CHAPTER

6

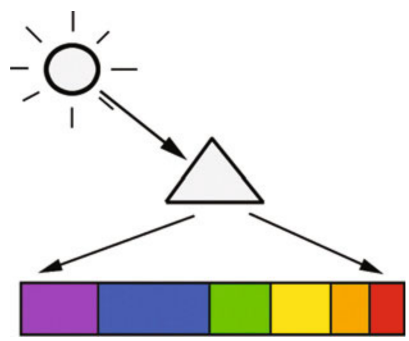
Color

Color, without a doubt, is the most misunderstood visual component. Probably due to the misguided color education we received as children, our knowledge of color and how it works is almost unusable.

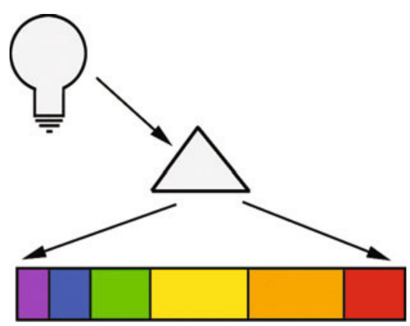
Light

We use sunlight or artificial lights to illuminate objects so we can see them. Naively, we might say that sunlight is normal "white" light because it doesn't seem to change the color of objects. A white car parked outside in the sun still looks white, so sunlight is not reddish, greenish, or bluish. Sunlight appears to be normal "white" light.

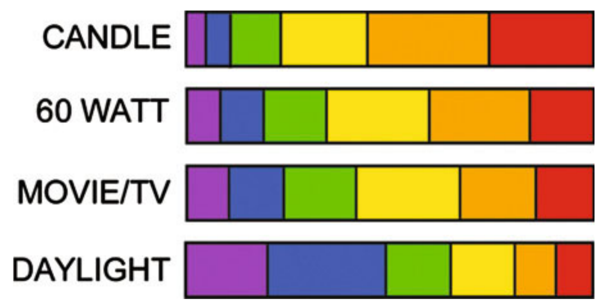
By contrast, the same white car parked in a dark room illuminated with only red light appears changed. The car looks red. The red light is not "normal." But the light from the sun is not normal or white, either.



Take a glass prism and shine a beam of sunlight through it. The prism will refract the light into a rainbow, or the visible spectrum: red, orange, yellow, green, blue, and violet. The prism experiment shows that sunlight contains all the colors of the visible spectrum.



This time, the prism refracts the light from a 60-watt light bulb. The 60-watt light bulb also produces the visible spectrum but the proportions of the colors have changed. The 60-watt bulb contains more red-orange color than the sunlight.



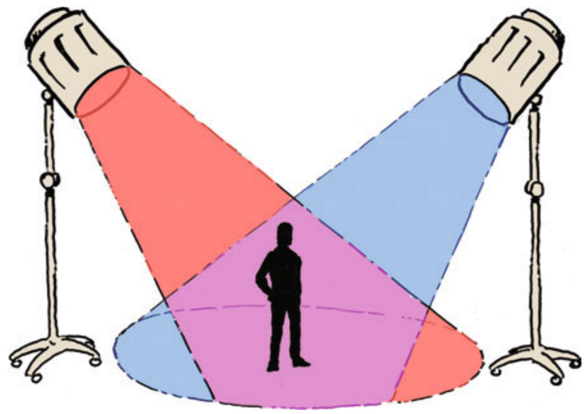
Here are four visible spectrums, each produced by a different light source. Each spectrum has a different proportion of color. A candle produces a reddish light; a 60-watt household lightbulb has an orange-ish light; stage lights used in color photography are less orange, and daylight is predominantly blue. Although none of these light sources produces white light, the human vision system has the ability to adjust for the color variances in different light sources and make them all appear as normal white light. For a detailed explanation of light sources and their relationship to film and color temperature, see the appendix.

Color Systems

There are two basic systems for organizing and mixing color: additive and subtractive. Although these two systems share terms and certain characteristics, each must be considered separately.

The Additive System

The additive system of color involves the mixing of colored light. Colored light is mixed by taking a light of one color and a light of another color and beaming them onto a common surface. Where the two colors of light overlap or mix, a third color is produced.

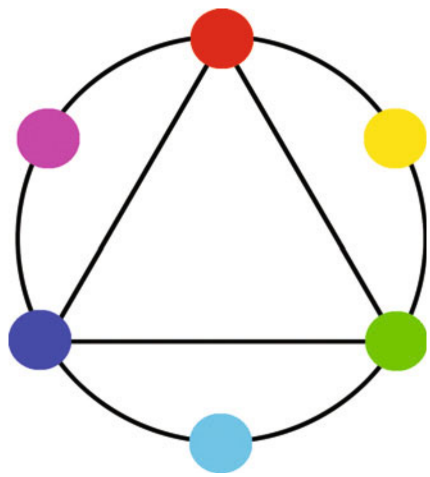


The additive system is used most often in theatrical lighting (theatre plays, music concerts, circus shows, night clubs, etc.). A red spotlight and a blue spotlight are aimed at a performer on a stage, and where the spotlights overlap a magenta color is produced. This is additive color mixing. The red light is adding its wavelengths to the blue light, and a third color, magenta, is the result.

Television and computer screens do not mix color using the additive system. See the appendix for an explanation of color mixing on computer and television monitors.

The Additive System Color Wheel

A color wheel organizes colors and shows their relationship to each other. The additive system color wheel is shown here.



The primary colors in the additive system are red, green, and blue. Combining two primary colors produces the other colors needed to complete the color wheel. Remember, the additive system is the mixing of light.

RED + BLUE = MAGENTA

GREEN + BLUE = CYAN

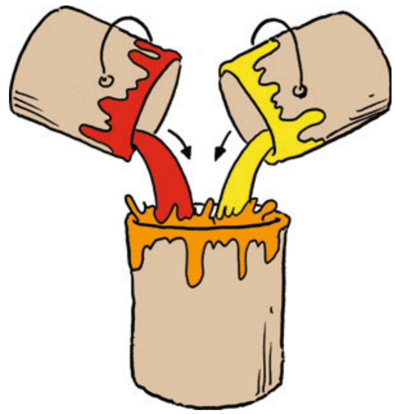
RED + GREEN = YELLOW

Magenta is similar to purple, but more reddish. Cyan is like turquoise, but more greenish.

When the additive primaries are mixed together equally, they produce white light (or what appears to be white light). Colors opposite one another on the color wheel are called complementary colors. The complementary pairs in the additive system are cyan and red, green and magenta, and blue and yellow.

The Subtractive System

The subtractive color system is completely separate from the additive system, even though they share terms and certain definitions. The subtractive system is used in the mixing of pigments, which includes paint and dye. This system seems more familiar, because everyone has mixed paint in art class or repainted a room. Subtractive mixing is as easy as pouring one color of paint into another.

