chapter two

The Element of Color

Color immediately attracts attention. When presented with a collection of bottles filled with liquid in various colors, very young children will group the objects by color rather than by size or shape. Color has great emotional power, and designers carefully choose a color palette that supports the mood of each project. An interior designer may use rose-red walls in a restaurant to increase emotional warmth, while using light blue walls in a day-care center to encourage calm.

Selecting the right colors can make or break a design. To assist their clients in project planning, the Neenah Paper Company produced a witty and informative brochure describing the effects of color (2.1). Each color was given a personality as distinctive as an astrological sign. The colors were then organized in a booklet, creating an easy-to-use index of possibilities. While systems of this kind provide a shortcut to basic decision making, in this chapter we will see that color is a complex element that defies easy formulas. We will consider relationships between color and light, describe three major characteristics of color, explore harmony and disharmony, and analyze uses of color in various compositional contexts.

2.1 Neenah Papers and Partners design firm, brochure for Neenah Papers. Courtesy Neenah Papers and Partners Design. Color Attributes courtesy of Dewey Color System ®, deweycolorsystem.com.

COLOR PHYSICS

To use color fully, we must understand the major types of color, how they are created, and how they interact. **Color theory** is the art and science of color interaction and effects. In *The Art of Color,*[1] Johannes Itten lists the following approaches to color theory:

- The physicist studies electromagnetic wavelengths in order to measure and classify color.
- The chemist, working with the molecular structure of dyes and pigments, seeks to produce highly permanent colors and excellent paint consistency.
- The physiologist investigates the effects of color and light on our eyes and brain.
- The psychologist studies the expressive effects of color on our mind and spirit.

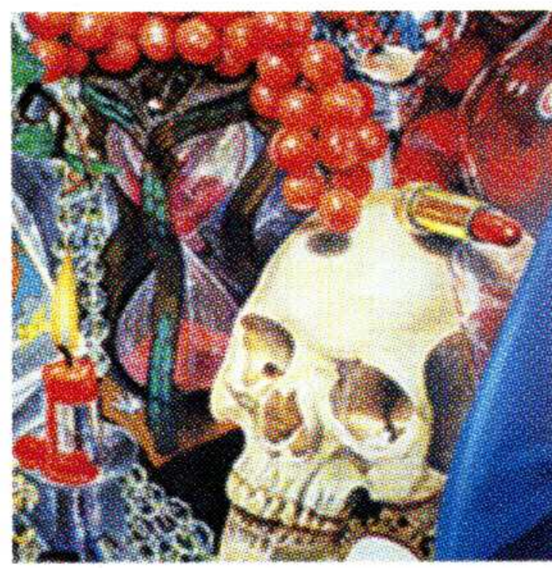
An artist combines all these areas of knowledge. Like the physicist, the artist uses color wavelengths to create visual effects. Like the chemist, the artist must be aware of the safety and permanence of dyes and pigments. When using color to create the illusion of space, the artist puts into practice theories developed by the physiologist. And both communication and expression are strongly affected by the psychological impact of color.

Additive and Subtractive Color

Two major color systems are used in art and design. **Additive color** is created using beams of light (2.2A). Red, green, and blue, the familiar RGB on a computer screen, are the primary colors in this system. Millions of colors can be mixed from these primaries. **Subtractive color** is created when white light is reflected off a pigmented or dyed surface (2.2B). The subtractive primaries are blue, red, and yellow.

2.2A Light primaries and their additive mixtures.

2.2B Pigment primaries and their subtractive mixtures.

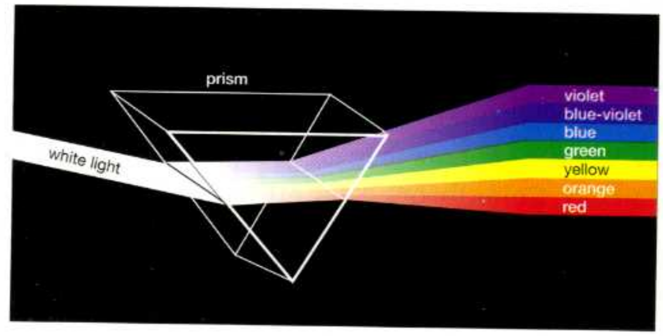


2.3 Color printing detail of *Wheel of Fortune*, showing dot pattern used in CMYK printing.

A Yellow **B** Magenta **C** Yellow and magenta **D** Cyan **E** Yellow, magenta, and cyan **F** Black **G** Full color printing

2.4A–G Color separation in CMYK printing. Dots of yellow, magenta, cyan, and black are layered to create a full-color image.

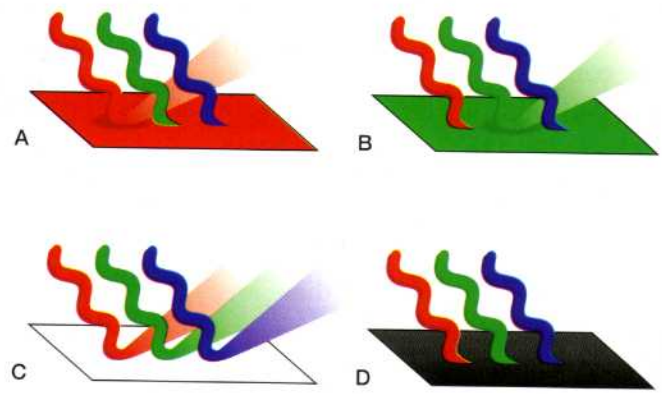
This book was printed using cyan blue, magenta red, and yellow, the transparent primaries (or **process colors**) commonly used in mass production. Figure 2.3 provides an example of process printing. As viewers, we optically combine thousands of cyan, magenta, and yellow dots to create a coherent image. Black (abbreviated as *K* in the CMYK printing system) was then added to enhance detail and increase contrast (2.4A–G).



