RIMAGE®

THE SCIENCE OF COLOR

EXECUTIVE SUMMARY

OBTAINING PROPER COLOR IN A VARIETY OF PRINTED MATERIALS CAN BE A SOURCE OF MYSTERY FOR THOSE NOT WELL-VERSED IN COLOR THEORY. HOWEVER, A BASIC UNDERSTANDING OF COLOR CAN GO A LONG WAY TOWARD EDUCATING USERS ON WHY WHAT THEY SEE ON THEIR COMPUTER SCREEN DOES NOT MATCH WHAT ARRIVES FROM THE PRINTER. WITH A BASIC UNDERSTANDING OF COLOR, MARKETERS CAN WORK EFFECTIVELY WITH DESIGNERS, PRINTERS AND THEIR OWN IN-HOUSE STAFF TO PRODUCE HIGH-QUALITY PRINTED MATERIALS THAT LOOK GREAT ON THE SCREEN AND PRINT OUT TRUE TO COLOR ON THE FINAL COLLATERAL.

I. Introduction

We have all been there: the colors on your printed sales brochure do not match the printing on your companion CD or DVD, which is a little bit different from your website's color scheme. No one wants to look unprofessional to clients, especially when the slightest mismatch of colors can lead to a bad first impression and potentially the loss of business in this competitive marketplace. This guide to color is designed to help you understand how color technology works, without burying you in technical jargon. This summary will provide you with the information needed to understand color and technology and how Rimage can offer your company a solution for the best color results on your printed discs.

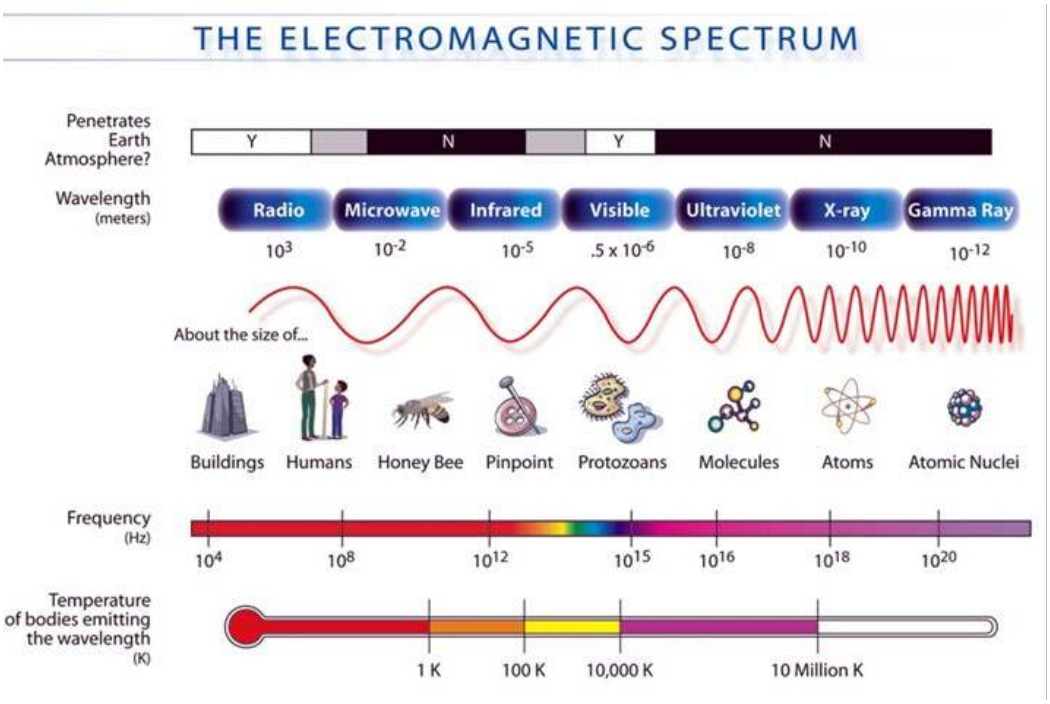

Figure 1. The Electromagnetic Spectrum

II. Color Defined

Color is reflected light, and light is electromagnetic (EM) energy. Light can come from the sun or another source like a light bulb. The human eye can only see a small portion of all the energy there is to see. You may be familiar with most of the EM spectrum, like microwaves, radio waves and x-rays (See figure 1).

Humans can see in the "visible" portion of the spectrum. The longest wavelengths correspond to colors like red and orange. The shortest wavelengths correspond to colors like purple and blue. Other animals, such as birds and insects, can see more of the EM spectrum than people can, extending into the ultraviolet. In other words, animals see more colors than people.

