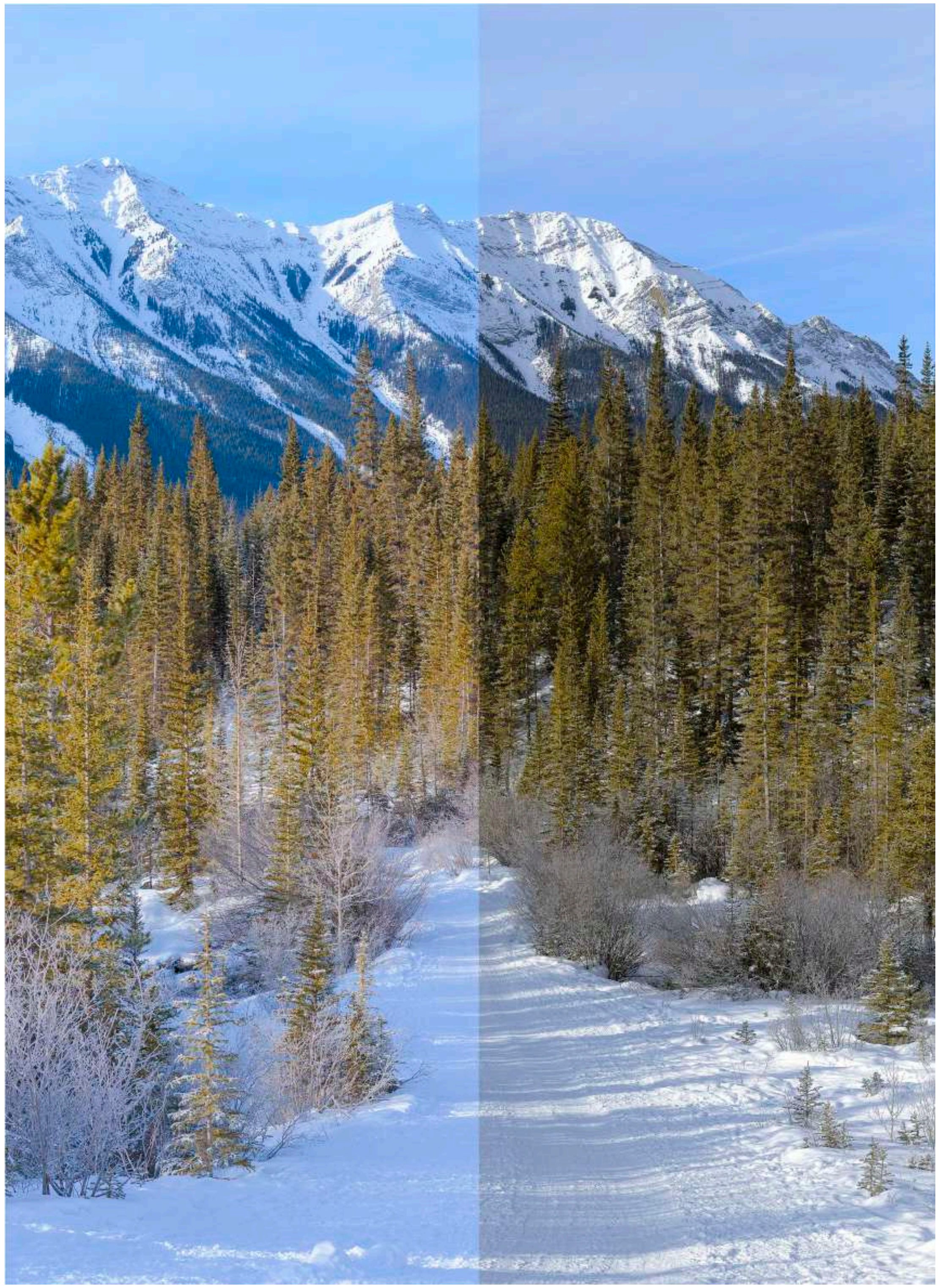
The RCA company was able to get the NTSC to repeal this misguided color folly and adopt their electronic process in 1954. Television manufacturers began aggressively selling color TVs in the mid-'60s as more color broadcasts became available.

