



GRC 101 INTRODUCTION TO GRAPHIC COMMUNICATIONS

WHAT IS COLOR?

Information
Sheet No.

300

Basic Requirements

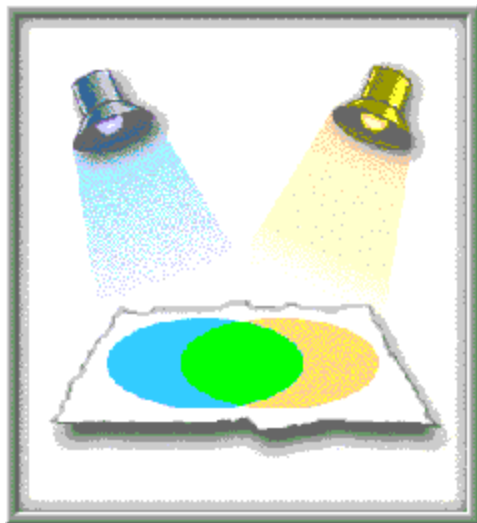
Pure white light, such as sunlight, is composed of all visible colors. Sir Isaac Newton discovered this in 1666 by passing a beam of light through a prism.

The renowned English scientist was 23 years old at the time. He was made to stay home from Cambridge University for over a year because the plague that was sweeping Europe had closed it down. It was during this period that Newton performed his famous spectrum experiments. To alleviate the boredom of quarantine, he punched holes in the curtains of his darkened room to study the effects of light passing through a prism.

The light separated into the same progression of colors found in the natural rainbow.

Although he found an infinite number of colors in this spectrum, Newton wanted to show that there were just seven main colors, like the seven known planets and the seven musical notes in the diatonic scale. He identified red, orange, yellow, green, blue, indigo and violet. This was also in keeping with Aristotle's seven classes of color which he thought were all mixes of black and white.

Using a second prism, Newton showed that each color in the spectrum is monochromatic—that is, composed of a single, unique wavelength which can't be further



separated into other colors.

Newton's experiments showed that light can be combined to form different colors. For example, combining blue and yellow light produces a green light that appears identical to the pure green found in a prism spectrum. (Modern techniques, however, show these greens to be two very different colors. Such color pairs are called metamers because they appear to be identical even though they have different wavelengths.)

Using two prisms, Newton found that some color combinations produce pure white instead of colored light. In effect, they complete each other when mixed. These pairs of colors are called complements. In this example you see that purple and yellow lights combine to form white



What Are the Color Characteristics?

Color Attributes

There are literally millions of colors but fortunately they can be divided into just a few color families. And every color can be described in terms of having three main attributes: hue, saturation and brightness.

Hue is identified as the color family or color name (such as red, green, purple). Hue is directly linked to the color's wavelength.

Saturation, also called "chroma," is a measure of the purity of a color or how sharp or dull the color appears.

Brightness, also called "luminance" or "value," is the shade (darkness) or tint (lightness) of a color. Areas of an evenly colored object in direct light have higher brightness than areas in shadow.

Color Classifications

The concept of the color wheel was invented when Sir Isaac Newton bent the color spectrum into a circle. Since then, the color wheel has been used as a tool for understanding color relationships and creating harmonious color schemes. The color wheel clearly shows which colors are warm and cool, complementary, split complementary and analogous. The diagrams in the following pages demonstrate each of these concepts.

Cool colors range from blue to violet, the half of the color wheel with shorter wavelengths. Cool colors have a calming effect. They are frequently used for backgrounds to set off smaller areas of warm colors. Used together, cool colors can look clean and crisp, implying status and calm. However, it is important to note that usage of bright cool colors generates more excitement than light, medium or dark cool colors.



Warm colors range from red to yellow, essentially the half of the color wheel corresponding to the longer wavelengths. Warm colors are active, attention-grabbing and aggressive. They stimulate the emotions, motivate and seem to come forward off the screen or page.

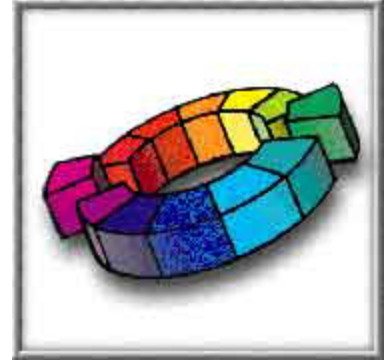
Complementary colors lie opposite each other on the color wheel. They complete or enhance each other. Impressionist painters in the 19th century often placed dots of pure complementary pigment on a color's surface to make the color come alive. While the dots weren't apparent to the viewer, the color appeared especially vibrant.

When mixed together equally, subtractive complements, such as paints, should theoretically produce black or gray. In practice, the pigments are

never perfect and the result is a muddy brown instead.

Using complementary colors in an image is quite pleasing to the eye. The colors seem to belong together. The most effective use of complements is to let one of them dominate by giving it a bigger area or a fuller saturation, while using the other as an accent.

Split complements (also known as contrasting colors or triads) lie on either side of a color's complement on the color wheel. These colors offer many of the same benefits as complementary colors, but the effect is more subtle. As two of the colors will be very similar, using fully saturated colors may be too strong. Dilute the saturation by using darker shades or lighter tints to draw the colors together.



Analogous color schemes use colors that are adjacent on the color wheel and so have similar hues. For example, blues, blue-greens and greens are analogous. When using analogous colors in a presentation, make one color dominant to avoid confusion and use the other colors as accents.

A monochromatic color scheme uses a single hue with variations in the saturation and brightness only. Such a color scheme produces simple images with no discord. However, if you plan to use monochromatic colors for your business graphics, make sure that you have the contrast necessary to make clear distinctions for the audience and to emphasize the important points. This is also important for achromatic graphics, which use white, black and shades of gray.

Achromatic color schemes have no color. They use black, white and shades of gray to represent colors. It may be that while your graphics will be presented in color, you'll need to produce black-and-white handouts. If so, review each handout carefully for legibility, as colors don't always translate to grayscales as expected. If a grayscaled image isn't clear enough, consider replacing blocks of color with patterns to increase legibility.

Color Harmony

In art as well as music, harmony comes from a pleasing arrangement of the parts. The science of color harmony traces its roots back to 1893 when Chevreul's "The Principles of Harmony and Contrast

of Colors," was published. The science of color harmony categorizes colors and determines harmonious groupings, such as complements, split complements, triads and analogies. Where science becomes art is in knowing how to use these colors, in what proportions and in what order.

In color and music, contrasts intensify each other. Complementary colors bring out the attributes of each other. White becomes brighter on a black background, blue enhances the warmth of orange; opposite hues are especially attention-getting. This hue contrast can cause tension in the image, if you are using fully saturated colors. Complementary colors can be brought into harmony by reducing the saturation or by mixing a little of each color with the other.