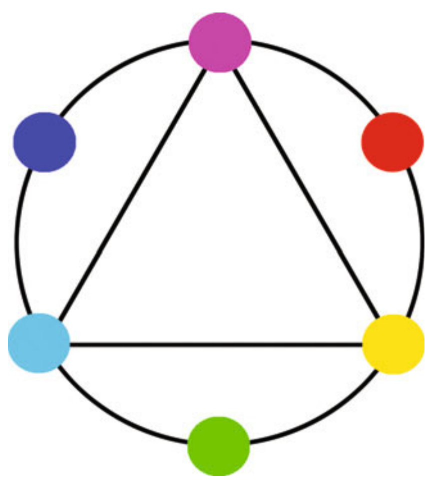


When red and yellow paint are mixed together the result is orange paint. The red and yellow paints subtract their wavelengths from each other and create a new color.

Almost everything in our real world has been painted, dyed, or pigmented using the subtractive system. In photography, lighting and lens filters use the subtractive system. Colors at a paint store are mixed using the subtractive system. The dyes used for fabrics and rugs; printing inks for magazines, books, and newspapers; paint for walls, cars, appliances; and colors occurring in nature all use the subtractive system.

The Subtractive System Color Wheel

The subtractive color wheel looks similar to the additive wheel but the primary colors are different, as shown here.



The primary colors on the subtractive color wheel are magenta, yellow, and cyan. Combining two primary colors produces the other colors needed to complete the color wheel.

MAGENTA + YELLOW = RED

YELLOW + CYAN = GREEN

CYAN + MAGENTA = BLUE

Mixing magenta, yellow, and cyan pigments together equally produces black.

Colors opposite one another on the subtractive color wheel are called complementary colors. On the subtractive wheel the complementary pairs are magenta and green, blue and yellow, and red and cyan.

Why is basic color theory so misunderstood? The additive and subtractive systems are often mistakenly combined into a single incorrect, confusing system. Most people believe that the primary colors are red, green, yellow, or blue. Many elementary school teachers believe that red, green, blue, and yellow "look" primary, so magenta and cyan colors aren't even introduced.

Another problem with teaching color is that color identification is subjective. People have different ideas in mind when describing a color. It's impossible to know exactly what someone means when they say: red, blue, or green. The variety of colors people accept as primary covers an unfortunately broad range. Additionally, manufacturing the exact paint to create a true primary color is nearly impossible, and standardization of color names is difficult, so we tend to accept a wide range of colors as primary.

Ask anyone in the business of printing pictures in magazines or books and they'll tell you that the subtractive primary colors have always been magenta, yellow, and cyan (and black to compensate for inadequacies in the printing inks). Computer ink jet and laser printers also use the subtractive system's primary colors.

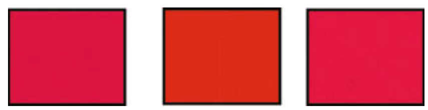
Colored filters that are used on camera lenses and theatrical lights also use the subtractive system. These filters are usually colored glass or acetate sheets called *gels*. Filter colors are mixed subtractively by laying one filter over another. The mixing results are exactly the same as when mixing paint. Overlapping a cyan and a magenta filter creates a blue color. Overlapping magenta and yellow filters creates red; overlapping cyan and yellow filters creates green. If magenta, yellow, and cyan filters are overlapped together, black or no light transmission occurs. Each filter has subtracted its wavelength from the other two, leaving no light at all. How camera filters can affect the color of light is explained in the appendix.

This is not an instruction book about mixing watercolors, acrylic, or oil paints for artists. The theories and systems for mixing artist's colors vary greatly, depending on the artist's choice of paint manufacturer and style of working. The purpose of this chapter is to identify, organize, and control color in the photography of film and video productions.

The Basic Components of Color

Talking about color is difficult because words can never accurately describe a color. Commercial paint stores use names like “King’s Ransom,” “Liberty,” or “Sorrento” to describe colors in their catalogue. Interior designers use words like “mushroom” or “peach,” which may generally describe a color, but still aren’t very specific. Sometimes colors are given names like “sea-calm” or “romance,” which tell more about the emotion the color hopes to evoke rather than a description of the color itself.

Ultimately, it’s impossible to accurately describe a color using words. What color is “candy apple red”?

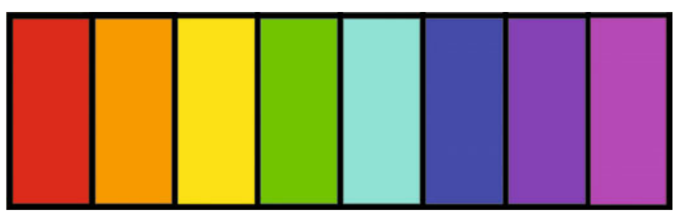


Here are three red colors—any one of them could be “candy apple red.”

The only way to describe a specific color is to have an actual sample of the color in hand. Commercially available systems, like the Pantone Color System and the Munsell Color System, provide color swatches that are accepted worldwide. These systems specify a color based on numbered charts or swatches of color, rather than a verbal description.

If color swatches aren’t available, there are three terms that can verbally describe any color: hue, brightness, and saturation.

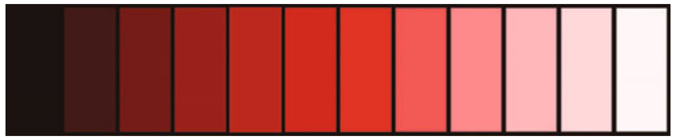
Hue



The eight hues are shown here. Hue is the position of a color on the color wheel: red, orange, yellow, green, cyan, blue, violet (or purple), and magenta. That’s it. There are only eight hues. Pink, brown, turquoise, and beige are not hues. Using the hue name is a good way to begin to describe a color. Stop signs are red, a lemon is yellow, and grass is green. Although this lacks subtlety, describing exact colors using words is impossible.

Brightness

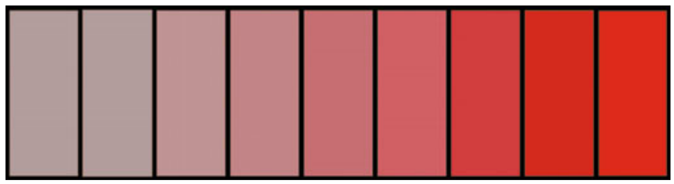
Brightness (sometimes called value) is the addition of white or black to the hue. Brightness is the position of a color in relation to the gray scale.



Adding white to a red hue creates a bright red (called pink). Adding black to a red hue produces dark red (called maroon or burgundy).

At noon, the sky is bright or light blue. At twilight, the sky is dark blue. Words can describe color only in a general way.