In order to boost sales, the TV manufacturers quickly picked up on one of color's peculiarities. The laundry detergent industry had already been using this color trick to sell their product. They'd found that putting a small amount of blue dye in their product made the washed clothes seem brighter. Advertisements of the day claimed that clothes washed in their product came out "whiter than white." TV manufacturers picked up on this and began to deliberately manufacture their sets with a blue color cast. This made the TV set seem brighter. It was thought that the consumer's eye would pick the brightest television as the best one. As there was no regulation of color accuracy, industry insiders began to jokingly refer to the NTSC standard as '**N**ever **T**wice the **S**ame **C**olor.'

This was the color reality when the sRGB standard was introduced in 1996. Obviously, it wasn't a good situation for anyone wanting correct color. Even after the advent of digital and flat panel technology, some of this thinking still remains, although to a lesser degree.

It stands to reason that if a monitor is not calibrated to display accurate color, then there's no way of post-processing an image with any hope of color accuracy. Although it's not possible to know what an image might look like on a non-calibrated monitor, it has a better chance of looking OK if it's correct to begin with.

Prints are also dependent on accurate color, which will be discussed in Part Three of this series. For now, just know that monitor calibration is very important for accurate color printing. This will be thoroughly detailed in the next installment.



MONITOR CALIBRATION

This image is a simulation of a non-calibrated monitor on the left and a calibrated one on the right. Before calibration, many monitors are typically too bright, too blue, and lacking in contrast.

The purpose of calibrating a monitor is to have it display colors, brightness, and contrast as accurately as possible. When the capture device and the output are also calibrated, the workflow is referred to as a color managed.

Let's assume for a minute that a printer is calibrated and that it produces colors accurately. Let's also assume that the monitor is not calibrated and it shows red as being purple. Image processing would require a color adjustment in order to see the purples as reds on the monitor. The resulting reds would then have been altered. A calibrated printer would accurately print that altered red, which is now more of an orange.

Key Lesson: Prints that are not the same color as what is seen on screen can be the result of a monitor that is either badly calibrated or not calibrated at all.