This tension is at its strongest when large areas of complementary colors touch. Leonardo di Vinci was the first to study this effect, known as simultaneous contrast. For the most part, it's visually disturbing and should be avoided. Separating large areas of complementary colors with a thin line of neutral white, gray or black will diminish the effect.

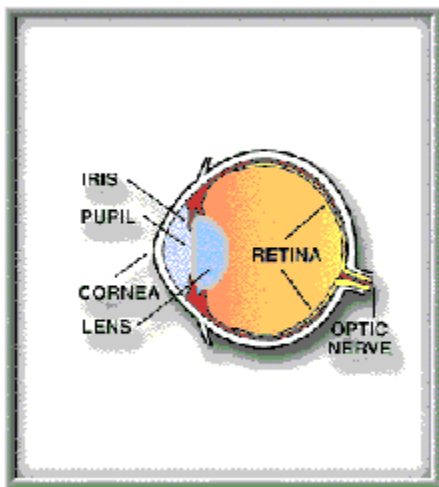
Varying the saturation or brightness of a color can cause light and dark contrasts. By simply working with complementary and analogous colors, a harmonious color scheme can easily be created. Pay attention to the saturation and brightness of the colors to prevent unexpected contrasts or to create intentional ones. If two colors are equal in saturation and proportions, the dominant color will be the one whose brightness is furthest from the background's. Similarly, if two colors have identical brightnesses, the dominant color will be the one whose saturation deviates more from that of the background.

How Do We See Color?

How We See Color

The human eye and brain together translate light into color. Light receptors within the eye transmit messages to the brain, which produces the familiar sensations of color.

Newton observed that color is not inherent in ob-



jects. Rather, the surface of an object reflects some colors and absorbs all the others. We perceive only the reflected colors.

Thus, red is not "in" an apple. The surface of the apple is reflecting the wavelengths we see as red and absorbing all the rest. An object appears white when it reflects all wavelengths and black when it absorbs them all.

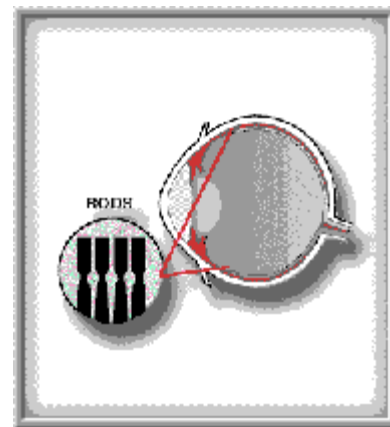
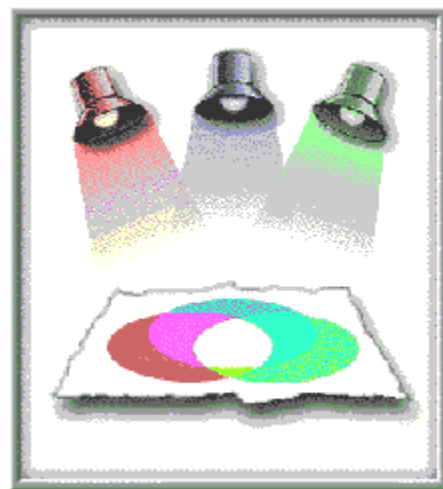


Red, green and blue are the additive primary colors of the color spectrum. Combining balanced amounts of red, green and blue lights also produces pure white.

By varying the amount of red, green and blue light, all of the colors in the visible spectrum can be produced.

Considered to be part of the brain itself, the retina is covered by millions of light-sensitive cells, some shaped like rods and some like cones. These receptors process the light into nerve impulses and pass them along to the cortex of the brain via the optic nerve.

Have you ever wondered why your peripheral vision is less sharp and colorful than your front-on vision? It's because of the rods and cones. Rods are most highly concentrated around the edge of the retina. There are over 120 million of them in each eye. Rods transmit mostly black and white information to the brain. As



rods are more sensitive to dim light than cones, you lose most color vision in dusky light and your peripheral vision is less colorful. It is the rods that help your eyes adjust when you enter a darkened room.

Cones are concentrated in the middle of the retina, with fewer on the periphery. Six million cones in each eye transmit the higher levels of light intensity that create the sensation of color and visual sharpness. There are three types of cone-shaped cells, each sensitive to the long, medium or short wavelengths of light. These cells, working in combination with connecting nerve cells, give the brain enough information to interpret and name colors.

The human eye can perceive more variations in warmer colors than cooler ones. This is because almost 2/3 of the cones process the longer light wavelengths (reds, oranges and yellows).

About 8% of men and 1% of women have some form of color impairment. Most people with color deficiencies aren't aware that the colors they perceive as identical appear different to other people. Most still perceive color, but certain colors are transmitted to the brain differently.

The most common impairment is red and green dichromatism which causes red and green to appear indistinguishable. Other impairments affect other color pairs. People with total color blindness are very rare.

Birds, fish and many other mammals perceive the full spectrum. Some insects, especially bees, can see ultraviolet colors invisible to the human eye. In fact, color camouflage, one of nature's favorite survival mechanisms, depends on the ability of the predator to distinguish colors. The predator is expected to be fooled by the color matching of the prey. Until recently, it was thought that dogs didn't see any color at all. Recent studies now show, however, that dogs can differentiate between red and blue and can even pick out subtle differences in shades of blue and violet.

How Does Color Affect Us?

COLOR PSYCHOLOGY

Generally, color is the effect produced on the eye and its associated nerves by light waves of different wavelength or frequency. Light transmitted from an object to the eye stimulates the different color cones of the retina, thus making possible perception of various colors in the object.

Our personal and cultural associations affect our experience of color. Colors are seen as warm or cool mainly because of long-held (and often universal) associations. Yellow, orange and red are associated

with the heat of sun and fire; blue, green and violet with the coolness of leaves, sea and the sky. Warm colors seem closer to the viewer than cool colors, but vivid cool colors can overwhelm light and subtle warm colors. Using warm colors for foreground and cool colors for background enhances the perception of depth.

Although red, yellow and orange are in general considered high-arousal colors and blue, green and most violets are low-arousal hues, the brilliance, darkness and lightness of a color can alter the psychological message. While a light blue-green appears to be tranquil, wet and cool, a brilliant turquoise, often associated with a lush tropical ocean setting, will be more exciting to the eye. The psychological association of a color is often more meaningful than the visual experience.

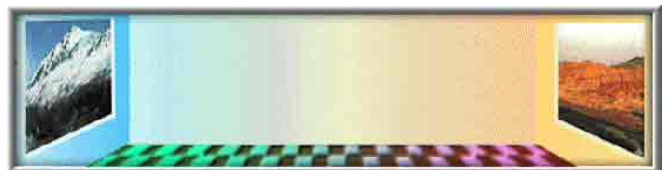
Colors act upon the body as well as the mind. Red has been shown to stimulate the senses and raise the blood pressure, while blue has the opposite effect and calms the mind.

Las Vegas casinos know that people will actually gamble more and make riskier bets when seated under a red light as opposed to a blue light.