2.5 When white light passes through a prism, the spectrum becomes visible.

Color and Light

These two systems exist because of the inseparable connection between color and light. When white light passes through a prism, it is refracted, or bent. This creates a wide spectrum of hues, which is dominated by red, orange, yellow, green, blue, blue-violet, and violet (2.5). Each hue, or separate color, is defined by a specific electromagnetic wavelength, with red the longest and violet the shortest. When white light hits a colored surface, some wavelengths are reflected, while other wavelengths are absorbed. As shown in figure 2.6A, a red surface reflects the red wavelengths while absorbing the blue and green wavelengths. Similarly, a green surface reflects the green wavelengths while absorbing the red and blue (2.6B). All wavelengths are reflected off a white surface (2.6C); all wavelengths are absorbed by a black surface (2.6D). Color reflection and absorption are rarely total. As a result, we can often see hints of various colors within a dominant color.



2.6A–D We see color when the primaries of light are reflected off a colored surface. A red surface absorbs the green and blue wavelengths, while reflecting the red. All wavelengths are reflected by a white surface. All wavelengths are absorbed by a black surface.

Using Additive Color

Lighting designers, videographers, and Web site artists use additive color extensively. Beams of red, green, and blue light are used to create a full-color video projection. The mixture of adjacent beams creates cyan, magenta, and yellow, which are the secondary colors in the additive system. When all three beams are combined, white light results.

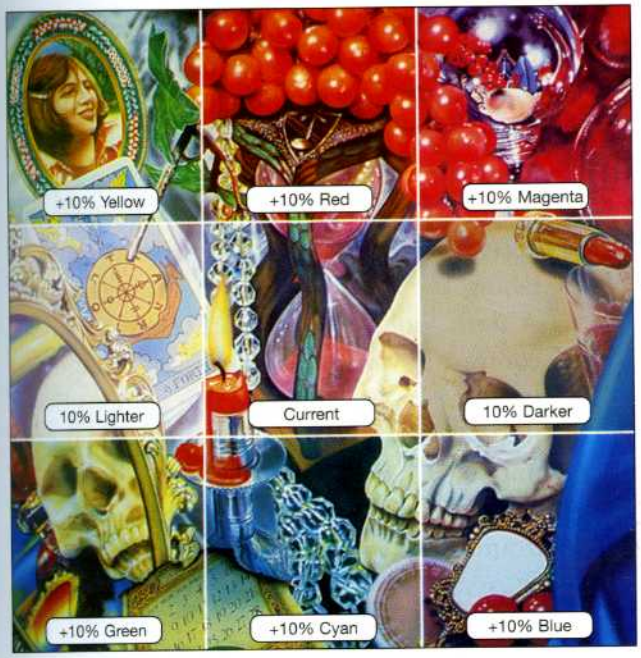
We can quickly and easily create variations in additive color on a computer. In figure 2.7, the current color choice is shown in the center. Variations are shown in the eight surrounding squares. Even a 10 percent increase in a given color produces a very different result.

Our perception of additive color is influenced by

- The intensity (or wattage) of the projected light.
- The light source, from incandescent light and fluorescent light to daylight.
- The surface quality of the illuminated object. Projected light behaves very differently on transparent, translucent, and textured surfaces.
- The ambient (overall amount of) light in the environment.

Using Subtractive Color

Painters, printmakers, and illustrators use subtractive color in various forms, including acrylics, oils, pastels, and inks. Each pigment or dye used in the manufacture of such materials is chemically unique. Quinacridone red and pthalocyanide blue are