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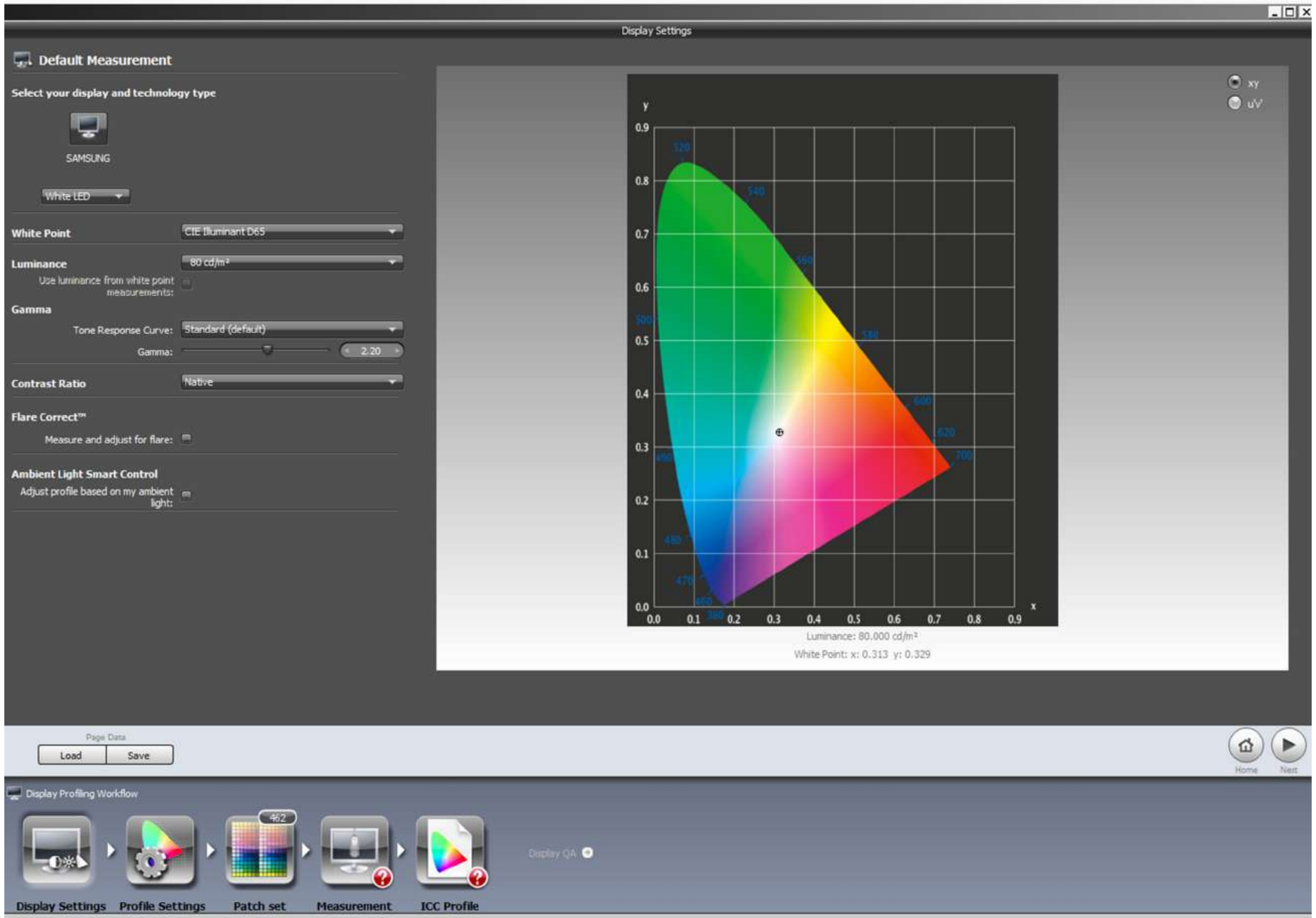
There are a few different devices on the market for calibrating monitors. They're fairly inexpensive, especially if compared to the cost of a good camera or lens. Given that a flat panel monitor will only require recalibration once a month, sharing a calibration device with other photographer friends could make one even more affordable. Two of the companies making these colorimeter devices are X-Rite and Datacolor.

I personally use X-Rite's i1Display, so any direct references here will be to their hardware/software. Datacolor's products make the same corrections as those of X-Rite. For specific details, please refer to the manual of the product of your choice. Whichever one you choose, be sure it has luminance adjusting. Some devices don't have this feature, and it's an important feature in getting the brightness and contrast adjusted correctly.

The calibration process of all of these devices is approximately the same. The calibration device is placed on the front of the monitor to measure the brightness, contrast, and color. A series of dark to light screens of various colors are displayed. The software compares the monitor's output to the known color values and makes whatever corrections are necessary, bringing the monitor's output as close as possible to the known values. An ICC monitor profile is then saved to the system level of the computer to complete the calibration.

Because the use of these calibration devices is so well supported by YouTube and manufacturer videos, a detailed walkthrough of each isn't necessary in this guide. What is important, though, is an understanding of the choices to be made in the calibration process.



This image shows the first screen of the i1 PROFILER software. On the left side are several choices that have to be made.