For most people, one of the first decisions of the day concerns color harmony. What am I going to wear? This question is answered not only by choosing a style and fabric appropriate to the season, but by making the right color choices. And it goes on from there. Whether you're designing a new kitchen, wrapping a present or creating a bar chart, the colors you choose greatly affect your final results.

How often have you caught your breath at the sight of a flowerbed in full bloom? Most likely the gardener has arranged the flowers according to their color for extra vibrancy. Have you ever seen a movie in which a coordinated color scheme helps the film create a world unto itself? With a little knowledge of good color relationships, you can make colors work better for you in your business graphics and other applications.

Color is light and light is energy. Scientists have found that actual physiological changes take place in human beings when they are exposed to certain colors. Colors can stimulate, excite, depress, tranquilize, increase appetite and create a feeling of warmth or coolness. This is known as chromodynamics.



An executive for a paint company received complaints from workers in a blue office that the office was too cold. When the offices were painted a warm peach, the sweaters came off even though the temperature had not changed.

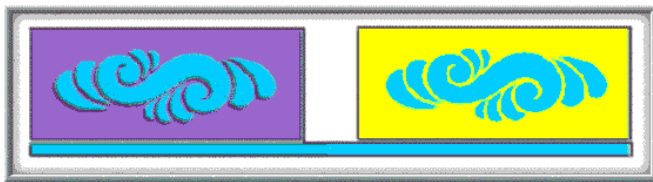
The illusions discussed below will show you that sometimes combinations of colors can deceive the viewer, sometimes in ways that work to your advantage. They can also cause unfortunate effects in your graphics, so be sure to watch out for these little traps.

Sometimes colors affect each other in unexpected ways. For example, most colors, when placed next to their complements, produce vibrating, electric effects. Other colors, in the right combinations, seem quite different from what you'd expect.

The most striking color illusions are those where identical colors, when surrounded by different backgrounds, appear to be different from each other. In a related effect, different colors can appear to be the same color when surrounded by certain backgrounds.

When you look at a colored object, your brain determines its color in the context of the surrounding colors.

In this picture, the two bows are the same color,



but because the surrounding areas are strikingly different in contrast, it seems to our eyes that they are different. Keep this effect in mind when creating graphics where color matching is critical. If you attempt to match your corporation's official colors, you may find that even if you achieve an exact match, it may look wrong in context.

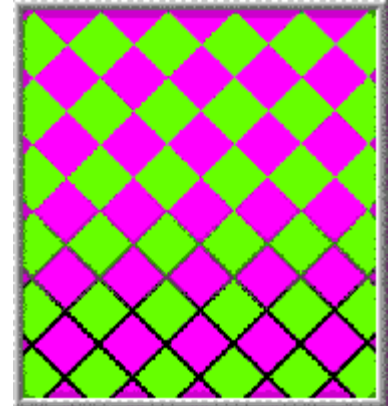
In the same way that one color can appear different in different surroundings, two similar colors may appear to be identical under some conditions. Even though the two symbols are actually slightly different tones, the contrasting backgrounds cause our brains to think that they are the same color. This effect is harder to control, but be aware of it because it can affect your graphics in hidden ways.

The feeling you get when looking at bright complementary colors next to each other is a vibrating or pulsing effect. It seems that the colors are pulling away from each other. It's caused by an effect called color fatiguing. When one color strikes a portion of the retina long enough, the optic nerve begins sending confused signals to the brain. This

confusion is intensified by the complementaries.

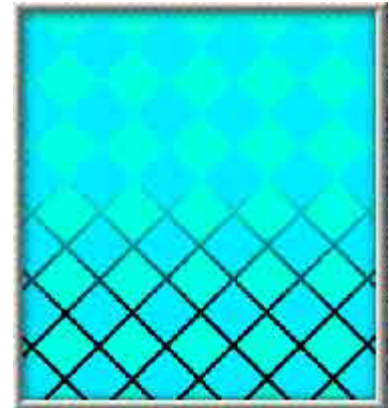
Mixing brilliant complementary colors gets attention, but it should be used with restraint. The effect is disconcerting and can make your eyes feel like they've been shaken around.

If you want to use complementary colors without causing discomfort, you can outline each of the colors with a thin neutral white, gray or black line. The outlines separate the two colors, which helps your brain keep them separated.



When two very similar colors touch in an image, both colors appear to wash out and become indistinct. This is because the borders between the colors are difficult to distinguish and your brain blurs the colors together.

If you outline each of the colors with a thin neutral white, gray or black line, the colors become easier to distinguish. This is called the stained glass technique and is a way to reduce this blurring of the colors.



What Are Other Ways to Define Color?

Color Models

When you ask children to tell you the names of all the colors, they'll know red, blue, yellow and a few more. A more sophisticated adult will be able to name periwinkle, mauve, fuchsia and maybe another hundred. There are, however, thousands of regularly used colors and millions more that can be distinguished by the human eye. To give a name to each of them would be impossible, so scientists have devised various ways of assigning numeric values to colors. These systems are called color models, and they provide precise methods for naming and reproducing exact colors. Some are based on the

optical components of the colors and others are based on how people "feel" colors are related to each other.

RGB (RED, GREEN, BLUE) MODEL



In the RGB system, the red, green and blue dots are assigned brightness values along some scale, for example 0 to 255, where 0 is dark and 255 is bright. By listing the three values for the red, green and blue phosphors, you can specify the exact color that will be mixed.

Additive colors get lighter when mixed. As each component of light is mixed in, the combination becomes a new color.

Red, green and blue are the three additive primaries. You can mix any color of light with different combinations of the additive primaries. When you mix all three together in balanced amounts, you get white.

These three primaries are the basis of the additive color model. It's called the RGB model, and it's usually used to create color on your computer display as well as other electronic devices.

By mixing together various amounts of red, green and blue light, you can make almost any color. The RGB color space is a multi-colored cube with different points showing what colors different mixtures of red, green, and blue make. Television screens and computer monitors make their colors by mixing red, green and blue lights. A monitor or television screen mixes a color by illuminating tiny dots of red, green and blue phosphors with an electron gun located at the back of the monitor. By illuminating each of the dots to a different brightness, the monitor creates different colors.

The next several pages have descriptions of the major color models and some experiments to help you visualize how they work.

Because the RGB model is only capable of producing a certain range, or gamut, of colors, there are some colors that cannot be reproduced accurately by a computer monitor. The number of colors visible on a monitor is further reduced by the limitations of the video hardware in the computer, which may display anywhere from just black and white up to 16.7 million colors.

Cyan, magenta and yellow are the three subtractive primaries. Nearly any color can be produced

with different combinations of these three colors. When you mix all three together in equal amounts, you get a near black.

These three primaries are the basis of the subtractive color model.

