Color in our daily lives

S-3-X: Can analyze the use of color science in the modern world and its effect on human behavior.

- Can describe what color is and the variations of color.
- Understands how color is measured.
- Understands how colors affect every aspect of our daily lives.

When I was first hired to set up the quality program at a printing company, I had a basic understanding of color and how it relates to product identification and branding. However, I quickly learned that there are very specific attributes that identify a color. Also, color can affect how we perceive a product, surroundings or even a person. Colors are all around us in our everyday lives and though they may not be a moving part of life, they do have a tremendous impact on our everyday lives.

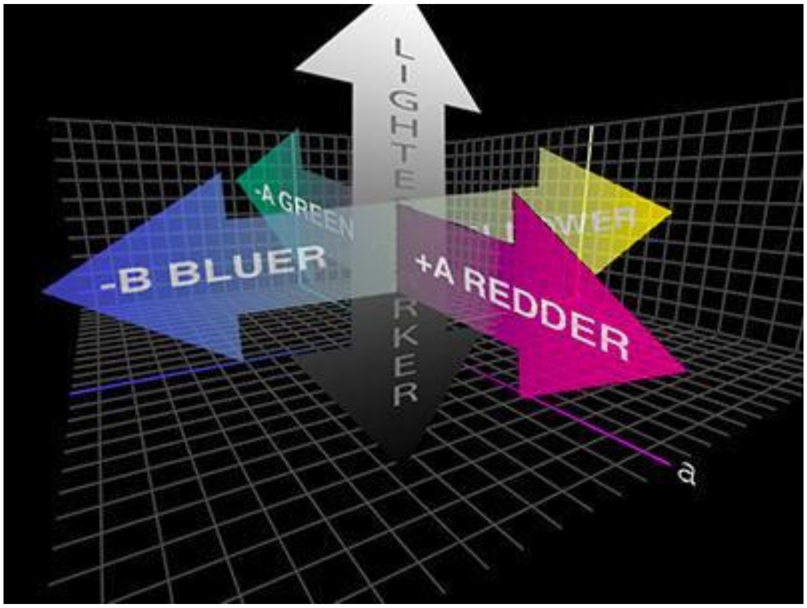
In this paper I will speak about the technical aspects behind color and then speak about how color plays a role in our everyday lives.

First of all, what is color? Merriam Webster defines color as “a phenomenon of light (as red, brown, pink, or gray) or visual perception that enables one to differentiate otherwise identical objects” (Merriam-Webster, Color, 2015). Color can also be described as how the human eye interacts with an object when illuminated by a light source within an environment. When the human eye sees an object the receptors in the eyes translate the wavelengths that are reflected off of the object into a color (Kuehni, 2013).

A commonly known acronym is ROYGBIV, which stands for seven of the primary colors: red, orange, yellow, green, blue, indigo and violet (Shevell, 2003). One can use these names to generically describe a color. The United States dollar bill is described as green, the sun is described as yellow, and the sky is described as blue, on a clear day. These are only a few examples of how we use color to describe some of the things in our daily lives. How I see an orange may be different than how someone else sees an orange. For example, if someone were to tell me they saw an orange lion on a trip to Africa I will more than likely visualize a different orange color than what the person actually saw. Though we have primary colors, the differences within a color, using the lion as an example, is called changes in hue. Differences in the shade of the color is another way to describe what hue is (Merriam-Webster, Hue, 2015). A light shade orange color versus a dark shade orange color is a great example of how to describe changes in hue when it comes to a specific color. Another characteristic that affects color is the change in saturation. A color can be more or less saturated, which changes the color. For example, the pigment in the lion's hair could be heavily saturated thus causing a dark color of orange or it could be lightly saturated resulting in a lighter shade or color of orange. Another example would be making a cup of hot tea. Depending on how long the tea bag is left in the cup will change the color of the tea. Less time will result in a tea that is less saturated with color, or it will have a lighter shade of brown and will appear more transparent. More time will result in a tea that is more saturated with color, or it will have a heavy shade of brown and will appear more opaque.

Defining a color is more than just hue and saturation, but it is also about brightness (Shevell, 2003). With this in mind a color is actually three dimensional in nature. The most common way to visualize a color is by looking at the graph below in figure one. Colors are considered to be light or dark, blue to yellow, or green to red. The light and dark is represented as the 'L' axis, the green and red is represented by the 'a' axis, and finally the blue and yellow is represented at the 'b' axis. Moving around these three axes changes the hue, saturation and brightness and thus changes the color.