2.7 Color variations using a computer.

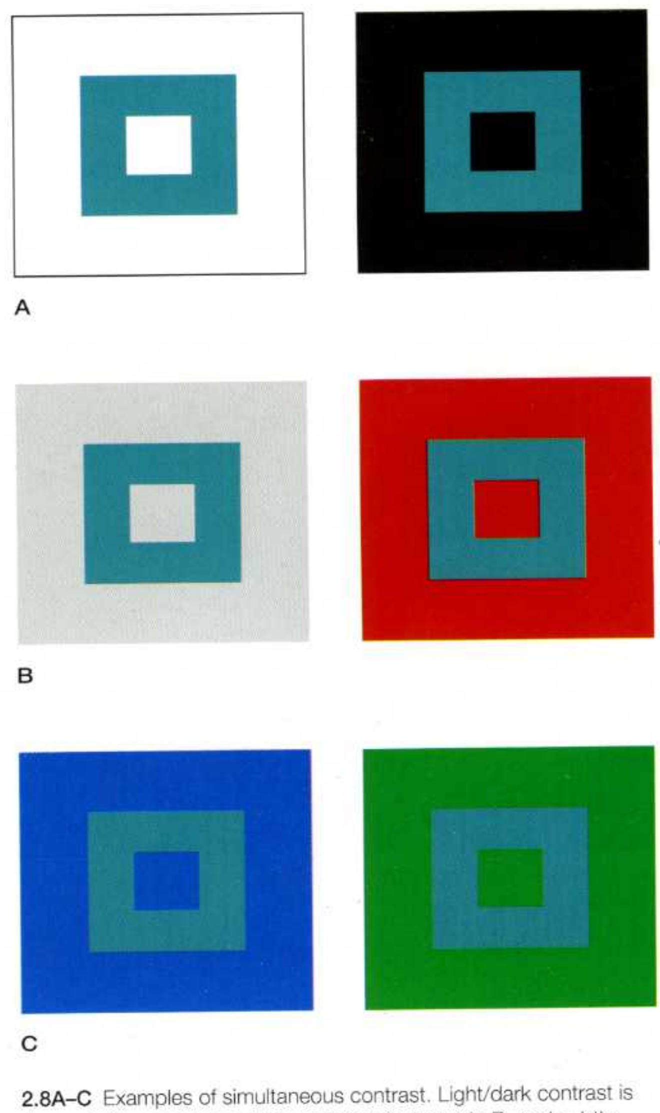
transparent and intense. The cadmiums and earth colors are generally opaque. **Color overtones** complicate matters further. Color theorist David Hornung defines an overtone as "a secondary hue bias in a primary color." For example, alizarin crimson is a red with violet overtones, while scarlet is a red with orange overtones. To create a wider range of mixtures, artists and designers often use a six-hue palette, including two reds, two yellows, and two blues, plus **achromatic** black and white, which have no hue. Since many foundation color projects are done using paint, ink, or colored paper, the remainder of this chapter will focus on subtractive color.

Color Interaction

Color interaction refers to the way colors influence one another. Colors are never seen in isolation. The blue sheets of paper we examine in an art supply store may remind us of the blue of the sky, the ocean, or the fabrics in a clothing store. Lighting also affects our perceptions. Incandescent light creates a warm orange glow, while standard fluorescent lights produce a bluish ambiance. And, when our blue paper is added to a design, it is profoundly affected by the surrounding colors.

The way a color changes when paired with another color is called **simultaneous contrast.** Three principles of simultaneous contrast are shown in figure 2.8A–C. Light/dark contrast is shown in the first pair of images. A blue-green square appears much lighter when it is placed on a black background. A complementary reaction is shown in the second pair. The same blue-green square appears to glow when it is surrounded by red rather than a neutral gray. In the third pair, the same blue-green square appears almost green when it is surrounded by solid blue, yet it appears almost blue when surrounded by green.

The **Bezold effect** demonstrates the profound influence of color interaction. Color theorist Wilhelm

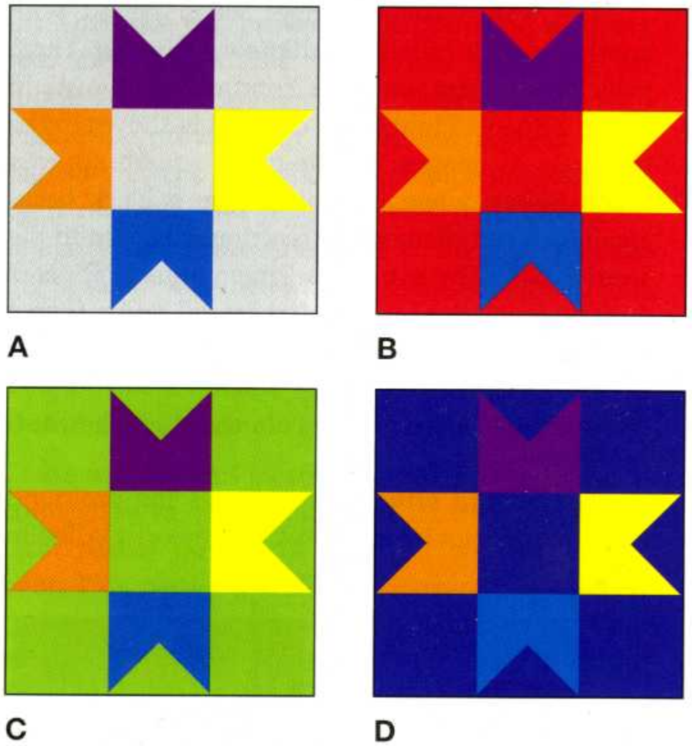


A

B

C

2.8A–C Examples of simultaneous contrast. Light/dark contrast is shown in A, a complementary reaction is shown in B, and subtle variations are shown in C. The blue-green square is the same color in all examples but appears different due to the surrounding colors.



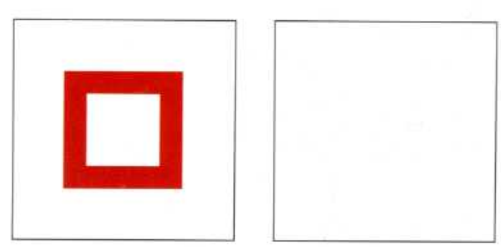
2.9A–D **The Bezold effect.** Changing a single color alters the entire design.

2.10 Pat Steir, *Inner Lhamo Waterfall*, 1992. Oil on canvas, 114 × 90¼ in. (289.6 × 229.2 cm).

Bezold (1837–1907) realized that change in a single color can substantially alter our perception of an entire pattern. In figure 2.9A–D, changing the background color from gray to red adds an electric energy to the design. A light green background accentuates the darker shapes while diminishing the brightness of the orange shape. A dark violet background creates a strong contrast in value and pushes the orange and yellow shapes forward. The compositional impact can be substantial, even when only one color is changed.