III. Color Accuracy and Color Repeatability

What we need to focus on when it comes to printed discs is color accuracy and color repeatability. Color accuracy refers to how well a color matches up against an industry-wide standard; this is what red looks like, this is what blue looks like, and so on, including all of the millions of colors in between. Color accuracy is determined using a device called a colorimeter, which measures the colors produced on a computer monitor and compares them against agreed-upon standards so that a computer monitor or other device can be adjusted to display or produce color correctly.

Color repeatability is a related term that refers to how well a device like a printer can produce the same color consistently over multiple printed pieces. Printers are basically mechanical objects that use a variety of means such as ribbons, lasers or very small ink nozzles to apply color to an object. Like any mechanical device, printers do not operate exactly the same every time. The goal is for a printer to function within a very fine "tolerance zone." This means that even if one envelope is printed in a shade of "sky blue" and it is a tiny

percentage different than the next, as long as the two shades of blue are within the tolerance allowed, they are both considered “sky blue.” The goal is to produce high quality printers that are able to consistently print multiple pieces with a small margin of color error.

Here is an example: You are buying gallons of paint for your home. The person at the hardware store mixes up three gallons of satin finish ivory for you. The goal is make sure that the first gallon of paint that goes into the paint mixing machine is accurate (a true representation of ivory), but that the next two gallons are accurate as well (repeatability). The truth is that every gallon is just a little different than the next, because machines are only so precise. Yet, the paint is so close to being the same color that only a detailed scientific analysis could distinguish them—and certainly not your eyes when you apply the paint.

Color Gamuts:

A color gamut is the portion of all the colors that a particular device can display or print, like a computer monitor or printer. Every device is limited to displaying a certain number of colors.

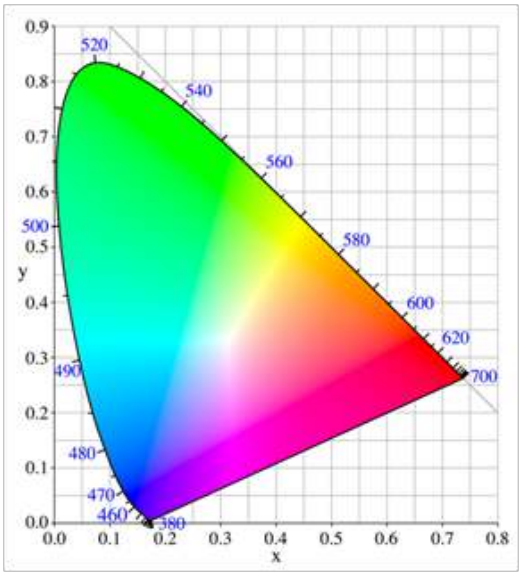

Figure 2: Colors the human eye can see.

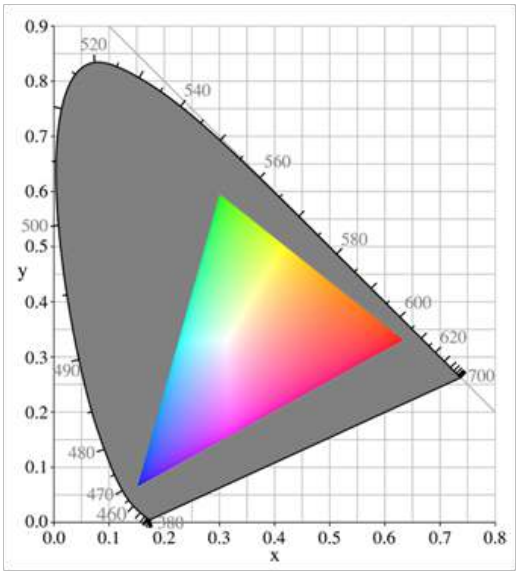

Figure 3: Color gamut for a CRT monitor.

IV. Color Gamuts:

Now that we have talked about what color is, color accuracy and color repeatability, we will talk about color gamuts. A color gamut is the portion of all the colors that a particular device can display or print, like a computer monitor or printer. Every device is limited to displaying a certain number of colors.

Figure 2 is a graphic representation of the colors the human eye can see. However, not every device can reproduce all of these colors. For example, Figure 3 shows the portion of the entire visible color spectrum that can be displayed on an old-style cathode ray tube (CRT) computer monitor. As you can see, it is a much smaller portion of the entire color spectrum than the human eye can see, due to the way that CRT technology works. We will learn more about that in the next section.