Figure one



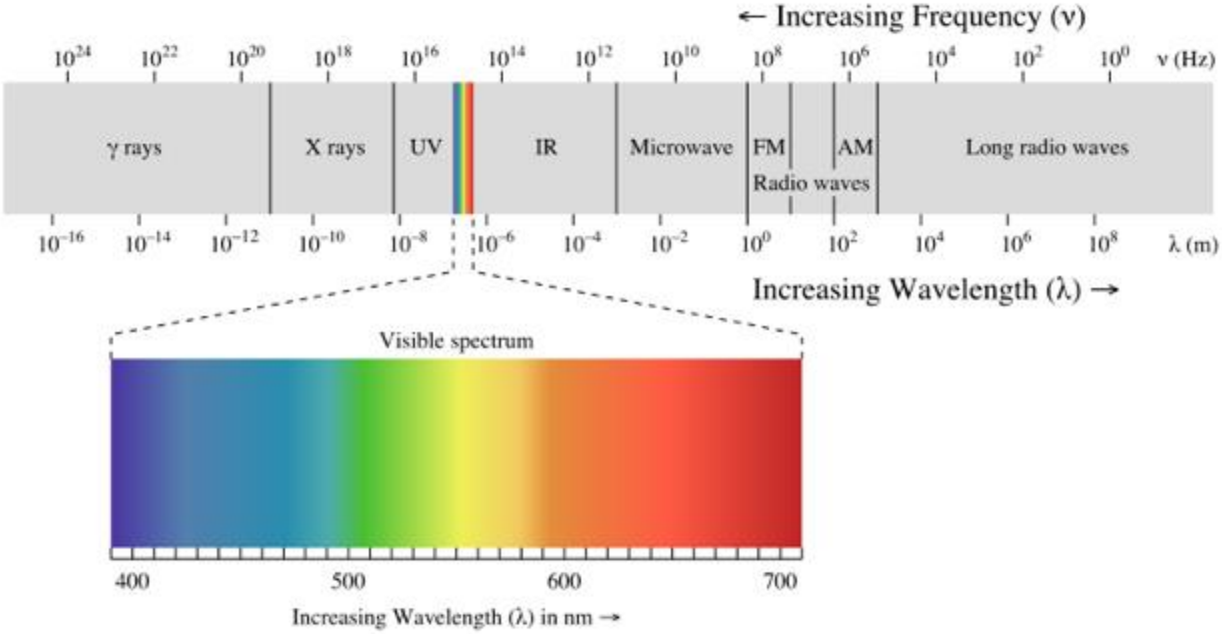
(Hill, 2014)

This graph can also be used to visualize hue. Hues fall into one of four descriptions: yellow/red, red/blue, blue/green and green yellow (Shevell, 2003). In looking at the graph one can see how starting at yellow and going clockwise there is a pattern going from yellow to red to blue to green and then back to yellow. In following this pattern one can visualize the changes in hue across the color space.

When it comes to visualizing saturation the graph shows that the further out a color goes from the center "L" axis the more saturated a color becomes. For instance, along the "a" axis, the higher the numeric value of a red color means that it is further away from the light/dark axis and is more saturated.

The colors the human eye can see are not the only colors that are in our world. There are the colors that are invisible to the human eye. Below, in figure two, is a chart showing the spectrum of light and the colors humans can see as well as color that are outside of the human spectrum.

Figure two



(Foresman, 2009)

This spectrum chart shows what colors are visible to the human eye in the "Visible Spectrum" portion. Color is not just a color but it is actually light bouncing off of an object and is measured in the form of a wavelength. The length of the wavelength determines what colors our eyes are seeing. As seen in the chart, UV, or ultraviolet color or wavelengths are not visible to the human eye, though we hear about the importance of ultraviolet and protecting our skin from the damage it can cause, especially on sunny days. As the chart also shows, there are a variety of other wavelength spectrums that the human eye cannot see, though they do exist and are part of our daily lives. Infrared wavelengths or colors are used to run the remote controls for our electronic devices. Microwave wavelengths or colors are used to transmit cellular signals or to heat up food. FM and AM wavelengths or colors are used to transmit music or talk shows to our automobiles or other devices that are tuned to "see" these wavelengths or colors.