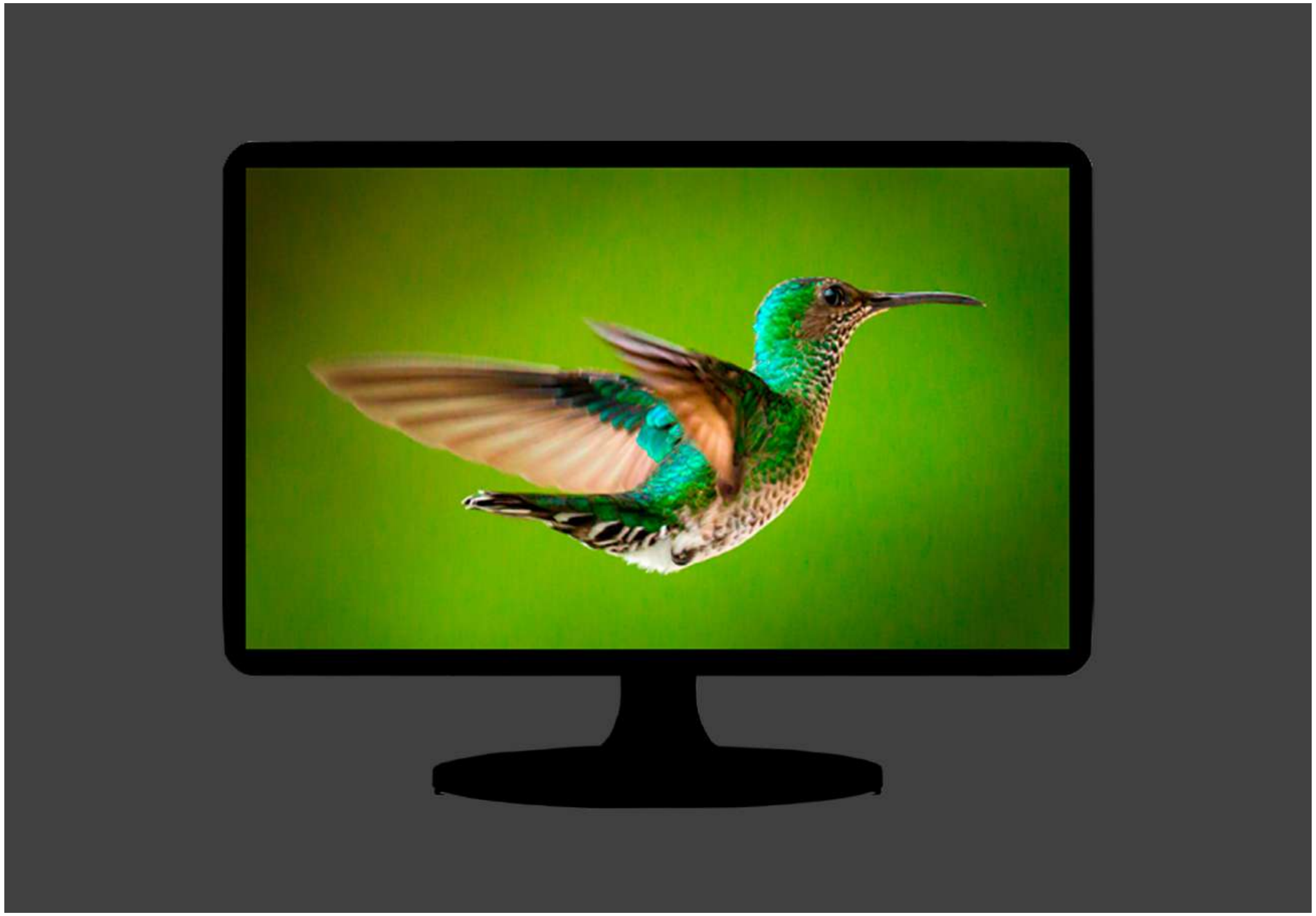
The first choice is the white point because the monitor needs to be set to a color temperature that establishes the color of neutral gray. The CIE (International Commission on Illumination) sets the standard daylight illuminant by the color of sunlight at high noon in northern Europe. This setting should be set to D65 (6500 Kelvin), which is the appropriate setting for photography and graphics. The D50 setting is typically used for prepress.