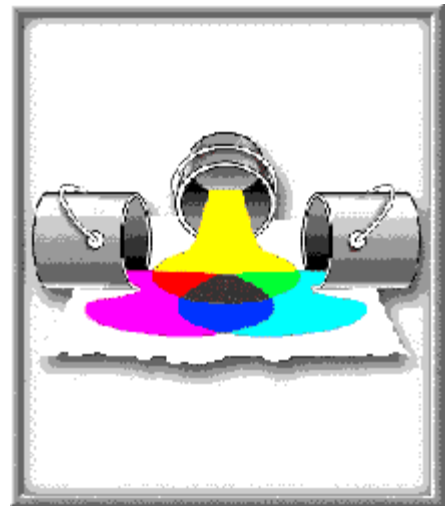
That's why it's called the CMY model. A close relative of the CMY model, called CMYK, is commonly used by printers and some software.

CMYK (Cyan, Magenta, Yellow, Black) Model

Many computer printers and traditional "four-color" printing presses use the CMYK model. In the CMYK model, by using cyan, magenta, yellow and black inks or paints, you can mix nearly any color.

In theory, you can mix any reflective color by mixing a combination of cyan, magenta and yellow. In the real world, however, the inks that printers use are not perfect. This becomes most obvious when you mix all three to make black. The color that results is muddy brown, due to impurities in the inks. That's why printers use black ink to get the best results.

Subtractive colors get darker when mixed. Each of the mixed paints or inks absorbs different components of the light. If the right combination of paints is mixed together, all of the components of light are absorbed and the result is a near black.



When preparing a color image for printing, the prepress operator makes four separation plates. Each plate is for one of the four colors of ink in the CMYK model. When all four plates are aligned and printed on top of each other, the inks will combine to simulate the proper colors. This method is referred to as "process color" (or "four-color") printing.

HSL (Hue, Saturation, Luminance)

Model

The HSL model is very similar to the RGB model. In fact, when they're expressed mathematically, they're identical. The difference lies in how colors are expressed numerically.

The hue determines which basic color it is. Red, green, blue, yellow, orange, etc. are different hues. Saturation and luminance tell more about the variations of these basic colors. Saturation is the vividness (or "purity") of the color, i.e., how much of the color's complement is mixed in. Finally, luminance refers to the "whiteness" of the color. It may also be termed "brightness," "value" or "intensity."

Other models related to the HSL model are the HSB (Hue, Saturation, Brightness) and HSI (Hue, Saturation, Intensity) models. These terms are all similar but not interchangeable.

CIE (Commision Internationale l'eclairage) Model

The CIE model is a more subjective description than the others. In 1931, the Commision Internationale l'Eclairage tested many people and found that the sensitivity of the receptors in the eye caused certain colors to be associated with others. The CIE color space includes all visible colors, whether or not they can be defined in the RGB or CMYK models.

Computer printers and other devices for displaying color have practical limitations that prevent them from making ALL of the visible colors. The colors that they CAN create are collectively called the color gamut. The CIE model is useful in part because a printer's color gamut can be drawn on the CIE color space showing what colors cannot be printed.

Other color models closely related to CIE are UCS (Uniform Color Space), CIELAB and CIELUV.

PANTONE® COLOR REFERENCE SYSTEMS

The PANTONE MATCHING SYSTEM® is a solid color communication system based on the visual matching of individual, pre-mixed colors.

The PANTONE MATCHING SYSTEM is a series of books with thousands of precisely printed colors alongside printers' formulas for mixing those colors.

The PANTONE MATCHING SYSTEM is used by artists and commercial printers to select, specify and match colors very precisely. Many logos are created with specific PANTONE Colors that can be very closely reproduced. By using PANTONE Colors, designers can be confident that their output will match their expectations.

The original PANTONE MATCHING SYSTEM in-

cluded 504 colors and has since been expanded to include 1,012 colors along with their printing ink formulations. For four-color (CMYK) printing, the PANTONE Process Color System® specifies more than 3,000 colors and shows the screen percentages for printing.

Recently, as computers have been used more extensively for business and professional graphics, software users have begun to specify their colors with the PANTONE MATCHING SYSTEM and the PANTONE Process Color System. More and more software products have been licensed by Pantone, Inc. to ensure a greater degree of consistency throughout the industry.

Hexachrome®

More recently, Pantone has introduced a revolutionary, patented six-color process printing system called Hexachrome. By providing an enhanced set of Cyan, Magenta, Yellow and Black, plus the addition of PANTONE Hexachrome® Orange and PANTONE Hexachrome Green, the color gamut for reproducing printed photographic images and simulated spot colors has been substantially increased.

One of the inherent short-comings of printing with CMYK (commercially and/or digital printers) is that the resultant color gamut is relatively restricted, resulting in a considerable loss of color from the original artwork. In fact the four-color (CMYK) gamut can only reproduce 50% of the spot/solid PANTONE MATCHING SYSTEM Colors. With Hexachrome, you can now reproduce over 90% of these spot/solid colors, and get a substantially enhanced reproduction of the photograhic images.

How Can We Reproduce Color?

Colorful graphics get the attention and the professional admiration of your viewers, but producing color graphics on the computer used to be so time consuming and expensive that it was only used for professionally published work. Now that the technology has become accessible to even casual users you may find yourself expected to produce colorful handouts, slides or reports on a regular basis.

For some purposes, it is sufficient to be able to display your graphics on screen and show them informally. In a meeting, you may need to print out a few copies as handouts. Occasionally you'll need to publish hundreds or thousands of copies to distribute more widely.

COLOR DISPLAYS

No matter how you intend to show your computer graphics, you'll see them first on a computer

monitor. All monitors have limitations that you should know about before you begin.

Most color computer monitors work on the same principle as a television. The screen is composed of phosphor dots that are illuminated from behind. On a color monitor, red, green and blue dots are distributed evenly. These dots are illuminated to different brightnesses to mix the different colors you see on the screen. If you look very closely, you can see these individual dots.

Most computer display systems are made up of two components: the monitor and a video adapter card that resides in the computer itself. The quality of the display is affected by both the monitor and the video card.

Besides the size of the screen, computer display systems have two primary features that determine the quality of the image: resolution and color depth. Resolution determines the fineness of detail on the screen. The color depth determines how much control you have over the coloring of your graphics.

The video card determines how many colors can be displayed by the monitor. Since the colors are created by mixing different brightness levels for each of the three color dots, a monitor can only mix as many colors as the number of brightness combinations it can make. The number of colors that can be displayed by a video card is called its color depth and is usually specified in bits per pixel.

Color depths in commercial video cards range from black and white (one bit) to over 16 million colors (24 bits). Of course, the human eye can't distinguish that many colors, so these higher-end displays are more powerful than most people need.

When designing on the desktop, your first concern is to assure that you are seeing color on your monitor as accurately as possible. The PANTONE Personal Color Calibrator™ software gives you the ability to set the manufacturer's standard profile for a specific brand and model of monitor, but further lets you set up and save your personal preference for red/green/blue acuity, brightness, contrast and lighting condition

In many cases, the number of colors in an image will exceed the capabilities of the device used to display the image. For example, it may be necessary to present a 256-color image on a 16-color display system, or to print a scanned photograph on a low-end dot-matrix printer. In situations such as these, the image is automatically simplified to reduce the number of colors. This process is referred to as color reduction.