How is color measured in an objective manner? First, let us look at the colors the human eye can see. There is an electronic instrument called a spectrophotometer which measures colors. This unit uses a given light source and when a sample of a color is inserted into the unit, the light source is introduced or bounced off of the sample. There is a sensor which captures the light or wave lengths that bounce off of the sample. The wave length data collected by the sensor is fed to a computer, which then measures and numerically assigns different values related to the sample. Every color absorbs light differently. The darker a color is the more light it will absorb and conversely the lighter a color is the more light it will reflect. Other data, such as transparency or opaqueness, can also be calculated from the data collected from the sample. Using the data, the spectrophotometer can create a chart or graph that visually puts or plots the color into the three dimensional space like in the Lab graph in figure one. Rather than just looking at a bunch of data, one can visualize or see where a color lies within the three dimensional space (Blauch, 2014).

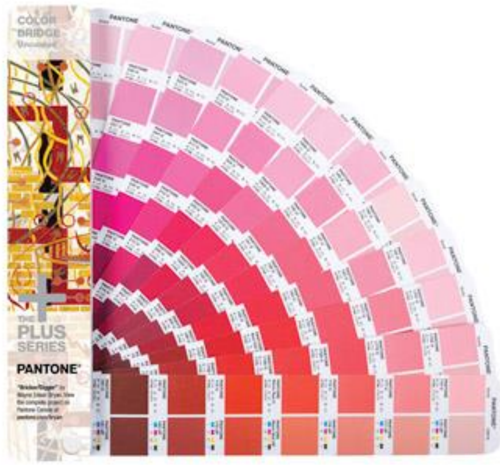
How can one measure the colors beyond what the human eye can see? Spectrophotometers are also used to measure the other spectrum of wavelengths the human eye cannot see. Each spectrophotometer is built to measure a specific set of wavelengths. To measure colors that are visible to the human eye, the unit is fitted with sensors and software that are appropriate for measuring these wavelengths. To measure ultraviolet or infrared wavelengths, for example, the units are fitted with sensors and software that measure these specific wavelength groups.

When it comes to identifying a color, one has to consider the light source. Colors can look different under different light sources. When this occurs it is called metamerism (Kuehni, 2013). An example of this would be how a car looks when it is in daylight versus inside a garage which is illuminated by fluorescent lighting. The color of the car could look like a light shade of blue in the daylight while it could look a totally different blue when exposed to the fluorescent lights. When the spectrophotometer measures a color sample it can also collect data on how the color “looks” under different light sources. The calculation is called a metameric value. The more similar the metameric values are from one light source to another, the less likely there will be a visual difference in color when observed by the human eye (Kuehni, 2013).

Not only can colors look differently under different light sources but they can look different under the same light source depending on the amount of light. A study shows that when children sorted candy based on color they were able to do so more accurately when there was a higher amount of light versus less light in a classroom environment. When there was less light the children were not able to clearly discern colors; a blue candy appeared to be black, a red candy appeared to be brown and a yellow candy appeared to be orange (Blattner, Hug, Ogrodnik, & Korol, 2013).

How does one maintain consistency when it comes to color matching? When it comes to printing or any manufacturing process there can be a lot-to-lot variation with color. A yellow carton printed on a Monday may not look the same as a yellow carton printed on a Friday. Companies use colors as part of product identity, and in turn people identify products by color. Coke has Coke Red, Kodak has Kodak Yellow, Tide laundry detergent containers are a very specific orange red, but the most common standard for maintaining consistency when it comes to color matching is what is called the Pantone Matching System, or PMS. The PMS company issues standard colors in the form of a booklet and when you “fan” the booklet you can see the broad spectrum of colors within that booklet, starting with the light colors on the right and going to the dark colors on the left. On each “page” there are colors printed that cover different hues of a specific color. For instance, on one page there will be a series of reds, a light shade red on the top and a dark shade red on the bottom. In between there are different shades or hues printed within that red group. Each printed color will have a number such as PMS 485. Here is an example of what a PMS book looks like:

Figure three

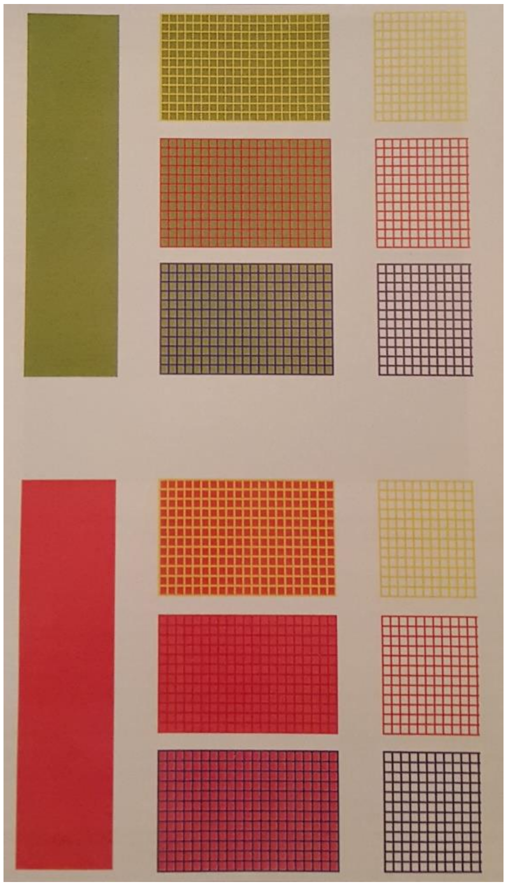


(Pantone, 2015)

Using that PMS standard takes all the guess work out of what the color match should be. It makes the color matching objective rather than subjective. In using a standard, whether it be Coke Red or a PMS standard, one can minimize the differences that may occur during the manufacturing process. The goal is to make sure that the yellow carton printed on Friday is going to look exactly, or very close to the yellow carton printed on that previous Monday. Referring back to the lion example, if a person were to say the color of the lion was PMS Orange 123 then another person knows exactly what that color looks like when using a standard such as the Pantone Matching System.

Hue, saturation, brightness and light sources all affect the appearnace of a color. Can colors look differently when put next to different colors? Yes, and this is called chromatic adaptation (Shevell, 2003). In figure four, two colors are shown on the left side and three different colors in a grid pattern are shown on the right. When the grid pattern colors are overlayed on top of the two solid colors the appearance of the two solid colors changes significantly.

Figure four



(Shevell, 2003)

A real-world example of this is how colors can look differently in the printing industry. When it comes to food packaging colors are typically chosen using the Pantone Matching System. As seen in figure three the Pantone samples are printed individually. When colors are picked for any type of printing one has to be awre that a red may look fine by itself but when another color is introduced to the art work for, let us say, a new butter carton, that red can look totally different when the words“Unsalted Butter” is printed on top of it in a bright blue. One way to get around a potentially very costly mistake is to produce what are called mock-ups of the art work so that a customer can see how colors interact with each other or how colors chromatically adapt.

Now that we have a better understanding of color, its properties and how to measure color, let us now look at how color affects us personally; how it affects our moods and our daily lives.

Everything we look at has a color. Whether it is the alarm clock we first see in the morning or the night sky we see at night before we go sleep; color is everywhere.

Different colors can affect us differently. Red colors can cause excitement or they make someone feel warm. Red can also evoke someone to think there is danger or could see it as a warning, such as a stop sign or warning label. Red is used to convey love and passion, such as red roses or Valentine's Day. A less saturated red or a pink can initially be soothing but after long exposure can become very irritable (Elliott, Maier, Moller, Friedman, & Meinhardt, 2007). Red takes on interesting characteristics when it comes to food and food packaging. When it comes to food, the human eye translates red into an appetite enhancer. It is one of the reason why red is so prevalent in food packaging (Elliott, Maier, Moller, Friedman, & Meinhardt, 2007).

One study shows that when it comes to student testing, students do not perform as well if a test is printed on red paper. When a test is printed on blue paper, students perfrom better, and the study shows that students perform best when tests are printed on whtie paper (Tal, Akers, & Hodge, 2008).

Blue colors are the most abundant in the everyday environment that surrounds us. Blue colors convey tranquility and are soothing. Blue colors also convey stability and trust. Blue colors can also be very energetic, such as a bright neon blue. Blue colors can also covey coolness depending on the subject matter (Holzman, 2010). A blue ice cube or blue water in the artic are good examples of how blue colors can make us feel cool. Big corporations such as Blue Cross & Blue Shield, AT&T, IBM and others know the value of using blue, as a way to convey trust, across their entire corporate structure.