Color interaction becomes especially dramatic when complementary colors, such as red-orange and blue-green, are used in a composition. In the human eye, two types of cells, known as rods and cones, are arranged in layers on the retina. These cells serve as photoreceptors. The rods record lightness and darkness, while the cones distinguish the hues, such as red and blue. According to **opponent theory,** the cones can register only one color in a complementary pair at a time. Constant shifting between the opposing colors creates a visual overload at the edges of the shapes, resulting in an electric glow. In *Inner Lhamo Waterfall* (2.10), Pat Steir used this effect to suggest the majesty and mystery of the falling water.

A similar characteristic of human vision can be used to create an **afterimage.** If we stare at a red square for 20 seconds (2.11) and then stare at a white sheet of paper, a blue or green shape will seem to appear. This is due to fatigue in the cones, the color sensors in our eyes. Overloaded by the intense red, our eyes revert to the blue and green cones, creating the afterimage.



2.11 Afterimage exercise.

DEFINING COLOR

Hue

The **hue,** or name of a color, is determined by its wavelength. Red, blue, green, yellow, and so forth are all hues.

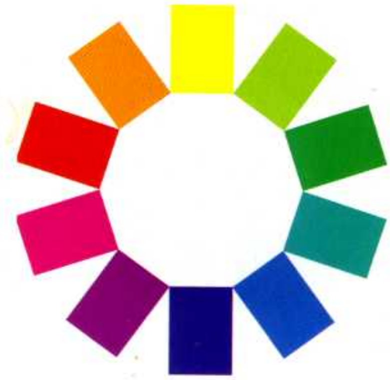
Physicists, painters, and philosophers have devised numerous systems to organize hues. Johannes Itten's 12-step color wheel (2.12) is a clear and simple example. Red, blue, and yellow **primary colors** are in the center. These colors can be mixed to produce many other colors. The **secondary colors** of green, orange, and violet follow. These colors are mixed from adjacent primaries. A circular spectrum of **tertiary colors** completes the wheel. The mixture of a secondary color and the adjacent primary color creates a tertiary color.

The Munsell color wheel (2.13) more accurately identifies cyan blue, magenta red, and yellow as the subtractive primaries, while the three-dimensional Munsell color tree (2.14) provides examples of changes in color value and intensity as well as hue.

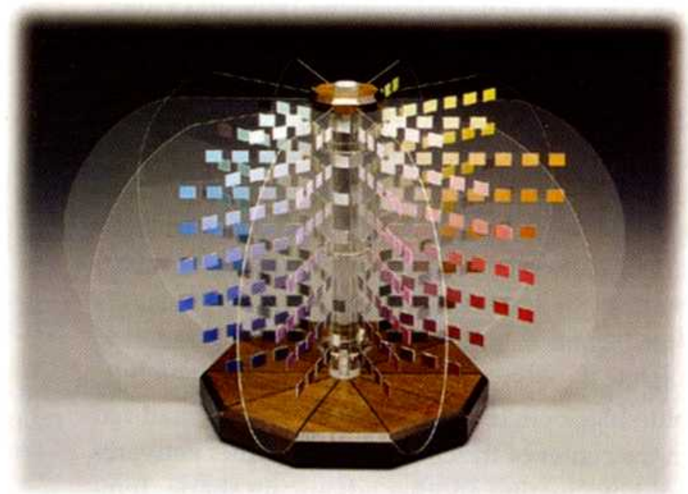
Artists often use a wide range of hues to capture the richness of reality. In *Wheel of Fortune* (2.15), Audrey Flack used a full spectrum of hues to define a collection of symbolic objects in meticulous detail. The makeup and mirrors symbolize vanity; the candles, hourglass, and skull suggest the passage of time; the grapes suggest passion. Reds, blues, and yellows dominate the painting. Hints of orange, violet, and green complete the spectrum.

As demonstrated by Pat Steir's *Waterfall* (2.10, page 42), a limited range of hues can be equally effective. In this painting, interaction between just two hues creates an electric visual impact.

2.12 The 12-step Itten color wheel.



2.13 The 10-step Munsell color wheel.



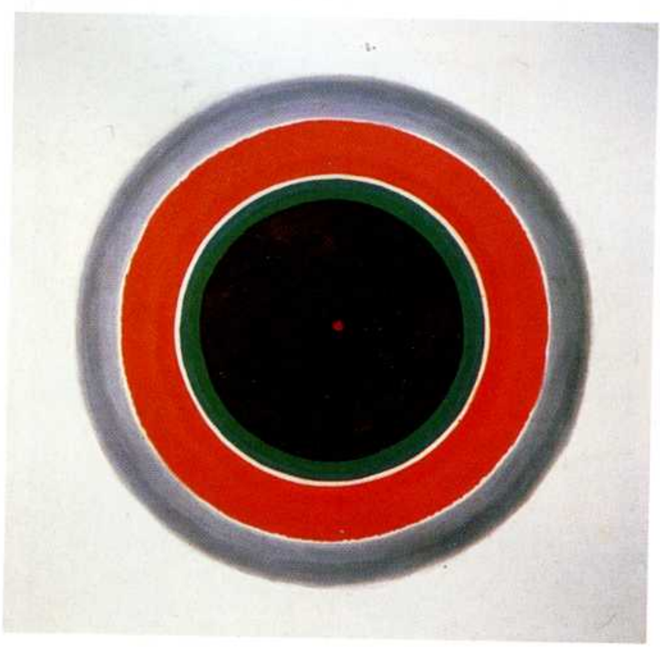
2.14 Munsell color tree, 1972. Clear plastic chart, 10½ × 12 in. (26.7 × 30.5 cm); base size 12 in. (30.5 cm) diameter; center pole size 12⅝ in. (32.1 cm) high; chip size ¾ × 1⅜ in. (1.9 × 3.5 cm).