The next choice is luminance. This is the setting for the brightness of the monitor. The device manufacturers typically recommend 120 as the average setting. In my experience, this can lead to a few issues. A setting of 120 can make it more difficult to see detail in the highlights and can also cause prints to be too dark. A setting of 80 to 100 is usually better, with 80 being my choice because I print. Keep this in mind when we discuss printer calibration in Part Three.

Gamma comes next. This is a complicated topic, but here is a simplified explanation: Digital cameras see double the amount of photons hitting the sensor as twice as bright, but our eyes do not see this increase as twice as bright. We see this as only slightly brighter. Our eyesight is actually more sensitive to changes in darker tones than to brighter ones. It's gamma that translates between our eye's sensitivity and that of the camera. Digital cameras in the sRGB or Adobe RGB color space use a gamma correction of 2.2. Images from the camera are gamma encoded with this gamma value. Monitors, on the other hand, usually use a gamma correction of 2.5 when manufactured. If the monitor isn't adjusted to a gamma of 2.2, then the images are going to be dark and unlike the original captures. Put simply, it's gamma that sets the brightness value of an image to what we would normally perceive.

Next is contrast. Choosing the monitor's native contrast will take full advantage of what it can do. Brightness and black levels are inherently part of contrast, and they can be adjusted either automatically by the software, or manually in the monitor's menu. When adjusting manually, it's important to understand that the brightness control is for setting the black level and the contrast control is for setting the brightness. That seems counter intuitive, but that's just the way the industry labeled them in the beginning.

Lastly comes the choice of how large of a color patch set to use. A larger patch set will yield more accurate results, so use that if given the choice. After the calibration is completed, you'll be given the opportunity to name the monitor's profile before saving it. Use a name that includes the monitor name and the date, so you know when it was last calibrated. The monitor has now been adjusted to the ICC color standard, and the profile makes sure that each color is as accurate as possible. As a result, the images that are sent to a print house, printer, or used on the web will look like what is intended.



Calibrating the monitor, however, is only part of setting up the post-processing environment. There are a few other things to be aware of which can influence color perception and tonality.

- How bright is the room? If the room is too bright, the tendency will be to turn up the brightness of the monitor. As discussed earlier, this can result in images that are too dark. Set the room brightness appropriately before calibrating the monitor.
- What color is the light in the room? LED bulbs are available in a variety of color temperatures. They range from 2700 Kelvin (very warm) to 6500 Kelvin (daylight). After calibrating the monitor to D65 it makes little sense to wash the room in yellow (2700K - 4100K) light. Use a bulb in the 5000K to 6500K range, and if it's dimmable that's a plus.
- What color are the walls? The neutral gray from a ColorChecker passport is ideal. Take it to the paint store and cover up those brightly colored walls.

- Use a monitor hood. This is a must to keep light from falling on the screen. That light will result in the apparent contrast being diminished. This doesn't have to be expensive. It's easy to make a hood from black coroplast, which is cheap and readily available at most home building supply stores.
- Be aware of dominant bright colors in your photo editing space. A reflective screen can be a mirror for that favorite bright red shirt you're wearing.

Calibrating the monitor and being aware of the color of items and objects in the editing environment will make editing much easier and more accurate. This is really only the starting point, though. What comes next is calibrating the capture device and dealing with output settings and printer calibration. All of this will be discussed in Part Three of this color-managed workflow guide.

Enjoy the journey! Happy editing!