More recently, scientific studies show that blue light sources can be used as forms of therapy. For instance, the human body responds to the blue sky during the day and this stimulates the body to be awake, while at nigth the body knows that it is time to sleep when the sky turns dark. For someone who works incosnsitent hours or swing shifts, a blue light source has been shown to “reset” the body back into a more normal rhythm in relation to the heart and emotions. Blue light sources have been shown to help people with dementia and other mental ailments (Holzman, 2010).

Yellow is a color that conveys brighness or excitement. Yellow is a color that can envigorate or stimulate people. Yellow is associated with the color of the sun which is what helps keep the earth warm, and so yellow, in general terms, is associated with warmth. With babies, however, one study shows that babies who are exposed to yellow for a long period of time tend to cry more (Sutton & Whelan, 2004). Yellow is used as a way to draw attention to something, such as a warning sign. Yellow is also the hardest color on the eyes and can cause one to feel tired or fatigued if exposed to this color for any length of time (Sutton & Whelan, 2004).

Orange, in a muted or less saturated shade is considered to be calming and warm. However, when it is a very saturdated or dark orange, it can convey excitement or energy (Sutton & Whelan, 2004). We associate orange as not only as a color but as an actual piece of fruit. We know not only the color when we see it, but we know what it can taste like when we actually see an orange!

Green is considered to be a soothing, calming and relaxing color. If you look at food packing decaffeinated tea or coffee is often times in a green package conveying the message that it does not stimulate like its caffeinated counterparts. One study has shown that if a person puts a piece of transparent green paper over reading materials they are more likely to be able to read more quickly and comprehend more of what they are reading (Sutton & Whelan, 2004).

Hospitals often use white as it is considered a pure color and is associated with sterilty and cleanliness. White colors have the hightest reflectence value and are seen at the brightest of all the colors. White is also considered a sign of purity, which wedding dresses often respresent when they are a pure white (Sutton & Whelan, 2004).

Death and tragedy are often defined by a pure black color. Colongne companies use black packaging or promotional materials to convey sophistication of their products (Sutton & Whelan, 2004). Black has the highest wavelength absorption values and is seen as the darkest of all the colors. One study was done and shows that hockey teams with black jerseys are more likely to be penalized when playing a home game when the visiting team is wearing white jerseys, as regulated by the National Hockey Leage in 2003 (Webster, Urland, & Correll, 2011).

Summary

Since Isaac Newton first became interested in color to present day time (Mollon, et al., 2003), man has figured out what actually makes up color, how to measure color, and gain an overall understanding of what color is from a scientific view point. Not only has color become tangible but man has also figured out that it is not just something we see with our eyes but it has “life” and is much more than just wavelengths and measurements.

Color is everywhere we look. Color defines brands. Color defines seasons. Fall consists of browns and yellows. Christmas is defined by green and red colors. Hanukkah is defined by white and blue colors. Spring is defined by green and the many bright and dark colors of flowers. Color defines clothes: blue for denim, white for dress shirts or management jobs, dark blue for blue collar or manufacturing jobs and uniforms, while a bright blue can convey royalty.

Color affects our moods. Pink can be soothing but over long periods of time can be irritating. Blue can represent trust, while green can represent mistrust in the business world. Blue can also be soothing. Yellow or orange can evoke excitement. Blue water conveys that the water is clear and clean, while brown water conveys that the water is dirty and unsafe. The color of water can either makes us feel happy and safe or dirty and unsafe.

As this in an election year we are constantly reminded of the colors of the United States flag by the different forms of political advertising such as television advertisements, mail brochures or bumper stickers. In our culture, when we see the white stars and the red and blue stripes on the American flag one cannot help but be reminded of patriotism. In another country, Mexico for example, red, white and green are the colors of the national flag and represent patriotism and this can be said for any country around the globe.

Colors, no matter what hue, level of saturation or brightness impact not only how we perceive the world around us, but also what we buy, how we adjust to season changes and how we interact with the environment we live in. People identify and connect to things based on color, whether it is the color of a piece of food, the color of a corporate logo or the colors used in a school or national flag. Color plays a very important role in our daily lives.

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