

Implications

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Figure 1: Munsell Color Wheel

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Seeing Color

Color is the most dominant design element, and ironically, the most relative aspect of design. The perception of color involves human physiological and psychological responses. Object, light, eye, and brain are involved in a complex process of sensation and perception. Color attracts our attention, helps us make sense of our environment, and affects our behavior. Color plays a cultural role, an informational role, and even a survival role. It functions on a basic level of appeal and can elicit strong feelings of like or dislike. Color is a source of sensual pleasure (Pentak & Roth, 2003).

Color Order Systems

We are familiar with the most common type of color arrangement—a color wheel arranged in spectral order. Spectral order is especially pleasing to the human perceptual system. The spectrum occurs in nature in the refraction of light into bands of color—red, orange, yellow, green, blue, and violet. One hue gradates into the next, creating a dynamic color sensation.

Theoretical Color Systems

Scientists, artists, and color theorists have developed variations of the color wheel. The first wheel appeared in 1611

and was developed by a Finnish astronomer, Aron Sigfrid Forsius and was soon followed by Newton's color wheel in 1704. The primary objectives of these systems are to give order to the variables of color and to concretely represent colors, because "words are incomplete expression as color" (Munsell, 1981). Munsell developed a three-dimensional color tree. The three variables of color — hue, value, and chroma are displayed on plexiglass branches, one for each hue (see Figure 1). Darker values of the hue are toward the bottom; lighter values are toward the top. Brighter hues are seen at the outside perimeter; duller hues are toward the center of the tree. A color wheel made of hats and shoes, featured in an exhibition in the Goldstein Museum of Design, arranged the objects in spectral order (see Figure 2).

Michel Eugene Chevreul developed a system to explain how colors affect each other. As director of the Gobelins tapestry studio (France), he realized that color systems did not account for perceived color and that colors tend to tinge adjacent hues with its complementary hue. In response, he designed a color circle that accounted for differences of saturation and value within each hue family. He also created a framework about the effects of simultaneous contrast.



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Figure 2: A color wheel made from hats and shoes that are in the collection of the Goldstein Museum of Design.

Practical Color Systems

Specialized color systems are used in product design and manufacturing. Both the Pantone color system and the Munsell system are widely used. Pantone has developed color systems and products for the graphic, interior, textile, architectural, and industrial design fields. Pantone has also recently begun forecasting color trends in fashion and interior design. The primary goal of both the Munsell and Pantone systems is to communicate color in a systematic way, leaving little room for error. The CIE (Commission Internationale de l’Eclairage) chromaticity diagram displays a color matching system based on light, and it is shaped like a luminosity curve. The system attempts to eliminate differences of color perception through mechanical measurement of the three variables of a color—luminance, hue, and saturation. While these practical color systems help to ensure accurate color specification, color appearance still varies due to lighting, context, and surface quality.

The Effect of Surface Quality on Color Perception

Surface quality contributes to the variability of color, “one and the same color evokes innumerable readings” (Albers, 1963, p. 1). This variability is due to differences in the human visual system, light, and the material and surface quality of the object. When we view the color of an object, we are really seeing reflected light. Objects are typically colored with either pigment or dyes. Dyes permeate the molecular structure of the object; pigments lay in a coat of color on the surface of an object. This difference is evident in viewing fabric that has been painted versus fabric that has been dyed.

Surface materiality also affects the appearance of a color. A smooth, glossy surface will reflect a hue very differently than a rough surface, and they tend to reflect more light than a matte or rough surface. Matte or rough surfaces reflect light in a scattered, diffuse manner that randomly mixes the wavelengths and tends to soften the color, changing it. Transparent materials allow color and light to be seen through them (see Figure 3). Reflection from glossy paper can make reading a menu or a magazine difficult just as reflection from a highly polished floor can create spatial perceptual challenges.



Figure 3: Glass designed by Dale Chihuly, Museum of Glass, Tacoma, WA.

Albers (1963) discusses the interdependence of color with form and placement, quantity, and quality. It is a constant challenge to predict how a color will look on the designed object when seen under different light sources. While the typical color wheel represents only two or three dimensions, a color system developed by Albert-Vanel attempted to include variations due to surface quality, light, and human perception. This system, called the Planetary color system and developed in 1983, includes not only hue, value, and chroma, but also accounts for contrast and material.



Figure 4: The colorful facades of Burano, Italy.