2.15 Audrey Flack, *Wheel of Fortune*, 1977–78. Oil over acrylic on canvas, 8 × 8 ft. (2.44 × 2.44 m).

2.16 Separation of the color wheel by temperature.

Temperature is an especially important aspect of hue. **Temperature** refers to the heat a color generates, both physically and psychologically. Try laying six colored squares of equal value on fresh snow on a sunny day. By the end of the day, the warm-colored oranges, reds, and violets will sink into the melting snow, while the blue and green squares will remain closer to the surface. Figure 2.16 shows a simple division of the color wheel by temperature.

Color temperature can help create the illusion of space. Under most circumstances, warm colors advance, while cool colors recede. This effect is demonstrated very clearly in Kenneth Noland's *A Warm Sound in a Gray Field* (2.17). The red ring with its light yellow halo pushes toward us, while the blue-black circle pulls us inward. The small red dot in the center of the composition further activates the void by creating another advancing shape. Temperature can also be used to create a strong emotional effect. In figure 2.18, the glowing oranges and reds create a radiant representation of Christ.



2.17 **Kenneth Noland, *A Warm Sound in a Gray Field*, 1961.** 6 ft 10½ in. × 6 ft 9 in. (2.1 × 2.06 m).

2.18 Page from the *Book of Kells*, Chi-Rho monogram, late 8th century. Illuminated manuscript.

Value

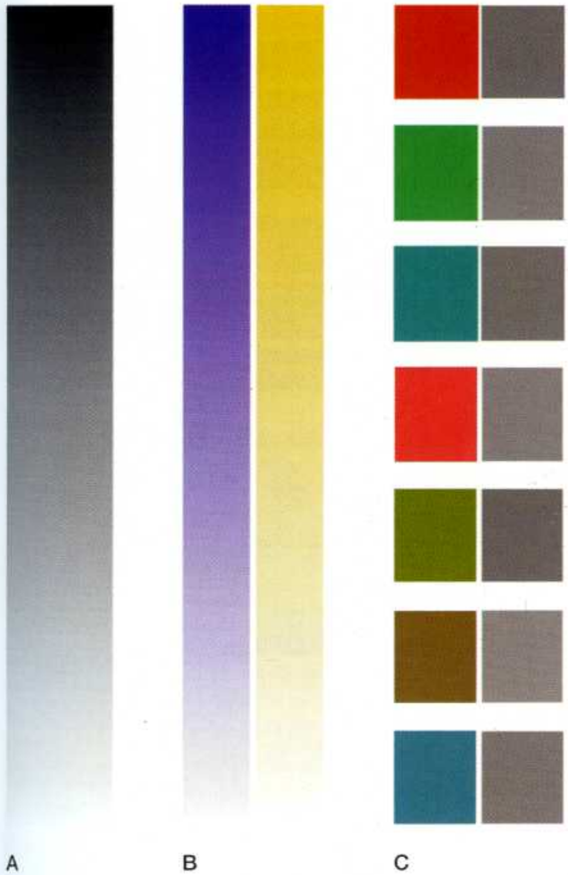
Value refers to the relative lightness or darkness of a color. By removing hue from the equation, we can create a simple value scale (2.19A) that shifts from white to black through a series of grays. As shown in figure 2.19B, hues such as violet, blue, and green are inherently darker in value than pure yellow or orange. Translation of color into value is shown in figure 2.19C; despite the wide variety of hues, all the colors have nearly the same value.

Three basic variations in value are shown in figure 2.20. When white is added to a hue, the resulting **tint** will be lighter in value. The addition of gray produces a **tone.** The addition of black creates a darker **shade.** One of the simplest ways to unify a design is to limit the colors used to the tints, tones, and shades of a single hue.

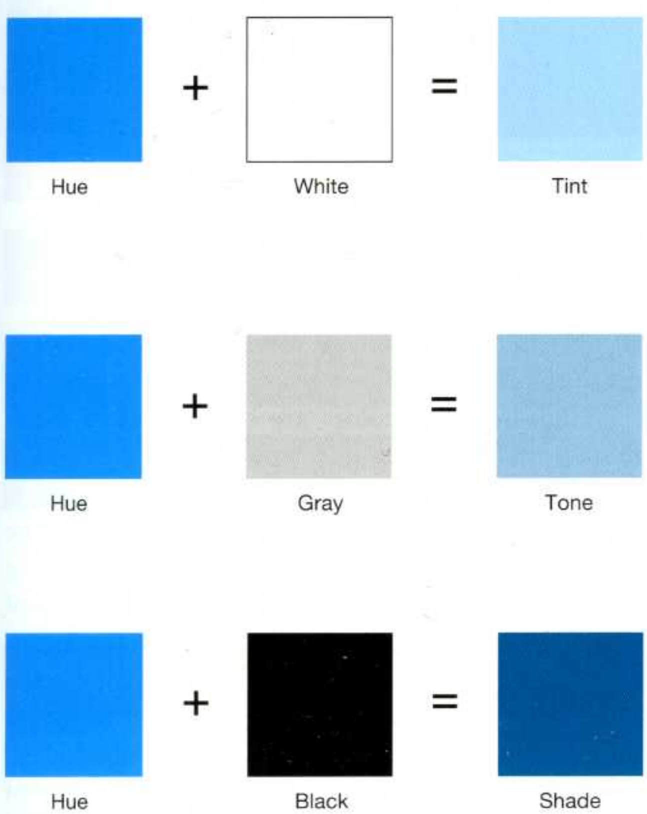
Using a full range of values, we can create a very convincing representation of reality. In *Vision* (2.21), Nicora Gangi transformed a simple still life into a dramatic drawing. A bright light in the background pushes the dark foreground vessels toward us. The limited value range in David Hockney's *Mist* (2.22) is equally effective. The gray-green palm trees dissolve into the peach-colored fog as quietly as a whisper.