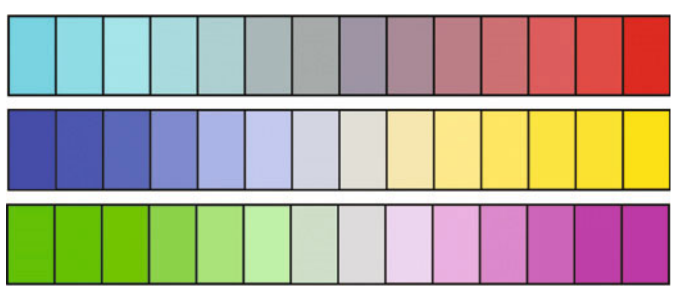
Saturation



The third term used to describe a color is saturation (sometimes called chroma or intensity) and its opposite, desaturation. Saturation refers to the purity of a hue. For example, fully saturated means the hue is extremely vivid. A saturated red is a red that hasn't been contaminated by any other hue. It's 100% red.

Desaturation involves a saturated hue and its complementary color. Complementary colors are opposite one another on the color wheel.

As an example, begin with the hue of red. Like all the colors on the wheel, this red is the purest, most vivid, saturated color possible. If a small amount of cyan (red's complementary color) is added to the red hue, the red begins to change. It begins to turn gray. This is called desaturation. The more cyan that is added, the grayer the red will become. When equal amounts of cyan and red are mixed together, there will be no trace of either hue; only gray will remain. Any color will desaturate (or turn gray) by adding its complementary color. When a hue is extremely pure or vivid, it is saturated. The grayer the color becomes the more desaturated it appears.

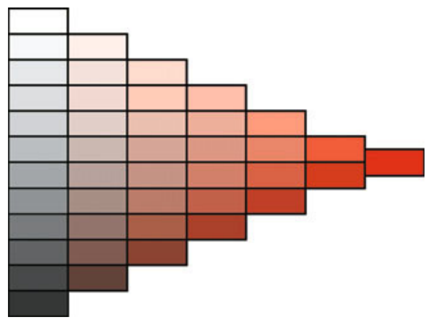


Here are the subtractive complementary pairs. As complementary colors are mixed together, they desaturate their partner and when mixed equally, create gray.

Hue, brightness, and saturation are the only terms needed to describe a color. These three terms are not exact, but using them is better than words found on designer brand paints like "sea-calm" or "liberty." To precisely describe a color, you must show a sample of it, but a color can be generally described using hue, brightness, and saturation.

There are a few other terms frequently used to describe a color. *Tint* and *pastel* mean adding white to a hue. *Shade* usually means adding the complementary color, but sometimes it means adding black. To avoid confusion, don't use these terms at all.

Look around you and try to describe the color of objects in terms of hue, brightness, and saturation. Most objects contain color, even if they appear gray. They're just partially desaturated.

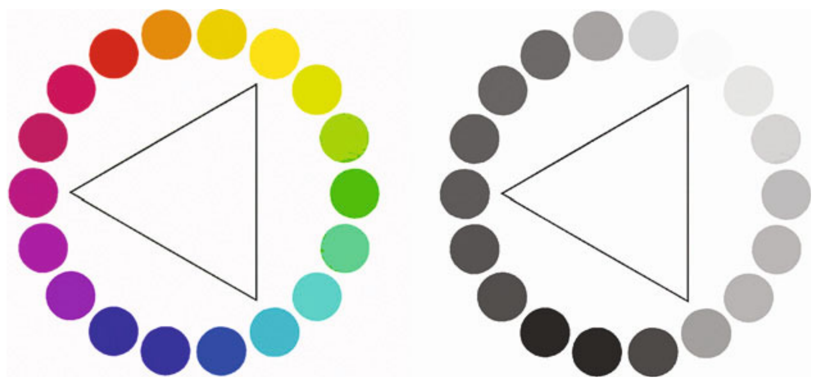


This diagram illustrates a range of colors that were created by adding black, white, or cyan to a fully saturated red. The red rectangle on the right is the most saturated. The colors desaturate as they move to the left, become brighter as they move up, and darker as they move down the diagram. Any one of the colors can be generally described in terms of hue, brightness, and saturation.

This diagram can be made for each of the six basic colors on the color wheel.

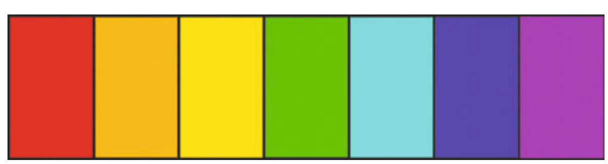
Brightness versus Saturation

A basic color wheel always displays the hues in their fully saturated (most pure or vivid) state. But the brightness of these saturated hues is different. A black and white photograph of the subtractive wheel reveals the wide brightness range inherent in fully saturated colors.

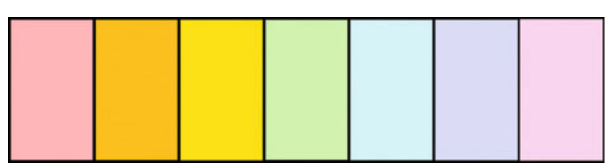


Here's a color wheel, and beside it, the same wheel reproduced in black and white. Yellow is the brightest saturated color. Orange is almost as bright. A saturated red, green, and cyan appear as middle gray. Blue and violet are the darkest saturated colors.

Knowing the inherent brightness levels of different saturated hues is important. A saturated yellow will always attract the viewer's eye first, not only because it's saturated, but also because it's very bright. A saturated blue will always appear much darker than a saturated yellow. By adding white, the brightness level of the blue can be raised to match the yellow, but the blue won't retain its saturation because it's too bright. It is impossible to create a basic color wheel where all the hues are simultaneously of equal brightness and equal saturation.



These hues are of equal saturation, but vary in brightness.



These hues vary in saturation, but are of equal brightness.

Contrast and Affinity

There are many ways to produce contrast or affinity of color. Remember contrast and affinity can occur within the shot, from shot to shot, and from sequence to sequence.

Hue

Contrast of hue occurs when the major color differences in a shot are due to hue.

The color differences in this picture are due to changes in hue.

Affinity of hue occurs when all colors in the picture are based on a single hue. Every color in the shot is green even though the brightness and saturation can vary.

Bergman's *Cries and Whispers* color scheme is based on a lightened, darkened, saturated, or desaturated red. Contrast and affinity of hue can occur within a shot, from shot to shot, and from sequence to sequence.

Brightness

Brightness refers to the tonal range of the colors in the shot. A scene that uses only very bright and very dark colors illustrates contrast of brightness. A scene that uses only bright colors will show affinity of brightness.

Here are illustrations of affinity (all dark red) and contrast (bright and dark blue) of brightness within the shot. Contrast and affinity of brightness can occur within a shot, from shot to shot, and from sequence to sequence.