Dyes and Colorants

The color of objects is dependent on the pigments or dyes used in the production of the product. Color trends often evolve out of technological developments. In the mid-1850s, William Henry Perkins accidentally developed effective synthetic dyes for wool and silk as he attempted to synthesize quinine from aniline. He named the color mauve. Other chemists developed synthetic aniline dyes that were significantly brighter and more saturated than early natural dyes. This discovery, along with the development of organic chemistry as a discipline, fueled the development of numerous synthetic dyes. Neon dyes and pigments that were developed in the mid-1980s resulted in bright fabrics, accessories, and paper products.

Color Harmony

There are strategies for creating color harmony: using similar values or hues, using hues with complementary contrast, or using a large number of hues in careful proportions. Contrast provides a sense of visual balance. Munsell recommended balancing light and dark hues, dull and bright hues, and cool and warm hues. A sense of color harmony is based partially in human perception and partially in color trends (see Figure 4).

Human Perception of Color

Color can have a profound effect on humans. It can affect our brain waves, heart rate, blood pressure, and respiratory rate. Color also affects us emotionally. Exposure to color has an effect on our biological systems. Not only does color affect our sense of well-being, but it also may play a role in medical treatments for depression, cancer, and bacterial infections.

Visual Perception

Our perception of color is dependent on light, object, and our eyes and brain. We know that colors are influenced by adjacent colors, indeed, it is rare to see an isolated color or color in its pure state. Chevreul discussed how colors tend to tinge neighboring hues with their complement. Including color opposites within close proximity in a particular space can mitigate this phenomenon. Surgical personnel in hospitals wear greenish-blue scrubs to counter-balance the visual effect of afterimages. During surgery, all eyes focus on the patient and typically see a variety of pink and red hues. The red receptors in the eye would become fatigued if not for the color of the scrubs providing the opposite hue and thus balancing the visual experience.

Color contrast is essential for our understanding of form and legibility. At least a 70% contrast between the background and letterforms is ideal for signs and

painted materials. Conversely, too much contrast in an environment may increase anxiety and tension. Sharp contrasts of color on flooring may create uncomfortable illusions for walkers as they determine whether the floor is flat or not. Research has shown that the most visible combinations of colors are yellow and black, white and black, white and blue, and red and white.

Psychological Responses to Color

We all react differently to color. We have different color preferences, and we all have our least favorite colors. Color response is highly personal. What one person believes is a restful color, another may find stimulating. Frequently these color preferences are based on our own personal experience—a fondly

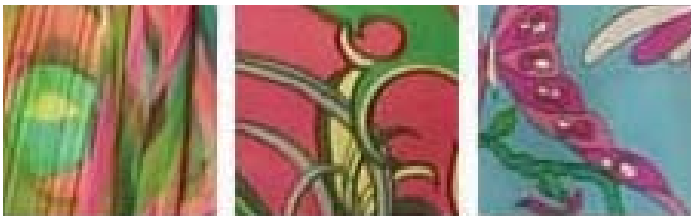


Figure 5: Fabric samples from 1960s-era clothing.

remembered yellow kitchen that belonged to grandmother. There are also cultural associations that influence our reactions to color. In several cultures, blue is seen as peaceful, protecting, and soothing color. Red typically signifies passion and revolution. There are multiple associations for each color. For example, black may be seen as sophisticated or as depressing. Orange can be warm or aggressive. Yellow can be upbeat or acidic.

Marketing research attempts to discover what colors influence human behavior and how people will act when they shop, eat, or travel. Findings by marketing researchers are typically short-lived, however; trends seem to come and go, and other variables in addition to color affect behavior. While technology contributes to color trends, culture and social phe-

nomena also affect the popularity of colors. Fashion prints in the 1960s used the bright palette of colors known as psychedelic. These colors were fully saturated and were intended to mimic the sensation caused by drugs (see Figure 5). Most of the information about color meaning is highly subjective and based on tacit beliefs, rather than research. There is a significant need for systematic research on color and human perception.

Typography and Color

Typography, the set of alphabetic characters, numerals, and symbols used to compose copy, can be manipulated in any number of ways by a graphic designer. Size, typeface, letterspacing, leading (the space between lines of type), case (upper or lower case), structure (normal, light, bold, italic, bold italic, etc.), and—of course—color can all be used to improve the legibility (how easy the text is to read), readability (how inviting the text is to a reader), and the hierarchy or structure of typeset copy.