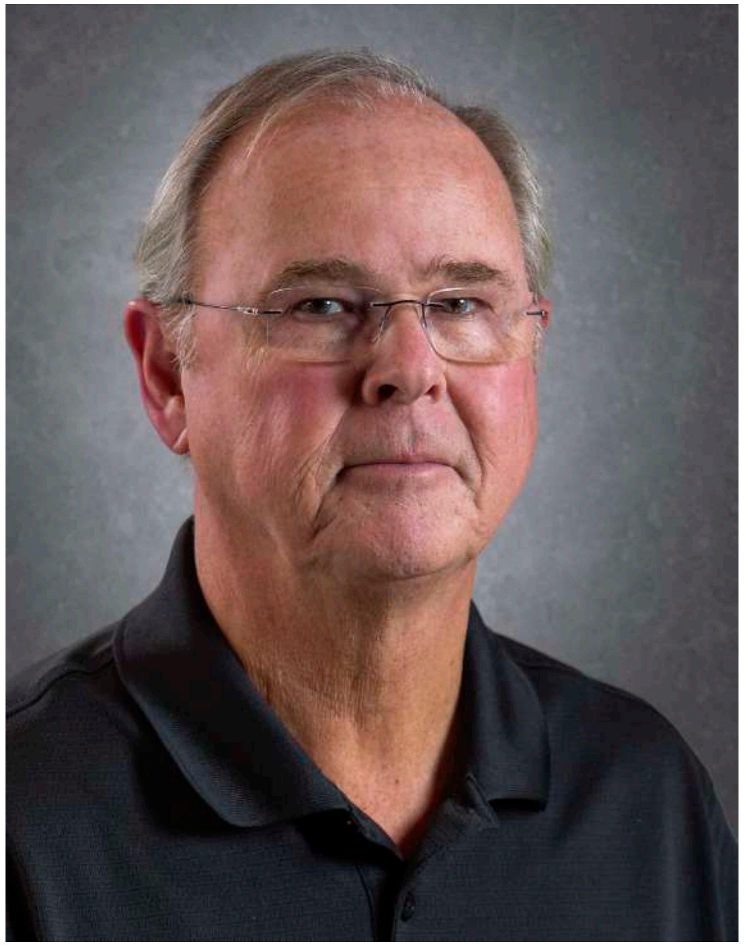
Self-Check Quiz:

1) When was the first color-managed version of Photoshop?
2) What is the color space of the internet?
3) A non-calibrated monitor is likely to have too much of what color?
4) What does brightness adjust on a monitor?
5) If prints are too dark, is the monitor too dark or too bright?
6) What device is used to calibrate a monitor?
7) Is the color of the photo processing environment important?
8) What should the monitor illuminate be set to?

Answers:

1) 1998
2) sRGB
3) Blue
4) Black level
5) Too bright
6) A colorimeter
7) Yes
8) D65

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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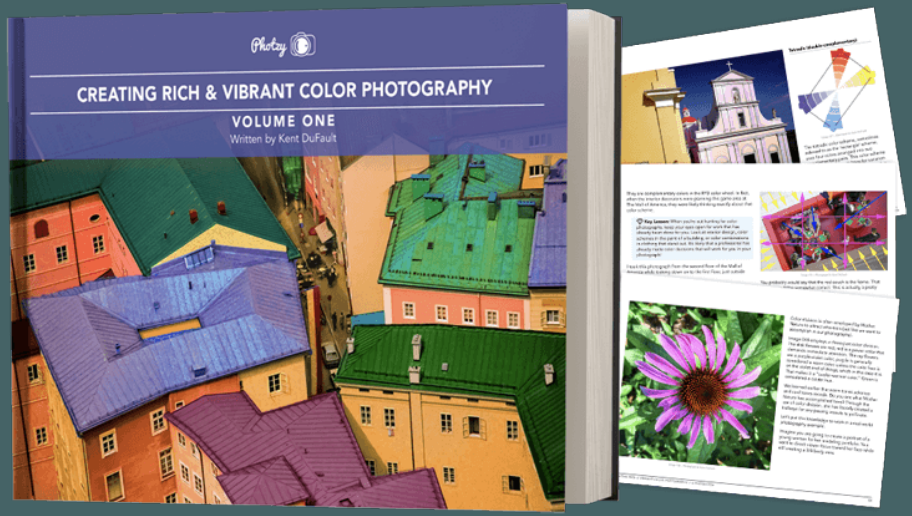

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