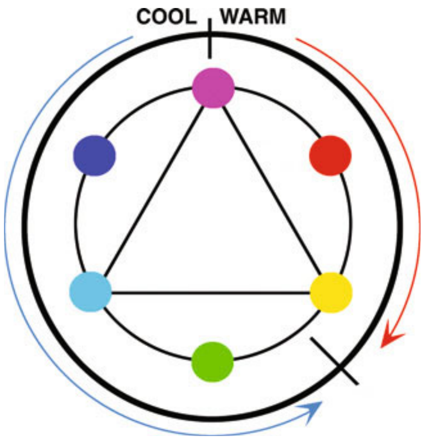
Saturation

A picture using only saturated colors illustrates affinity of saturation. A picture using saturated and desaturated colors illustrates contrast of saturation.

These examples show contrast or affinity of saturation. The first example is contrast; all the color in the shot has been desaturated, except for the fully saturated red jacket. In the second example, all the colors are grayed-out, creating affinity of desaturation.

Contrast and affinity of saturation can occur within a shot, from shot to shot, and from sequence to sequence.

Warm/Cool



A color wheel can be used to generally classify the warm and cool hues. The warm hues are red-magenta, red, orange, and yellow. The cool hues are blue-magenta, blue, green, cyan, and yellow-green.

In terms of visual perception, magenta appears to be a combination of a warm hue (red) and a cool hue (blue), so depending on the proportion of red or blue, magenta can appear warm or cool. Yellow is a warm hue, but when mixed with a small amount of green, it appears to lose its warmth and becomes cool.

Hues can be combined in an infinite number of ways to produce warm and cool colors. Mixing complementary hues can change the warmth or coolness of any color.

Here are examples of warm and cool affinity within a shot. Contrast and affinity of warm/cool can occur within a shot, from shot to shot, or from sequence to sequence.

Extension

Color extension deals with a color's brightness and physical proportion in relation to other colors.

The saturated hues are shown in color and gray tones that correspond to the actual brightness of the saturated color above it. Yellow is the brightest saturated color and blue/magenta, the darkest.

Here is a picture in color, and then the same picture in black and white. Notice how the tonal range is revealed.

Don't confuse tone with color. A saturated color might look intense, but the audience's attention will probably be drawn to brightness first. A saturated yellow will always attract an audience's attention, because it is not only saturated, but also extremely bright. A saturated magenta, because it is so dark, will tend to be ignored. As any color darkens, its ability to attract the eye decreases.

Interaction of Color

In his famous color studies at Yale University, the artist Josef Albers demonstrated and defined what has come to be called color interaction.

Albers' studies clarified theories about how colors appear to change their hue, brightness, or saturation when placed next to each other. His demonstrations, based on his personal work and the work of his students, developed into a set of rules that accurately predict how colors will interact.

Making a color change its appearance requires two ingredients:

- The susceptible color—This is the color that will appear to change.
- The neighbor—This is the color or tone that will activate the change in the susceptible color.

Here are three basic rules of color interaction.

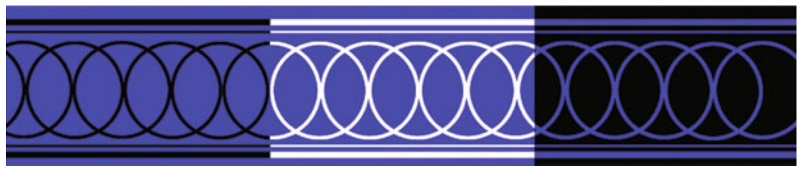
Hue and Black or White

Color interaction occurs when black or white is placed next to a color, but the results vary depending on the proportions.

This example uses cyan as the susceptible color and black or white as the neighbor. When cyan is surrounded by white, the cyan looks darker. Surrounding the same cyan with black makes the cyan look lighter.

The susceptible color shifts in opposition to the brightness of the neighboring tone. As the proportion of the neighboring white or black increases, the susceptible hue's tone appears to shift farther away from the background tone.

If the proportions and distribution of the black or white changes in relation to the susceptible hue, the opposite result occurs. This phenomenon, known as the *Bezold Effect*, has no satisfactory explanation as it completely contradicts the usual combination of black, white, and a susceptible hue. Sometimes called the *spreading effect*, the same color appears brighter when placed around white and darker when placed around black. The susceptible color adopts the brightness of the neighboring tone.

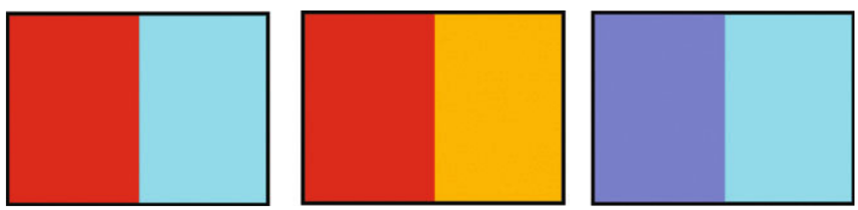


This figure shows the Bezold Effect.

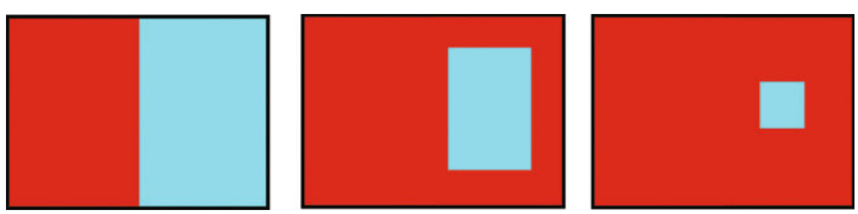
These kinds of color interactions are called simultaneous contrast because they occur within a single picture or shot.

Complementary Colors

The second type of color interaction involves complementary colors. Complementary colors are opposite one another on the color wheel. When complementary colors are placed next to one another, their saturation increases. In this example, both red and cyan are susceptible.



A red and cyan of equal proportion are placed side by side. These complementary colors will appear more saturated than if they were placed next to other colors.



As the proportion of the complementary colors changes, the larger color becomes less susceptible, and the smaller color becomes more susceptible. The red changes from a susceptible color to a neighboring color. The largest area of red is unchanged by the tiny cyan square. However, the tiny square of cyan dramatically increases in saturation, due to the large surrounding area of red.

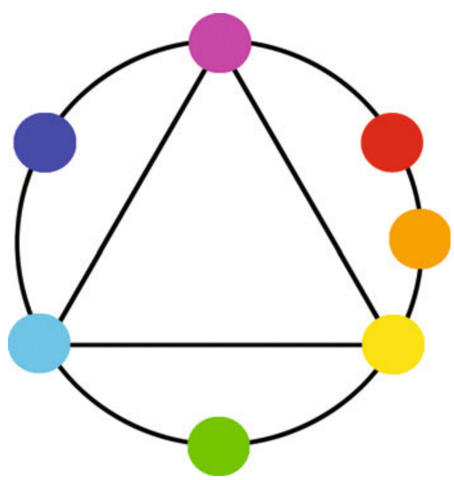
An orange swatch is placed on a blue background and on a yellow background. Even though the two orange swatches are identical, the orange on the blue background appears more saturated than the orange on the yellow background. This is called simultaneous contrast, because both susceptible orange colors are in the picture at the same time.