By making a black-and-white photocopy, we can easily check the range of values in a design. The photocopied image will be quite readable when the value range is broad. When a very narrow range of values is used, the photocopy will produce a solid gray image.

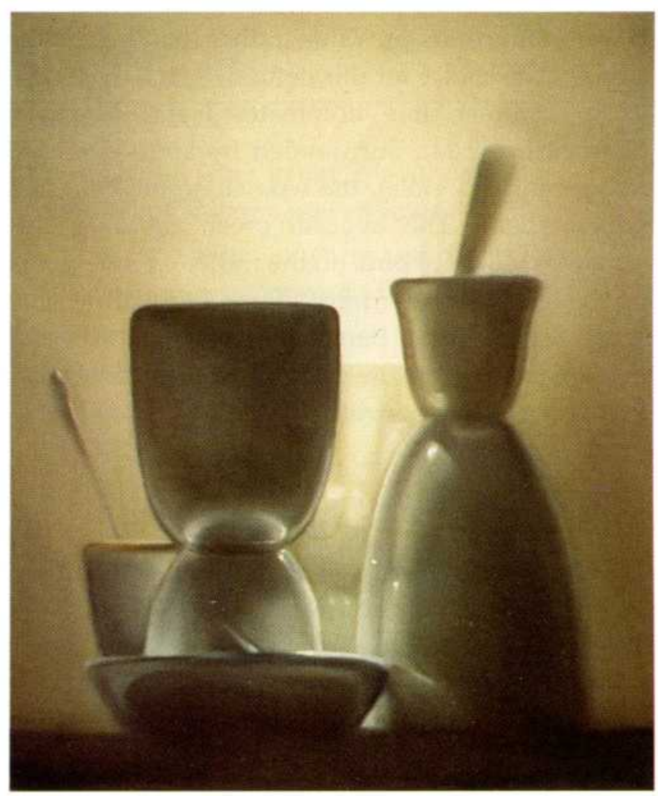
Value is the dominant force in some paintings, while hue is a dominant force in others. Each approach has a distinctive emotional effect. Romaine Brooks's *Self-Portrait* (2.23) is essentially a value painting. Blacks, whites, and grays dominate the image. The woman's eyes are concealed by the brim of her hat and the shadow it casts. Patches of red on her lips and coat add just a touch of color. She



2.19A–C Value scales.

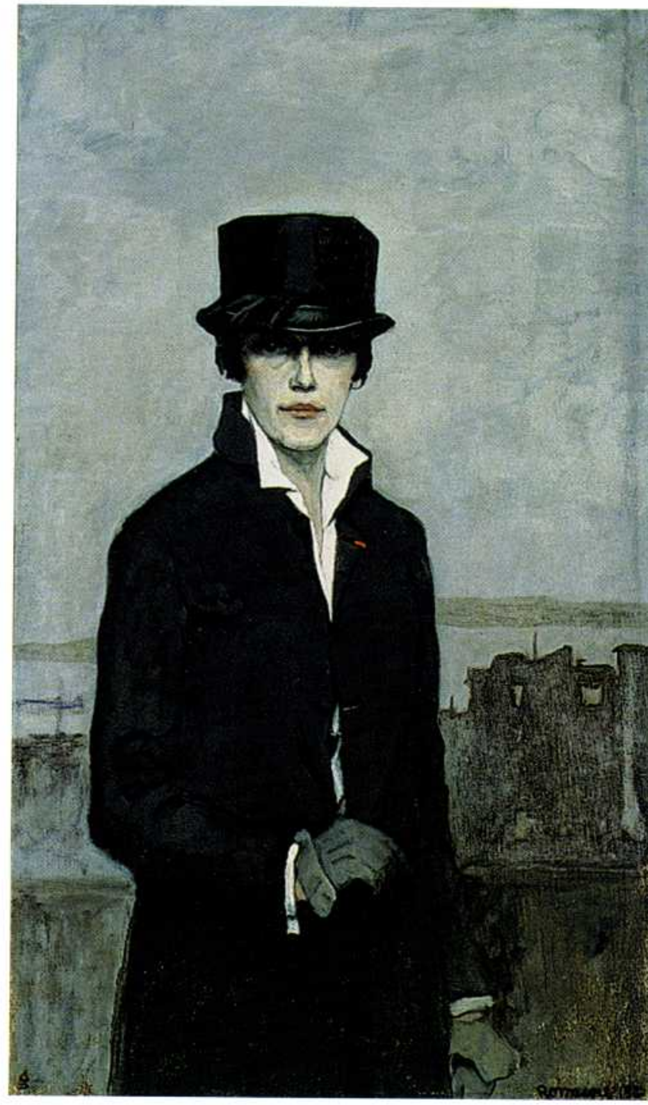


2.20 Tint, tone, and shade.



2.21 Nicora Gangi, *Vision*, 1994. Pastel, 10 × 14 in. (25 × 36 cm).

2.22 **David Hockney, *Mist,* From The Weather Series, 1973.** Lithograph in 5 colors, edition 98, 37 × 32 in. (93.9 × 81.2 cm).