While each of the previously mentioned characteristics can be manipulated by designers setting type, color is an especially important property. We often imagine type (or copy) that is set in black on a white background—this is perhaps the most familiar way to set type on a printed page. However, when we think of typography in signage and the built environment, a variety of colors and color combinations, come to mind. Consider the new, colorful green and yellow logo signage of BP (British Petroleum) that is employed in the design of gas stations. Or, think of the familiar white type on a green background of road signs. Color is employed frequently in environmental signage to create a memorable identity that helps users navigate a space, remember the business or company, and create a pleasant impression.

When creating environmental signage, it is critical to consider some of the variables associated with the application of color. Here are a few ideas and tips:

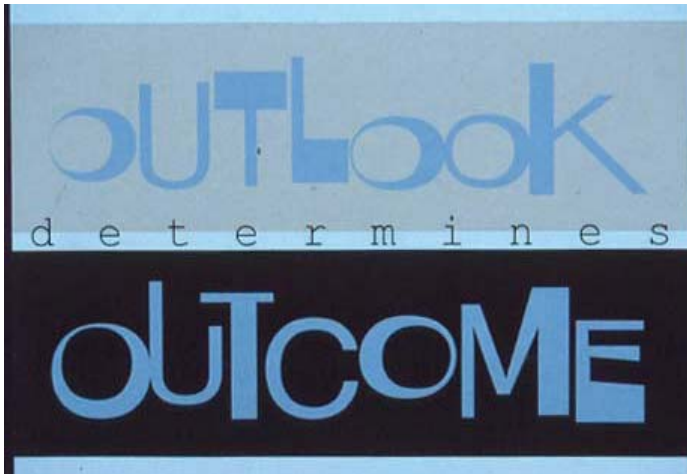


Figure 6: An example of poor and excellent contrast between typography and background.

- Consider the contrast between the color of the typography and the background to ensure that the type is easy to decipher and read. Type/background color combinations can cause the text to either advance or recede (see Figure 6).
- Consider the impact of color on interpretation and understanding of the content. What does a red heading indicate versus a brown heading? Does setting less important information in a brighter, more prominent color impact the order that information is retrieved?
- Consider the user. Be aware of the cultural context of the environment and the signage, and consider cultural norms for particular colors. For example, in Europe and the US, red typography generally means warning or attention. The application of color to type can either play into cultural norms for color or can contradict them.
- Consider the lighting levels of the environment. While a color combination may work well when evaluated in your office, the combination may be inappropriate when the lighting levels are different.
- Consider the properties of the signage material. How will a surface that is reflective or flat change the legibility of the content? How will lighting levels interact with the surface properties?

This is not an exhaustive list of issues to consider when applying color to environmental signage and typography. If possible, it is beneficial to have a graphic designer who understands the interactions between typography, color, and the built environment on a design team when designing environments with signage. In addition, Informedesign has Research Summaries about graphic design for the built environment.

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Additional Resources

www.digitalanarchy.com/theory/theory_main.html
www.colorsystem.com
www.colormatters.com/colortheory.html
poynterextra.org/cp/
www.colorcube.com/articles/theory/theory.htm
www.tigercolor.com/ColorLab/Default.htm
www.fadu.uba.ar/sicyt/color/bib.htm
http://webexhibits.org/colorart/ch.html
www.digitalanarchy.com/theory/theory_main.html

Related Research Summaries

InformeDesign has many Research Summaries about color and related, pertinent topics. This knowledge will be valuable to you as you consider your next design solution and is worth sharing with your clients and collaborators.

Bright, Saturated Colors Attract Attention
—*Color Research and Application*

Determining Color in the Built Environment
—*Color Research and Application*

Effects of Office Color Scheme on Workers
—*Color Research and Application*

Color Aids Wayfinding for Young Children
—*Early Childhood Education Journal*

Space and Color Affects Cooperation Among Children
—*Environment and Behavior*

Color Judgment is Influenced by the Aging Eye
—*Family and Consumer Sciences Research Journal*

Light Source, Color, and Visual Contrast
—*Family and Consumer Sciences Research Journal*

Color of Light Affects Psychological Processes
—*Journal of Environmental Psychology*

Color, Meaning, Culture, and Design
—*Journal of Interior Design*

Photos Courtesy of:

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