The same interaction can be created from shot to shot, which is called successive contrast. Now the viewer will look at one picture, and then at a second picture. This happens when an editor cuts from one shot to another. In successive contrast, only the second color is susceptible to change.

If a viewer is shown a primarily red scene and then a primarily cyan scene, the cyan becomes susceptible, and will appear far more saturated due to the color interaction of successive contrast.

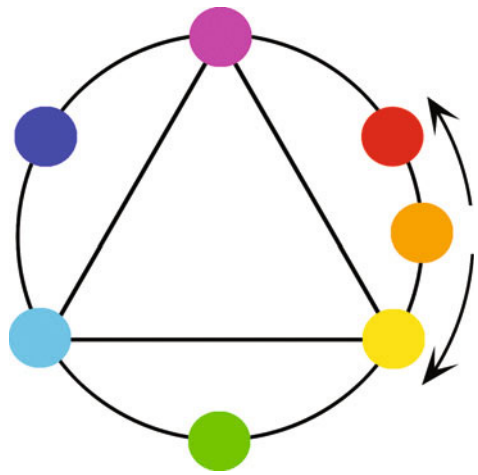
Analogous Colors

Analogous colors are neighbors on the color wheel. The third rule of color interaction states that when analogous colors are placed next to one another, they appear to push apart, or separate, in their position on the color wheel.



For example, red and orange are analogous colors.

In this illustration, orange is the susceptible color. An orange swatch on a red background will appear yellower. The same orange swatch on a yellow background will appear redder.



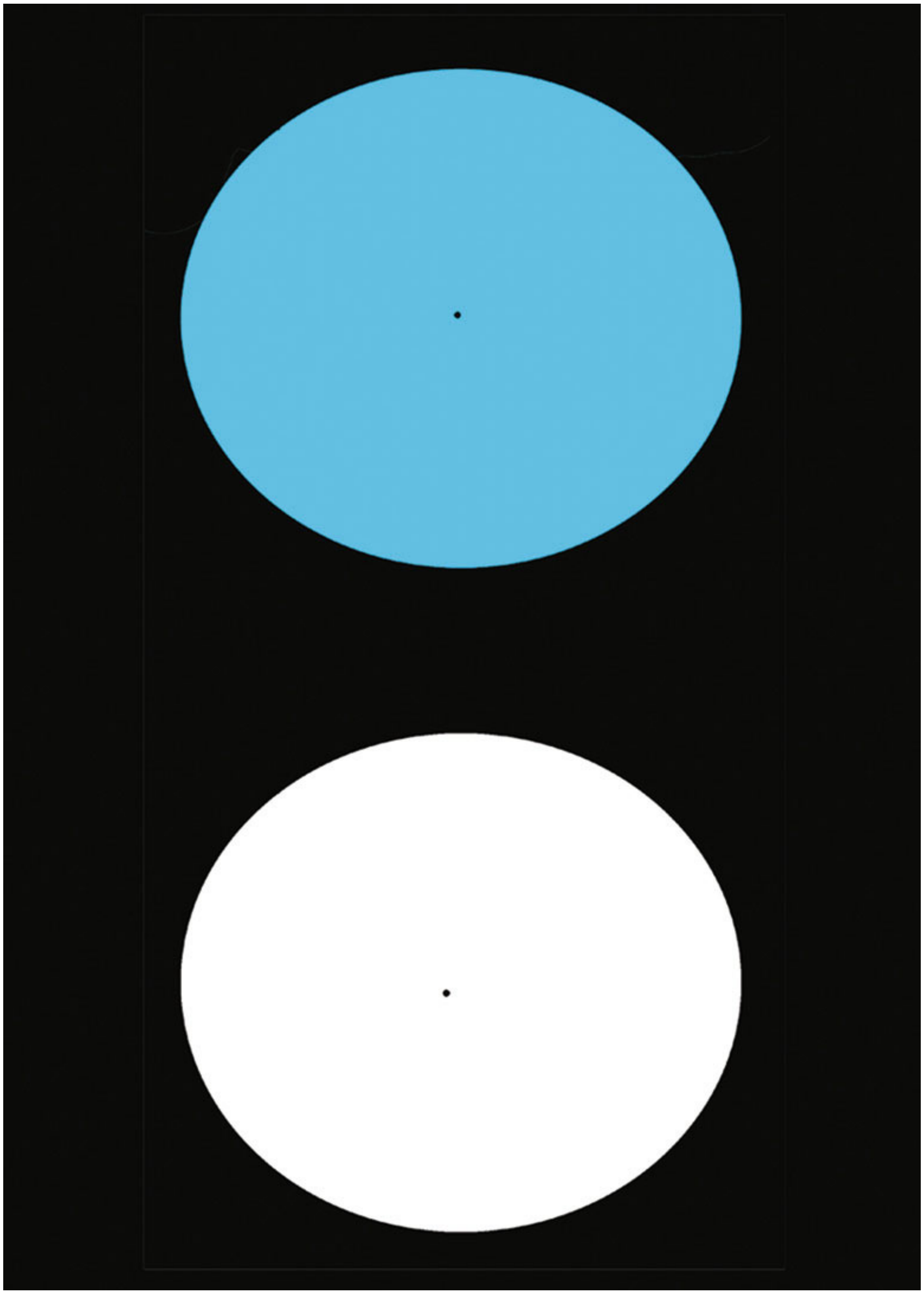
A color wheel can diagram this interaction. The red background pushes the orange toward the yellow. The yellow background pushes the orange toward the red.

How can color interaction be used in practical production? Suppose an action sequence requires red flames and, for dramatic effect, they should appear as saturated red as possible. Using interaction of color, it's possible to create a situation on screen that will help the flames appear more saturated. The solution involves simultaneous and successive contrast.

If a cyan background is placed behind the red flames, the flames will appear more saturated, because complementary colors increase saturation. This is simultaneous contrast (contrast within the shot). The red flames will appear more saturated because the viewer is simultaneously looking at complementary colors.

Another solution involves preceding the fire scene with a sequence of primarily cyan shots. This is successive contrast because the cyan color is seen first and the complementary red color follows (just like contrast from shot to shot). If the audience watches the cyan for approximately 15 seconds, and then sees the complementary red color, the red flames will appear far more saturated.

The exact physiological reasons why successive and simultaneous contrast works are not completely understood. However, a simple experiment can demonstrate the basic phenomenon.