2.23 Romaine Brooks, *Self-Portrait,* 1923. Oil on canvas, 46¼ × 26⅞ in. (117.5 × 68.3 cm).

is wary and reserved. Value, rather than hue, is the appropriate choice for this image.

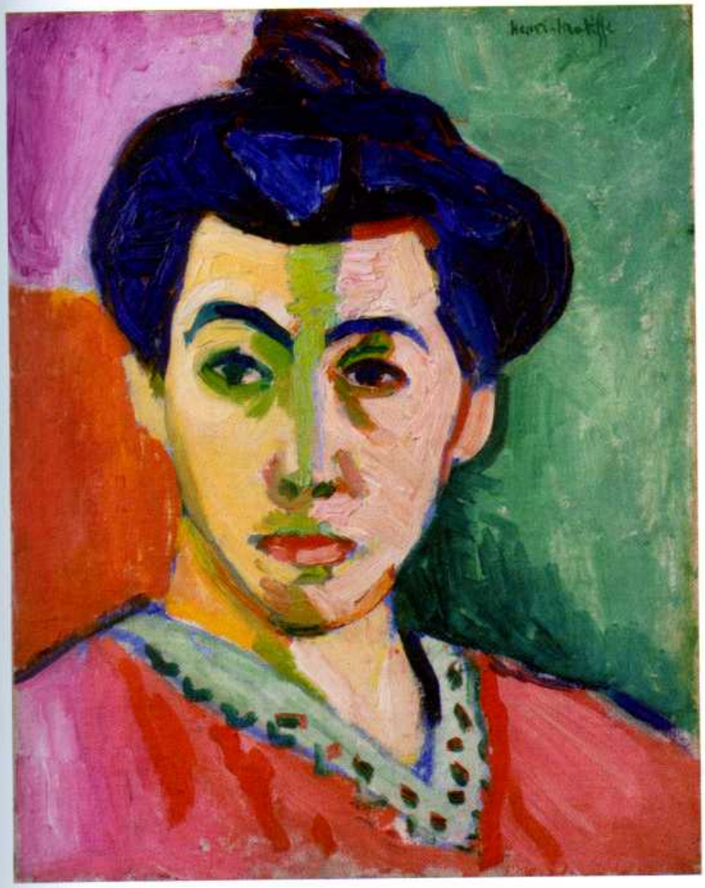
In contrast, hue dominates Henri Matisse's *Green Stripe* (2.24). Surrounded by large blocks of red, green, and violet, the woman seems bold and self-confident. The avocado-green dividing line separates blocks of pink on the right and lime-green on the left half of her face, suggesting warmer and cooler aspects of her personality. Even her eyes and hair are painted in blue-black, adding yet more color to this expressive portrait.

Intensity

Intensity, saturation, and **chroma** all refer to the purity of a color. The primary colors are the most intense. This intensity generally diminishes when colors are mixed.

Figure 2.25A–C presents three intensity scales. Column A shows the most intense primary, secondary, and tertiary colors. Column B demonstrates the loss of intensity when black is added to a single color. In column C, two complementary colors are mixed, producing a range of elegant, low-intensity colors.

High-intensity colors are often used to maximize impact. Grace Hartigan's *City Life* (2.26) explodes with energy, as a full palette of blues, reds, and yellows dances across the canvas. In the background, a blue and orange striped awning vibrates with complementary color. Dark blocks of violet in the lower-left corner and blue in the lower-right compress the warm reds, oranges, and yellows at the center of the composition, adding yet more energy. The entire scene is highly abstracted. Our understanding of both space and movement is based on the use of color rather than on photographic representation.



2.24 **Henri Matisse, *Green Stripe (Madame Matisse)*, 1905.**
Oil on canvas, 16 × 12¾ in. (40.6 × 32.4 cm).

2.25A–C Intensity scales. The most intense primaries, secondaries, and tertiaries are shown in A. The addition of black reduces the intensity of the color red in B. Mixing the complements yellow and violet creates low-intensity colors in C.

A combination of high- and low-intensity colors can be equally effective. Arshile Gorky used primary hues and subtle earth colors in *The Liver Is the Cock's Comb* (2.27). Grays, tans, and browns cover more than half of the surface. Surrounded by these low-intensity colors, the brilliant yellow and red shapes seem to pulsate with energy. Like variations in volume and tempo in an interesting piece of music, the interplay between subdued and intense colors adds complexity to the composition.

Gorky's masterful understanding of how the eye reads and responds to color gives his paintings their unusual vibrancy and sense of animation. There is a wider range in his application of muted color than in Hartigan's work, but the impact is comparable. In both cases, the viewer is drawn into and moves throughout the painting because of the use of color.

Key Questions

DEFINING COLOR

- Which will work better in your design, a limited or a wide range of hues?
- What proportion of warm and cool colors best communicates your idea?
- What happens when you combine low-intensity colors with high-intensity colors?