As a typical user, you don't need to worry about doing the color reduction. That's usually done for

you by the computer system or your software application. Color reduction takes its toll on the quality of your displayed images, however, and you will probably notice these effects in your work.

Color reduction typically uses a technique called dithering. In the same way that the monitor simulates individual colors with its red, green and blue dots, even more colors can be simulated by arranging individual pixels. This technique creates a coarse image which will only look good at a distance.

Over the years, a wide variety of dithering methods (or algorithms) have been developed and implemented for use in image processing. The choice of any particular method depends on the exact nature of the image, the display system and the desired results. Dithering usually creates various distracting patterns (called artifacts or moiré patterns) in the image. Some dither patterns produce better gradations and shading than others, but may require more processing time and memory.

When designing for Web site displays, you can reduce the effects of dithering and provide more consistent color on different monitors if you use the 216 "internet-safe," non-dithering colors. Pantone's ColorWeb® and ColorWeb® Pro software packages help you select and incorporate these colors in the popular Web authoring software programs.

Desktop Printing

If you want to print your graphics on paper but only need a few copies, you need a color printer for your computer. The cost and quality of these printers has been improving dramatically since they were first introduced, leaving you with quite a few choices. The four primary printer technologies for producing color output vary in cost, resolution, color depth and paper requirements. Individual printers also vary in quality, speed, reliability and lifespan.

Pantone has several software packages that can help you manage and control color on the desktop. PANTONE ColorDrive® and PANTONE ColorReady™ are designed to work with popular graphic design programs like Quark XPress™, Photoshop®, Illustrator® and the like, and also provide more accurate output on a wide range of desktop printers. The company also offers PANTONE OfficeColor Assistant™ which allows the reduction and use of PANTONE MATCHING SYSTEM® Colors in Microsoft® Word, Excel and Powerpoint to assist the business manager in producing more attractive presentations and reports.

Commercial Printing

If you need to produce hundreds or thousands of copies of your work, you will need to take your output to a commercial printer for a large press run.

This process is somewhat demanding and expensive, but is the only way to make large numbers of copies.

Commercial printing requires quite a bit of prepress work for each job. Producing camera-ready originals is somewhat technical, so most printing houses have full-time prepress technicians who can do some or all of the work for you, depending on your experience and budget.

When you are deciding what type of printing to do, speed, cost per copy and quality of the output are some of the deciding factors. The printer's estimator can advise you about the choices available.

There are two different ways color can be applied to paper in color printing: spot color and process color. Spot color is a method of applying a premixed color of ink directly to the page. Process color applies four or more standard ink colors (the basic four are cyan, magenta, yellow and black) in very fine screens so that many thousands of colors are created. Spot color is usually used when a few exact colors are needed. Process color is more useful for printing photographs, paintings and very complex colored images.

In some cases, both spot color and process color can be used on the same document. For example, a company brochure may include color photos (process color) and a corporate logo (spot color). Spot color applies a premixed ink to the page. This color is usually identified by a color system such as the PANTONE MATCHING SYSTEM. Spot color is useful for documents that require only a few colors, such as newsletters, brochures and stationery. Spot color is also used to match specific colors very closely.

The cost of printing color documents is related to the number of ink colors used. As process color requires four or more inks, spot color can be cheaper if you use fewer than four colors. Spot color also has the advantage of printing a wider range of clean, bright colors.

Look around you for an example of spot color printing. If a color seems smooth and even no matter how closely you look, it's probably printed with spot color.

Process color is a method used to create thousands of colors using four or more standard inks. The colors used in four-color process are the three subtractive primaries (cyan, magenta and yellow) plus black.

The original image is separated into its cyan, yellow, magenta and black components. A film is made for each separation and then a plate is produced from the film. The paper is run through the four stations of a four-color press to accept layers

of ink from each plate. When all four colors are printed together, the illusion of continuous color is complete.

More recently Pantone has patented a unique six-color process printing technology called Hexachrome®. By incorporating an enhanced set of cyan, magenta, yellow and black and adding PANTONE Hexachrome® Orange and PANTONE Hexachrome Green, the reproduction of photographic imagery can be substantially enriched. Additionally, nearly all the solid PANTONE MATCHING SYSTEM Colors can be accurately simulated, thus eliminating the need to supplement the image reproduction with several spot colors, scanning, designing, separating, proofing and printing.

Take a look around you for a full-color newspaper, book or magazine. If you look very closely at a color photograph, you can make out the halftone dots of the four inks.

If you are printing in process color, your image will require a plate for each of the cyan, magenta, yellow and black inks. As each color of ink used is laid down on the paper individually, a different plate must be created for each ink.

Spot colors each require their own plate as well.

Separations can be created in quite a few different ways. You may be asked to provide a full color printout to be optically separated. Your image will either be scanned or run through a separator, which separates the image using filters. On the other hand, you may be asked to provide a disk containing the graphics file. An imagesetter, which is essentially a very high-resolution printer, will create the separations directly from the graphics file.

Halftoning is the most common of the many ways printers create different shades of color from just one ink. A finely etched screen is used when making each plate. This screen changes the darker and lighter areas of the original into areas of larger and smaller dots. When printed, the larger dots will appear darker than the smaller dots, due to greater ink coverage. When multiple colors of ink are printed together, the different apparent shades will combine to simulate far more colors than are actually used.

Halftoning is done with a very fine screen when printing on glossy paper and for higher quality documents. Coarser screens are used for rough paper such as newsprint. Newspapers use coarse screens, so it's fairly easy to make out the individual dots in newspaper photographs. The fineness of halftone screens is determined by the number of lines of halftone dots per inch. This is called the "lines per inch" or the LPI.

Lithography means "stone-writing." Invented in 1799 by Aloys Senefelder in Germany, this process relies on the fact that water and grease repel each other. A lithograph stone is prepared by drawing the image to be printed on polished limestone with a greasy crayon. In commercial offset lithography, the lithography stone is replaced by thin metal plate that wraps around a printing cylinder.

The imaging areas on the plate are water repellent and accept ink, while the non-imaging areas accept water and reject ink. The ink is offset from the metal plate onto a rubber blanket and then onto the paper, preventing excess wear of the plate. Offset printing is well-suited for color printing, because a typical press can handle six colors with a single pass, including four process and two spot colors, or six-color Hexachrome.

WHY WYS IS NOT WYG

A common acronym in computer graphics is WYSIWYG. It stands for "What you see is what you get." Unfortunately, a common problem in reproducing color graphics is that what you see on the screen is not what you get when you print. Several effects come together to cause this problem:

1. Monitors and output devices have limitations. Each device has a range of colors it can reproduce, called its color gamut. These vary with the type and model. The printer type, ink and paper quality and the printer's condition also affect the results.
2. Equipment can easily become miscalibrated and require very expensive, specialized accessories to keep them standardized to a predictable performance.
3. Printers that dither can only create a limited number of colors. If you attempt to print a color which does not fall within its abilities, it will produce the nearest match. The printer's resolution is important to its dithering ability, so higher resolution printers usually print higher quality color.