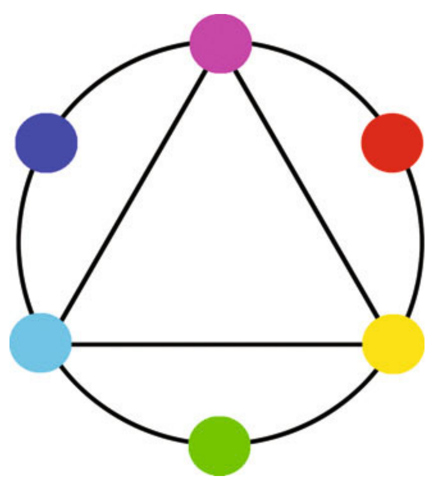
Position this book about 12 inches from your eyes in a strong light source. Get comfortable. Stare at the dot in the cyan circle for a full minute, and then shift your eyes to the dot in the white circle. You should see a red colored circle appear briefly in the white circle.

The red colored circle you saw is called an afterimage. The afterimage appears for a number of reasons. The eye will always produce the complementary color to what it sees. As you stared at the cyan circle you might have sensed that the cyan was getting less saturated, or less vivid. This was partly due to your eyes' color receptors beginning to fatigue.

At the same time, your vision system, being bombarded by a cyan color, adjusted to find a normal "white" color. Remember that human vision systems are always adjusting color and light. Since red is the complement of cyan, and mixing the two equally creates neutral gray (a visual equivalent for white), your vision system added the red color trying to make the cyan neutral gray. When your attention shifted to the white circle, you saw the red color your vision system had added to the cyan in an attempt to make it appear neutral.

When this principle is applied to the problem of the red fire, you can understand how preceding or surrounding the red with a cyan color will force the audience to generate a more saturated red color for the fire.

Color Schemes

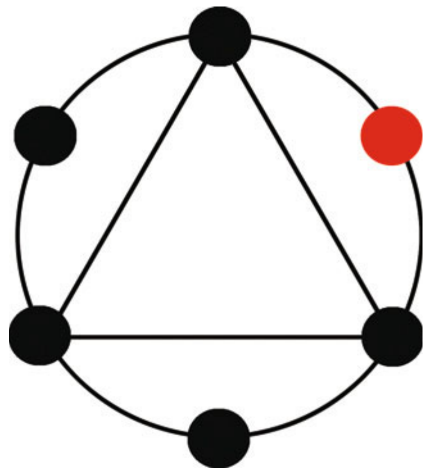


A color scheme is a color plan. Since color has so many variables, it's impossible to review all the possible color schemes, but the color wheel is a good place to begin, because it already has organized the hues into a simple circle.

Following are some possible color schemes using hue.

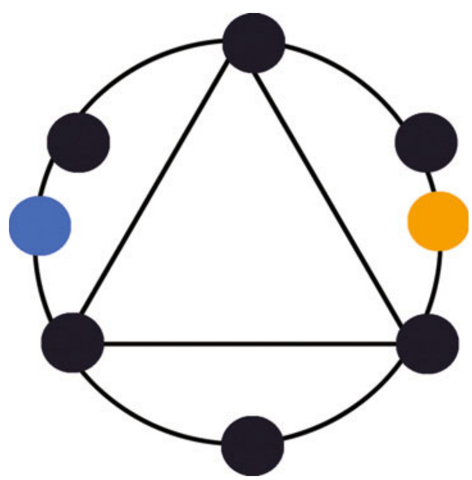
One Hue

A monochromatic color scheme involves finding a single hue for an entire production. Warren Beatty's *Reds* and Francis Ford Coppola's *The Godfather* use only the hue of red. Almost all the color in these films is a red hue that has been lightened, darkened, or desaturated.



This figure shows a monochromatic red color scheme.

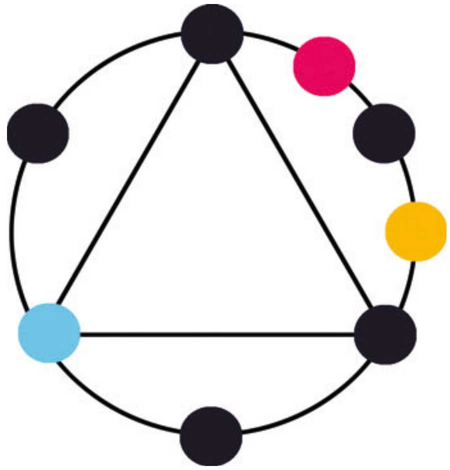
Complementary Hues



The most common complementary color scheme is blue/orange, as shown here.

A pair of complementary colors can be chosen as the basic scheme for all color in a production. The pair of hues can be assigned to any aspect of a production: one group of characters is blue, the others are orange; one location is blue, the other is orange (in Soderberg's *Traffic*, Mexico is orange and Ohio is blue); foregrounds are blue and backgrounds are orange; front light is blue and backlight is orange. Of course these arrangements can also be reversed.

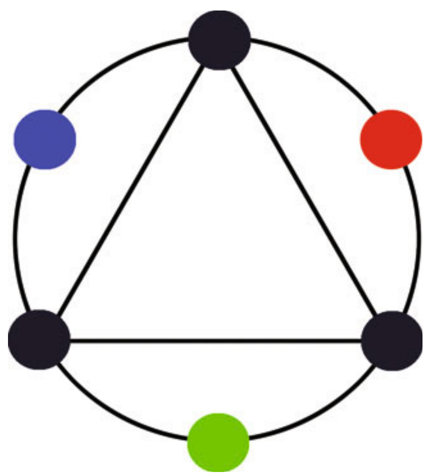
Split Complementary Hues



One of the complementary colors is split off into a pair of neighboring hues. This yields three hues instead of two. An example would be cyan and its split complementary orange and red-magenta. If the complementary pair is blue and yellow, a split complementary set could be blue, orange, and yellow-green.

This set of three colors can be assigned to any aspect of a production, but the three choices allow for more complex color schemes. For example, main characters can be orange, secondary characters yellow-green, and the backgrounds are blue.

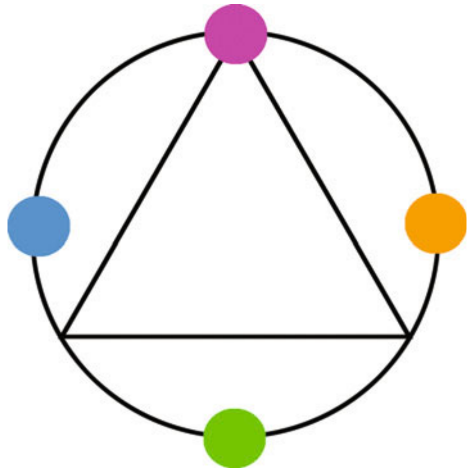
Three-Way Split



This color scheme uses any three hues, usually equidistant around the color wheel. For example, the three hue choices could be red, blue, and green. Maybe your production is a rural adventure with blue skies, green grass, and actors dressed in various red hues. Or at a forest location, assign blue to the heroes, red to the enemies, and green to the location. Perhaps night scenes are blue and green and daytime scenes are red. Here's an example of a three-way split color scheme.