2.26 **Grace Hartigan, *City Life,* 1956.** Oil on canvas, 81 × 98½ in. (205.7 × 250.2 cm).

2.27 **Arshile Gorky, *The Liver Is the Cock's Comb,* 1944.** Oil on canvas, 72 × 98 in. (1.86 × 2.49 cm).

HARMONY AND DISHARMONY

Relationships among colors are critical to the success or failure of a design, and many theories of **color harmony** have been developed to help artists, architects, and designers make good choices. A basic color wheel can help illustrate five common approaches.

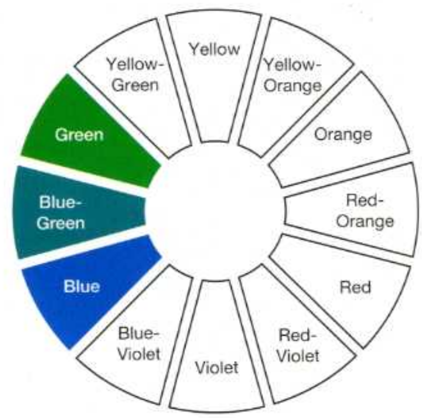
Monochromatic Color Schemes

Variations on a single hue are used in a **monochromatic** color scheme (2.28). The advantage of this system is a high level of unity: all the colors are strongly related. Boredom, due to the lack of variety, is a potential disadvantage. In *Tracers–Side Order* (2.29), Guy Goodwin used various textures, patterns, and words to add interest to the monochromatic image.

Analogous Color Schemes

Adjacent colors on the color wheel are used in an **analogous** color scheme (2.30). As with monochromatic harmony, a high degree of unity is ensured, but the wider range of hues offers greater variety and can increase interest. Blues and a surprising variety of greens activate the *Chromatics Place Settings*, shown in figure 2.31.

2.28 Monochromatic color system.



2.30 Analogous color system.

2.29 Guy Goodwin, *Tracers—Side Order,* 1999. Resin, polyurethane, ink on polycarbonate, 51 × 54 × 4 in. (130 × 137 × 10 cm).

2.31 *Chromatics Place Settings,* 1970. Gerald Gulotta, shape designer; Jack Prince, pattern designer. Porcelain, linen, and stainless steel.

2.32 Complementary color system.

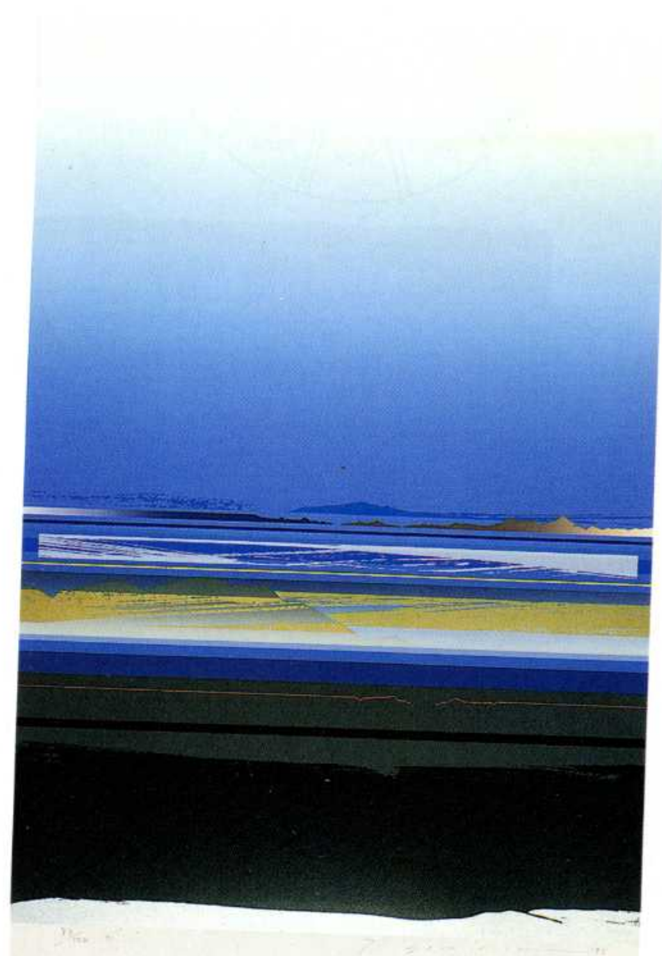
2.33 Francis Bacon, *Four Studies for a Self-Portrait*, 1967. Oil on canvas, 36 × 13 in. (91.5 × 33 cm).

Complementary Color Schemes

The palette dramatically expands in a **complementary** color scheme (2.32). Complementary colors are opposites on the traditional color wheel. When mixed together, they can lower intensity and produce a wide range of browns. When paired in a composition, complementary colors can become powerful partners. Each increases the impact of the other.

Francis Bacon's *Four Studies for a Self-Portrait* (2.33) is dominated by the complements red and green. The design is unified by browns, including the reddish brown filling the background. Vigorous slashes of pure green and red add visual energy and create the illusion of movement.

In *Brilliant Scape* (2.34), Tetsurō Sawada used variations on blue and orange to create a subtle abstract landscape. Horizontal bands of blue-violets in the bottom half visually extend the composition to the left and right, while the gradated block of light blue at the top creates a soaring sky. Activated by just three



2.34 Tetsurō Sawada, *Brilliant Scape (Blue)*, 1985. Silkscreen, 22⅞ × 15¾ in. (58 × 40 cm).