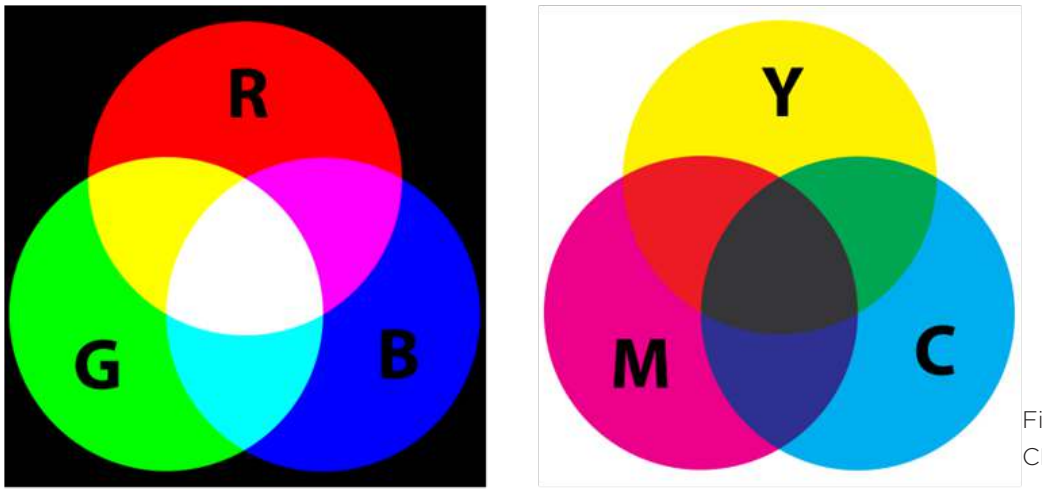

Figure 4: The RGB (left) and CMY (right) color models.

V. RGB & CMY

RGB and CMY are two ways that colors are displayed. RGB, or Red, Green and Blue, is called an additive color model in which red, green and blue light is added together to produce different colors. This is the model used by most electronic devices, like cameras, scanners, TVs and computer monitors. CMY is a subtractive color model that is used in printing. Three colors are applied to the white paper, which "subtracts" or removes certain colors from being seen by the human eye. The three colors are cyan, magenta and yellow.

The example above in Figure 4, shows the RGB and CMY color model comparisons. Can you see a problem right away? Remember, different devices can reproduce different portions of the color spectrum that humans can see (color gamuts). If your computer monitor, which uses RGB, shows one color, and your printer (which is CMY) tries to produce that same color on paper, what do you think might happen? Odds are the colors will not look exactly the same. As we discussed earlier, the colors might be repeatable, but they will not necessarily be accurate. Here is an example.

Suppose you design a complete set of marketing materials on your computer. Everything matches wonderfully from a color standpoint on the screen and it looks professional. You hire a local printer to produce folders and business cards for your marketing kit. You run off a booklet in-house on your company's color laser printer, and burn a few hundred CDs with your new color logo on your optical disc printer. You anticipate how impressed the boss will be with the finished project.

The boxes of folder and business cards arrive. You assemble all of the materials, slide the discs into jackets, stand back to admire your work...and nearly have a heart attack. The pieces that seemed to match on the screen are not consistent and the colors do not match.

The issue goes back to the disconnect between how your electronic devices, like your monitor, scanner and digital camera produce color, and how that is translated to your printer and disc printer. The computer screen can display some colors the printer and duplicator cannot print, and vice-versa. It may seem that you are limited to having a collection of mismatched marketing materials, but do not worry—there is a solution.

VI. Color Management

Color management is the science of matching colors accurately across a variety of devices such as printers, computer monitors, digital cameras, scanners, copiers and other equipment. It is a process that scientists and computer programmers have developed to allow what appears on your screen to look like what is printed out.

Color management can be done by people whose expertise may be in management, sales or some other area of the business, but it is best when left to the professionals. It is important to work with a design professional whose equipment has been characterized (the color has been measured) and calibrated (adjusted so that colors look the same across devices). Professional designers with experience making things look great across the board will be familiar with concepts like working spaces and color space conversion. They will use software that converts and translates between the different color gamuts that devices can display, shifting some colors around and applying tweaks where needed, in order to produce great results.

Working with Rimage disc printers, it is not important that you fully understand this part of the process. But what is important is that you understand that problems can arise when producing a variety of printed materials, using all sorts of different equipment. With this knowledge, you can explain to a designer and printing company what your desired output is (folders, brochures, optical discs, etc.) and ensure that everyone understands what steps need to be taken to make your company look great.

VII. When In Doubt

You do not have to be an expert in the science behind color, digital imaging technologies, or color management to have great-looking printed materials, including your printed optical discs. What is important is that as someone who expects matching color, you understand the basics of what color is, how different kinds of devices display and manipulate color, and what the potential pitfalls are to the end user. With this knowledge, you can work with a graphic designer, printer and other partners like Rimage to fully convey your needs. By doing so, you can be assured that your color will be consistent across all your company's communication collateral.

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