Four-Way Split

Obviously, this involves four hues, usually equidistant around the color wheel. A four-way split is an extremely complex scheme.

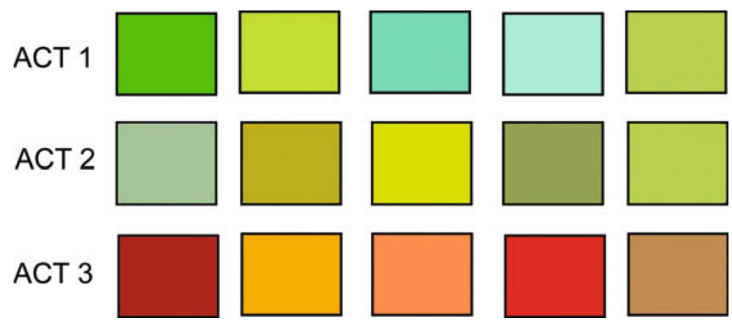


An excellent example of this scheme is Disney's animated feature *Sleeping Beauty* (1959). Magenta and green are assigned to the evil characters, and orange and blue/cyan are used for the good characters.

These schemes are based on hue only. Picking the hues is fairly simple, because there are few choices, and the color wheel organizes them so well. Next, you must decide on the brightness and saturation range of the colors in your production. This is where color can get complicated and difficult to control. At a certain point, discussing color becomes impossible, because words can't accurately describe it. A solution to the problem is a color script, which illustrates a color scheme with actual swatches.

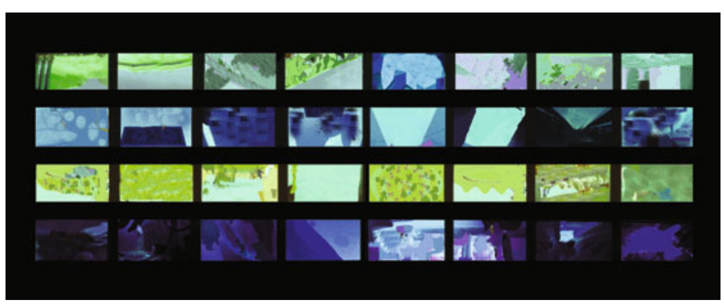
A color script can be as simple as a group of swatches specifying the color for an entire production. More complex color scripts can show color schemes for different acts, sequences, or scenes or shots. Using actual swatches eliminates inaccurate verbal descriptions of color.

This color script simply displays the colors for an entire production. The color scheme is all cool, desaturated colors.



Here, the color script illustrates the color for each act of the story. Notice the contrast of warm and cool between act 2 and 3 of the story.

This color script separates the present tense from the past with two different color schemes.



This more detailed color script specifies the color range for various shots in each of four sequences of a story. Notice how the color scheme changes as the story progresses.

Don't underestimate color's value as a visual component. Audiences notice color immediately and respond to it emotionally. Animated films and computer games rely heavily on color scripts since all the color must be created. Chapter 9, "Story and Visual Structure," will look at more approaches to creating and controlling color schemes.

Control of Color in Production

There are many ways to control color: the color palette, filters, time and location, film and digital photography, and the laboratory.

Color Palette

The best way to control color is to limit the color palette itself. The palette means the actual color of the objects (sets, props, wardrobe) in the picture. If you want your finished production to appear red and desaturated, then put only desaturated red objects in front of the camera. Give yourself strict rules about the color of your production and remove colors that are wrong.

A smart production designer knows how to control color. It's not just wardrobe and wall colors. Ideally the color of every object in every shot should be carefully chosen. This can get overwhelming, so limiting the color palette keeps control simpler and allows the colors being used to have visual meaning for the audience.

The art department can manipulate the color palette. In *Peggy Sue Got Married* (1986) the vintage look of 1950 Kodachrome photos was achieved by spray painting the grass an unusually saturated green and painting sidewalks purple. In Michelangelo Antonioni's *The Red Desert* (1964), everything in a street scene, including fruits and vegetables on a cart, was painted gray.

The color scheme for *The Godfather* (1972) is basically black, white, and red. So sets, locations, costumes, and props were picked and painted with this specific scheme in mind. *Chinatown* (1974) has a color scheme based on yellow and orange (the color of dried, parched plants) with an elimination of blue, unless it is associated with water.

Audiences have a poor color memory. If a viewer is asked to remember a specific blue swatch of color, they will be unable to select that blue from a group of similar, but different, blue colors. This lack of color memory can be used to your advantage in the control of color. The hue, brightness, and saturation of an object's color can be manipulated from sequence to sequence, and the audience will be unaware of the color change. The color of objects can be changed with paint or dye in the same way that lighting changes the brightness of objects. In both cases, the viewer will be unaware of the manipulation.

A color often photographs differently from the way it looks in real life. This problem is called color localization. It occurs if colors change hue, brightness, or saturation when they are reproduced with film, videotape, digital capture systems, television equipment, or printing inks and dyes. The resolution of a computer or television screen will affect localization. A high-definition screen (coupled with a high-definition source) will reproduce colors more accurately than a conventional NTSC television. The manufacturing process affects the color response of various image capturing chips in digital cameras. For example, a saturated yellow flower might appear too bright, and overly saturated, when seen on a digital screen. A group of dark blue hues might appear black on film. Without testing or experience, it's impossible to determine how a color might shift.

Filters

Placing colored filters on the camera lens and the light sources can control color. This engages the subtractive system. A filter cannot add any color; it can only subtract color. A filter will always subtract its complementary color and transmit its own color.

Lens Filters

Filters can be used on camera lenses. Adding a yellow filter to the lens makes objects in the shot appear more yellow, but the filter isn't adding yellow. Actually, the filter is removing the blue color (complement of yellow) and the remaining yellow color appears more dominant.

Using colored filters on the camera lens can be tricky. A wide range of standard color filters is available for all types of photography. These filters are extremely reliable and affect the picture in specific, predictable ways. But when other types of nonstandard, colored glass or plastic filters are placed over a lens, problems can occur. The color of nonstandard filters that you evaluate with your eye may not be the color you get on film or video. A nonstandard filter that looks blue to the eye might appear magenta on film, for example. Experience or tests are the only methods of properly predicting how film or digital cameras will react to nonstandard colored filters.

Lighting Filters

Colored filters can be placed on lights. Several manufacturers provide a wide range of colored plastic sheets called gels that are available in any imaginable color.

Placing gels on lights uses the subtractive system. Whenever a gel is placed over a light, the output of the light decreases. The colored gel absorbs its complementary color and transmits its own color.