Color management systems are available to help solve these problems if precise color matching is important to you.

The Basic Psychology of Color

Do Different Colors Affect Your Mood?

Like death and taxes, there is no escaping color. It is ubiquitous. Yet what does it all mean? Why are people more relaxed in green rooms? Why do weightlifters do their best in blue gyms?

Colors often have different meanings in various cultures and even in Western societies, the meanings of various colors have changed over the years. But today in the US, researchers have generally found the following to be accurate.

What Colors Mean

We live in a colorful world. In many countries colors represent various holidays; they are also used to express feelings and enliven language. Find your favorite color and see what it means around the world.

With the human brain able to distinguish over two hundred shades of white, able to see the same color no matter the light source, saying color is essential to our perception is no slight exaggeration. Viewing a black and white scenic full of all the shades of gray that a good paper and photographer can bring to light, the emotions just those shades of gray can evoke is tremendous! But that's just a small sampling of the potential a full palette of colors can bring to a photograph. I'm not going to pass myself off as a scholarly master of psychology or try to convince you that one must have one color over the other for a photograph to be successful. A sunset is going to be in a red band of light no matter what psychological message we might want to communicate. What I want to bring to the forefront of your photographic consciousness and understanding is what color can communicate and how you can make use of that in your photography.

When photographing wildlife, you'd be surprised by the emotional response color can evoke, and how color, especially the color of the background, can emphasize and enhance that emotional response. We can't change the color of a subject to any great degree, but we can definitely alter the colors of the world around the subject to some degree, using various technical tools at our disposal. (If nothing else, this will help you understand what images to send and not to send to editors.) But which colors communicate what? Let me give you some very basic descriptions of colors and how we subconsciously perceive them. (It's very important to realize that we are talking about

psychology of colors here; folks don't see certain colors, then rationally think about their emotional response to them.)

White - symbolizes purity, innocence and birth. It's closely associated with winter but is considered a summer color and can also represent surrender or truth. It is also often associated with cleanliness, purity, simplicity, innocence, readability, honest, bareness, clinical, clean, medicinal, clear, pure, spacious, simple. In the color spectrum, white is the union of all the colors. Its neutrality and conservative nature is widely accepted. Its simplicity and subtle quality makes it an ideal color for establishing clarity and contrast in your images.

White is popular in decorating and in fashion because it is light, neutral, and goes with everything. However, white shows dirt and is therefore more difficult to keep clean than other colors. Doctors and nurses wear white to imply sterility.

Notable uses of white

1. A white flag is the universal symbol for truce.
2. White means mourning in China and Japan.
3. Angels are usually depicted wearing white robes.
4. The ancient Greeks wore white to bed to ensure pleasant dreams.
5. The Egyptian pharaohs wore white crowns.
6. The ancient Persians believed all gods wore white.
7. A "white elephant" is a rare, pale elephant considered sacred to the people of India, Thailand, Burma, and Sri Lanka; in this country, it is either a possession that costs more than it is worth to keep or an item that the owner doesn't want but can't get rid of.
8. It's considered good luck to be married in a white garment.
9. White heat is a state of intense enthusiasm, anger, devotion, or passion.
10. To whitewash is to gloss over defects or make something seem presentable that isn't.
11. A "white knight" is a rescuer.
12. A white list contains favored items (as opposed to a blacklist).
13. A "whiteout" occurs when there is zero visibility during a blizzard.
14. A "white sale" is a sale of sheets, towels, and other bed and bath items.
15. A "whited sepulcher" is a person who is evil inside but appears good on the outside, a hypo-

crite.

16. "White lightning" is slang for moon-shine, a homebrewed alcohol.

17. A white room is a clean room as well as a temperature-controlled, dust-free room for precision instruments.

18. White water is the foamy, frothy water in rapids and waterfalls.

Black is the color of authority and power. It is popular in fashion because it makes people appear thinner. It is also stylish and timeless. Black also implies submission. Priests wear black to signify submission to God. Some fashion experts say a woman wearing black implies submission to men. Black outfits can also be overpowering, or make the wearer seem aloof or evil. Villains, such as Dracula, often wear black. Strong, powerful, credible, precise, definite, professional.

Yellow - is the most visible color and is the first color the human eye notices and is an attention getter! Yellow, the color nearest to "light" leaves a warm and satisfying impression, lively and stimulating and in many cultures symbolizes deity. While it is considered a cheerful, optimistic color, people lose their tempers more often in yellow rooms, and babies will cry more. It is the most difficult color for the eye to take in, so it can be overpowering if overused. Dark yellow can be oppressive while light yellow is breezy. Yellow's stimulating nature and high visibility to the eye is the reason why many road signs are bold yellow (contrasted by black text).

Yellow enhances concentration, hence its use for legal pads. It also speeds metabolism. Often interpreted as a way to indicate youth, energy, dynamics, encouragement, design, ideas, bright, invention, sunshine, happiness, optimism, imagination, cheery, unsettling.

Notable uses of yellow

1. In Egypt and Burma, yellow signifies mourning.
2. In Spain, executioners once wore yellow.
3. In India, yellow is the symbol for a merchant or farmer.
4. In tenth-century France, the doors of traitors and criminals were painted yellow.
5. Hindus in India wear yellow to celebrate the festival of spring.
6. If someone is said to have a "yellow streak," that person is considered a coward.
7. In Japan during the War of Dynasty in 1357, each warrior wore a yellow chrysanthemum as a pledge of courage.

8. A yellow ribbon is a sign of support for soldiers at the front.

9. Yellow is a symbol of jealousy and deceit.

10. In the Middle Ages, actors portraying the dead in a play wore yellow.

11. To holistic healers, yellow is the color of peace.

12. Yellow has good visibility and is often used as a color of warning. It is also a symbol for quarantine, an area marked off because of danger.

13. "Yellow journalism" refers to irresponsible and alarmist reporting.

Suggested Website Uses: Signs, childcare, food, entertainment, e-commerce, new technology.

Orange - is a good balance between the passionate red and the "yellow of wisdom." Orange is symbolic of endurance, strength, ambition, trust, fruitful, creative, dynamic, energetic, youthful, expressive, childlike, innocent, enthusiastic, vibrant, warm, enthused, health. It can represent the fire and flame of the sun. Orange is said to also have the cheerful effect of yellow, but is intensified in its closeness to the color red.

Suggested Website Uses

Childcare, food, entertainment, education, recruitment, sport.