Standard gels for photography usually are calibrated in degrees Kelvin, and will accurately and predictably warm up (with an orange gel) or cool down (with a blue gel) the color of the lighting. Another group of standard gels are more selective and will remove only small amounts of one specific hue. Nonstandard gels are manufactured for theatre lighting and have no correlation to film or video camera settings at all. Although these nonstandard gels can produce spectacular colored effects, they should be carefully tested before use.

Time/Location

Color can be controlled by the time of day and the color of the location or environment.

The color of daylight changes as the sun moves across the sky. A sunrise appears more lavender, noon daylight is bluer, and a sunset is redder. Filming during "magic hour" (periods of daylight when the sun is below the horizon) produces an unusual quality of shadowless, blue daylight.

Weather conditions can affect the color of daylight. On an overcast day, the direct rays from the sun (which are more red) are held back by the clouds, making the daylight bluer.

The color of light will also change, depending on the surrounding environment. Colored objects in any location become reflectors and, depending on their size, can change the color of the light.

Photographing near red brick walls will add red to the general color of the light. In a forest, the light that filters through the trees' leaves is greener than the light coming directly from the sky.

At an exterior desert location, daylight will be reflected off the yellow/orange desert ground surface. White clouds, acting like huge reflectors, will bounce back the color, making the ambient light in a desert location an even more yellow/orange color.

Film Photography

Color can be controlled by the choice of the film stock and the method by which it is exposed. Different film stocks have different color characteristics, depending on the manufacturer and ASA. Generally, the lower the film's ASA (sensitivity to light), the more saturated the colors will appear. Some stocks look warmer or cooler, more or less saturated, have better shadow detail, or appear more contrasty. The only way to determine which film stock will be best for your project is to test it.

Color on film can also be altered through exposure. The variables here are great. Film can be under- or overexposed and then brightened or darkened at various stages of postproduction to control saturation and brightness. This book will not go into the complexities of exposure. Again, experience and actual testing are necessary to fully understand the possibilities.

Digital Capture Photography

Digital cameras offer exposure controls identical to film cameras, plus many more digital choices. Sophisticated digital cameras have various settings to change the look of the image. Depending on the camera manufacturer, the hue, brightness, saturation, contrast, resolution, sharpness, and exposure latitude can be programmed into the camera. This can radically affect the image recorded by the digital camera. Many photographers prefer to capture a complete, unprocessed "raw" image and then alter that image in postproduction, where even more control possibilities exist.

Laboratory

There are two types of laboratories, one for film and one for digital photography. The film laboratory uses photochemical processes involving light and chemicals that can help control the color on the film.

Flashing

Flashing means the film is exposed to light twice: once when a scene is normally photographed, and again at the lab, either before (preflashing) or after (postflashing) the photography with a camera is completed. The lab's flashing exposes the film to a precisely measured amount of light (colored or white) that will desaturate the color, lower the contrast, and, if desired, add an overall hue cast. One film camera manufacturer has added a special flashing light inside the camera body, so the flashing can occur as a shot is being photographed.

Developing

The lab can alter the length of time the film is developed in the chemical solutions. The original film is underexposed during photography and then developed for a longer period of time (called *pushing* or *force developing*) to compensate for the underexposure. Pushing the film will desaturate the color.

Laboratories are willing to experiment with filmmakers by removing or adding steps in the chemical development process to alter the color film's hue, brightness, or saturation. Some labs have special chemicals or processing steps already in place that change the look of the film's color. Cross-processing involves developing color reversal film stock in chemicals designed for negative film stock. The result is a contrasty image that super-saturates specific colors. Another lab service called *bleach bypass* adds density to darker tones and increases overall saturation. Feature films, commercials, and music videos have used these laboratory techniques to give their film a unique look.

Photochemical Timing

The lab can also "time," or color correct the film. The term *timing* refers to early 1900s lab technicians who, using clocks, would control the black and white film's image by the length of time it was left in the chemical solutions.

Modern photochemical timing uses computer-controlled additive color printing machines to color correct films. Color timing is used to correct or smooth out the continuity of brightness and hue from shot to shot. Timing can also add overall hue changes, making scenes warmer, cooler, lighter, or darker to enhance a visual style. Photochemical timing cannot target one color without affecting the entire shot.

Digital Timing

Color timing in the digital laboratory refers to the color correction of images captured on video or transferred from film to a video source. This timing is done digitally using computers, and offers far more control than is available with photochemical methods.

Color timing in the digital laboratory can independently manipulate hue, brightness, saturation, and contrast in an entire production, or any single object within one frame. Whether you're working in video or film transferred to video, digital technology allows unlimited color flexibility in postproduction.

The digital laboratory has invented the Digital Intermediate (DI), which replaces the photochemical method of color timing film. A DI is a digital duplicate of an entire production that originated on film or a digital source. Once editing is complete, a high-resolution digital copy of each frame of a production is stored in a computer. The DI allows the production team to make any type of hue, brightness, saturation, or contrast change in any part of the picture. Color timing from a DI allows for unlimited color control. The color-corrected DI can be projected using digital equipment, broadcast directly on television, or recorded back onto film and projected conventionally.

Films to Watch

Saturated Hue

Cries and Whispers (1972)

Directed by Ingmar Bergman

Written by Ingmar Bergman

Photographed by Sven Nykvist

Production Design by Marik Vos-Lundh

The director said that his first idea for the film was an image of three women dressed in white, standing in a red room. The entire film uses a limited color palette of red, usually an extremely saturated red.

Contrast of Hues

The English Patient (1996)

Directed by Anthony Mingella

Written by Anthony Mingella

Photographed by John Seale

Production Design by Stuart Craig

This film takes place in two locations. Red, orange, and yellow are assigned to the desert. Blues and greens are assigned to the countryside.

Punch Drunk Love (2002)

Directed by Paul Thomas Anderson

Written by Paul Thomas Anderson

Photographed by Robert Elswit

Production Design by William Arnold

The two main characters are assigned a hue that remains constant throughout the entire film. He is blue and she is red.

Affinity of Hue

Sixth Sense (1999)

Directed by M. Night Shyamalan

Written by M. Night Shyamalan

Photographed by Tak Fujimoto

Production Design by Larry Fulton

The color red is used sparingly to represent death. All the other hues are desaturated or removed from the color palette.

The Shawshank Redemption (1994)

Directed by Frank Darabont

Screenplay by Frank Darabont

Photographed by Roger Deakins

Production Design by Terrence Marsh

In this movie, blue is the color of imprisonment and red is the color of freedom.

Limited Color Palette

Sin City (2005)

Directed by Frank Miller, Robert Rodriguez, and Quentin Tarantino

Written by Frank Miller

Photographed by Robert Rodriguez

Art Direction by Steve Joyner and Jeanette Scott

Photographed entirely in front of green screens, all the backgrounds and color were created in postproduction using a computer. This technique allows for extremely specific control over all the visual components. Color is used only to accent the visuals.