Red - The most emotionally intense color, red stimulates a faster heartbeat and breathing. It is also the color of love. Red clothing gets noticed and makes the wearer appear heavier. It is a bold color that commands attention! Since it is an extreme color, red clothing might not help people in negotiations or confrontations. Red cars are popular targets for thieves. In decorating, red is usually used as an accent. Decorators say that red furniture should be perfect since it will attract attention. It is often associated with credibility, power, cleanliness, focus, medical, profession, judicial, tranquility, peace, harmony, confidence, trust, appetite suppression. Red gives the impression of seriousness and dignity, represents heat, fire and rage, it is known to escalate the body's metabolism. Red can also signify passion and love. Red promotes excitement and action. It is a bold color that signifies danger, which is why it's used on stop signs. Using too much red should be done with caution because of its domineering qualities. Red is the most powerful of colors.

Notable uses of red

1. For the ancient Romans, a red flag was

the signal for battle.

2. Because of its visibility, stop signs, stop lights, brake lights and fire equipment are all painted red.

3. The ancient Egyptians considered themselves a red race and painted their bodies with red dye for emphasis.

4. In Russia, red means beautiful. The Bolsheviks used a red flag as their symbol when they overthrew the tsar in 1917. That is how red became the color of communism. 5. In India, red is the symbol for a soldier.

6. In South Africa, red is the color of mourning.

7. It's considered good luck to tie a red bow on a new car.

8. In China, red is the color of good luck and is used as a holiday and wedding color. Chinese babies are given their names at a red-egg ceremony.

9. Superstitious people think red frightens the devil.

10. A "red-letter day" is one of special importance and good fortune.

11. In Greece, eggs are dyed red for good luck at Easter time.

12. To "paint the town red" is to celebrate. 13. Red is the color most commonly found in national flags.

14. In the English War of the Roses, red was the color of the House of Lancaster, which defeated the House of York, symbolized by the color white.

15. The "Redshirts" were the soldiers of the Italian leader Garibaldi, who unified modern Italy in the nineteenth century.

16. To "see red" is to be angry.

17. A "red herring" is a distraction, something that takes attention away from the real issue.

18. A "red eye" is an overnight airplane flight.

19. If a business is "in the red," it is losing money.

Suggested Website Uses

Food, clothing, fashion, cosmetics, real estate, entertainment, health care, emergency services, hospitality, marketing, PR, sport.

Pink - The most romantic color, pink, is more tranquilizing. Sports teams sometimes paint the locker rooms used by opposing teams bright pink so their opponents will lose energy. Romance, creative, unusual, dainty, nostalgia, feminine.

Suggested Website Uses:

Florists, Travel, Dating, Crafts, Women's Retail, magazines/e-zines is the most gender specific. Pink represents femininity and has a gentle nature (which is not a bad thing). Pink is associated with sweets

like candy and bubble gum. It also symbolizes softness. Because it's so "feminine," use of pinks should be well planned. Pink and blue color combos are most associated with babies, soaps and detergents.

Blue - The color of the sky and the ocean, blue is the second most powerful color. It causes the opposite reaction as red. Peaceful, tranquil blue causes the body to produce calming chemicals so it is often used in bedrooms. Blue can also be cold and depressing. Fashion consultants recommend wearing blue to a job interview because it symbolizes loyalty. People are more productive in blue rooms. Studies show weightlifters are able to handle heavier weights in blue gyms. Credible, powerful, calming, clean, focused, medical, professional, judicial, tranquility, peace, harmony, confidence, trust, suppress appetite. Blue is often associated with somber emotions like sadness, gloom and fear. Blue is a contemplative color, meaning intelligence and strength. As pink represents femininity, blue represents masculinity. It is one of the most politically correct colors there is with no negative connotations of it anywhere on the globe.

Notable uses of blue

1. In ancient Rome, public servants wore blue. Today, police and other public servants wear blue.
2. In China, blue is for little girls.
3. In Iran, blue is the color of mourning.
4. Blue was used as protection against witches, who supposedly dislike the color.
5. If you are "true blue," you are loyal and faithful.
6. Blue stands for love, which is why a bride carries or wears something blue on her wedding day.
7. A room painted blue is said to be relaxing.
8. "Feeling blue" is feeling sad. "Blue devils" are feelings of depression.
9. Something "out of the blue" is from an unknown source at an unexpected time.
10. A bluebook is a list of socially prominent people.
11. The first prize gets a blue ribbon.
12. A blue blood is a person of noble descent. This is probably from the blue veins of the fair-complexioned aristocrats who first used this term.
13. "Into the blue" means into the unknown.
14. A "bluenose" is a strict, puritanical person.
15. A "bluestocking" used to be a scholarly or highly knowledgeable woman.
16. The pharaohs of ancient Egypt wore blue for

protection against evil.

17. The "blues" is a style of music derived from southern African-American secular songs. It influenced the development of rock, R&B, and country music.

18. "Blue laws" are used to enforce moral standards.

19. A blue ribbon panel is a group of especially qualified people.

Suggested Website Uses

Medical, dental, scientific, utility services, governmental, health care, IT, technological, recruitment, trades, podiatry, law.

Purple - is a mixture of somber blue and active red. It is often the color of royalty, and connotes luxury, wealth, and sophistication and can be mournful, yet soft and lonely. It can represent coolness, mist and shadows. Purple is described as an "unquiet color" being mysterious and mystic in a cultural sort of way. A study revealed that purple, the color of mourning among many peoples, meets with disapproval in six Asian countries.

It is also feminine and romantic but, because it is rare in nature, purple can appear artificial,) Spiritual, sensual, metaphysical, mysterious, magical, religious, evocative, senses, healing.

Notable uses of purple and violet

1. The Egyptian queen Cleopatra loved purple. To obtain one ounce of Tyrian purple dye, she had her servants soak 20,000 Purpura snails for 10 days.
 2. In Thailand, purple is worn by a widow mourning her husband's death.
 3. A "purple heart" is a U.S. military decoration for soldiers wounded or killed in battle.
 4. Purple is a royal color.
 5. Purple robes are an emblem of authority and rank.
 6. "Purple speech" is profane talk.
 7. "Purple prose" is writing that is full of exaggerated literary effects and ornamentation.
 8. Leonardo da Vinci believed that the power of meditation increases 10 times when done in a purple light, as in the purple light of stained glass.
 9. Purple in a child's room is said to help develop the imagination according to color theory.
 10. Richard Wagner composed his operas in a room with shades of violet, his color of inspiration.
- Suggested Website Uses: Body, mind and soul, podiatry, crystals, astrology, tarot, aromatherapy, massage, yoga.
- Green** - the most restful color and is the easiest color on the eye and can improve

vision. It's the universal color of nature as and often represents fertility, rebirth and freedom. It is often used to indicate nurturing, natural, organic, calm, youthful, instructional, education, adventurous, ecological. People waiting to appear on TV sit in "green rooms" to relax. Hospitals often use green because it relaxes patients. Brides in the Middle Ages wore green to symbolize fertility. Bright green can be uplifting while dark green evokes a mental picture of a pine forest. Street signs are painted a metallic green background contrasted with white letters because the combination is believed to be the easiest to read and recognize for the human brain. Dark green is masculine, conservative, and implies wealth. However, seamstresses often refuse to use green thread on the eve of a fashion show for fear it will bring bad luck. However, as with most colors, green also brings forth some negative connotations. The phrase "green with envy" also gives way to guilt, ghastliness, sickness and disease.

Green-symbolizes nature. It is a calming, refreshing color. .

Notable uses of green

1. Only one national flag is a solid color: the green flag of Libya.

2. Ancient Egyptians colored the floors of their temples green.

3. In ancient Greece, green symbolized victory.

4. In the highlands of Scotland, people wore green as a mark of honor.

5. Green is the national color of Ireland. 6. A "greenback" is slang for a U.S. dollar bill.

7. Green means "go." When "all systems are green," it means everything is in order. 8. The green room of a concert hall or theater is where performers relax before going onstage.

9. The "green-eyed monster" is jealousy. 10. A greenhorn is a newcomer or unsophisticated person.

11. Green is youthful.

12. Being "green around the gills" is looking pale and sickly.

13. "Green with envy" means full of envy or jealousy.

14. A person with a "green thumb" is good at making plants grow.

15. A green, or common, is a town park. 16. Green is a healing color, the color of nature.

Suggested Website Uses

Medical, scientific, governmental, recruitment, HR, tourism, eco-business

Brown - Solid, reliable brown is the color of earth and is abundant in nature and is associated with trees and wood. It represents conservancy and humility. Next to gray, brown, in one of its many shades, is one of the most neutral of the colors. It is useful in balancing out stronger colors, and because it is one of the most predominant hues in nature, it gives a sense of familiarity. Light brown confers genuineness while dark brown is reminiscent of fine wood and leather.

Light brown implies genuineness while dark brown is similar to wood or leather. Brown can also be sad and wistful. Men are more apt to say brown is one of their favorite colors. Nurturing, historical, retrospective, safe, financial, traditional, conservative, reliable, Conservative, simplistic, stable, boring, comfort, outdoors, warm homey. Suggested Website Uses: Mining, construction, veterinary, financial, real estate.

Gray - gives the stamp of exclusivity. It's the color "around which creative people are most creative." Gray is a neutral color that can enhance and intensify any other color it surrounds. It can enhance the psychological response of the other colors it supports.

Black - is associated with elegance and class (black-tie affair). It is the traditional color of fear, death and mourning. Look at the many terms using the word black to understand how it is perceived: "black sheep," "black heart," "black and blue" and "black mark." Despite the negative imagery that black brings, it is a preferred color in many designs since it contrasts with most colors quite well. If used correctly, it promotes distinction and clarity in your images.

Notable uses of black

1. The ancient Egyptians and Romans used black for mourning, as do most Europeans and Americans today.

2. The "Blackshirts" were the security troops in Hitler's German army, also known as the S.S.

3. Black often stands for secrecy.

4. Black humor is morbid or unhealthy and gloomy humor.

5. In China, black is for little boys. 6. A "blackhearted" person is evil.

7. If a business is "in the black," it is making money.

8. A "blacklist" is a list of persons or organizations to be boycotted or punished.

9. Black is associated with sophistication and

elegance. A "black tie" event is formal. 10. A black belt in karate identifies an expert.

11. A black flag in a car race is the signal for a driver to go to the pits.

12. A blackguard is a scoundrel.

13. The ancient Egyptians believed that black cats had divine powers.

14. Black lung is a coal miner's disease caused by the frequent inhaling of coal dust. 15. Blackmail is getting things by threat. 16. Black market is illegal trade in goods or money.

17. A black sheep is an outcast. 18. "Blackwash" (as opposed to "white-wash") is to uncover or bring out in the light. 19. A blackout is a period of darkness from the loss of electricity, for protection against nighttime air raids, or, in the theater, to separate scenes in a play.

20. When you "black out," you temporarily lose consciousness.

Suggested Website Uses

Corporate, financial, fashion, construction, manufacturing, cosmetics, mining, oil, marketing, trades.

If you're like most folks, you've probably never thought about color in this way. That's partly why it's called the psychology of color.

It is truly a powerful part of communicating, which is used on a daily basis in selling products. Learn to use the same principles to help sell your message, your concept or website?

Colors of the Flag

In the U.S. flag, white stands for purity and innocence. Red represents valor and hardness, while blue signifies justice, perseverance, and vigilance. The stars represent the heavens and all the good that people strive for, while the stripes emulate the sun's rays.

Food for Thought

While blue is one of the most popular colors it is one of the least appetizing. Blue food is rare in nature. Food researchers say that when humans searched for food, they learned to avoid toxic or spoiled objects, which were often blue, black, or purple. When food dyed blue is served to study subjects, they lose appetite.

Green, brown, and red are the most popular food colors. Red is often used in restaurant decorating schemes because it is an appetite stimulant.

Color is symbolism.

We say someone who is jealous is "green with envy". Someone who is sad is said to be "blue". When we are angry, we "see red". Colors affect us psychologically. They can stimulate our appetite or

suppress it. They can make us happy, excited, angry or sad. We all have the same reaction to color. It affects our emotions thereby leaving a lasting effect on us when we buy or purchase products.

You created your web design for usability. If you are selling "tarot cards" then consider using mystical, spiritual colors like purples, blues, golds. Put your user in an inspirational mood upon their first click to your site. The color emotion invoked in your user will be the best stickiness (keeping your user at your website) for your site. If they feel inspired through your color then they will stay here and read your text or see the crystal ball animated gif sparkling its "Welcome to my Psychic Homepage" sign.

Your web page colors should similarly allow your visitor to read the content, or view photos without strain. So remember your users when choosing your color scheme since they will be the ones who will click their credit card there.

Tips to stop scaring your visitors and your money straight to the competitor:

- Make sure you have avoided bright yellow backgrounds.
- Make your content stand out from the page by using darker colors on light backgrounds. Plus these pages are easier for users to print and read later.
- Make sure you have allowed busy backgrounds and photos to stand alone. You should not write text across either. It won't get read.
- Choose larger fonts for text on dark or black backgrounds. Staring at a computer provides enough strain on the eyes. Don't lose a visitor by adding to it.

A Special Note About Using Colors on the Web

Although modern computers are capable of displaying millions of colors on the screen, Web design is limited to only 216 colors. The reason for this is that Mac computers and PC's both use completely different color palettes. However, they have 216 colors that are common to both. These 216 colors are considered "Web safe". Using the 216 Web safe colors means that your Web site colors will look fairly consistent on different computers (Mac or PC), different operating systems (Windows or Mac), as well as different browsers (Internet Explorer and Netscape Navigator, to name two).

Colors speak their own language and evoke emotions instantly. Use colors sparingly, yet intelligently, in the creation of your website. Once you understand how to intertwine colors into your site, your sales should increase.