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Color Contrast and CAAD:
The Seven Color Contrasts of Johannes Itten

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Computer-aided architectural design is design with color-the monitor of a CAAD system is a display of color, a place where images are produced by color manipulation. The success of these images can be judged by the ability of the colors selected to communicate graphic ideas and to convey graphic information.

Color as a visual phenomena intrigued the impressionist painters at the end of the nineteenth century; it was the focus of much attention at the Bauhaus in Weimar Germany. When Johannes Itten was appointed as a Master of Form at the Bauhaus in 1919, he developed "an aesthetic color theory originating in the experience and intuition of a painter" (Itten, 1973, 11). In his definitive work, Itten postulates seven ways to communicate visual information with color. 'Each is unique in character and artistic value, in visual, expressive and symbolic effect, and together they constitute the fundamental resource of color design" (Itten, 1973, 36).

These seven contrasts provide a lexicon of the methods by which computer images convey graphic information. The colors which form a computer image can be simply manipulated to illustrate these contrasts; today's computers make color manipulation a very simple matter. This paper is composed of short essays about each of these contrasts and how they can guide the selection of appropriate colors to convey visual intent on a picture tube. Considered together the contrasts of Itten provide a fundamental resource for electronic graphic communication.

Contrast of Value
Contrast of black and white-of lightness and darkness-is the most fundamental of the visual contrasts. We have no trouble understanding the meaning of a black-and-white picture. We know that technicolor has added

considerable appeal to the movies and that color in television has added appreciably to the enjoyment of home entertainment systems, but it would be difficult to argue that the introduction of color has increased the understanding of content in either film or television, more than did the simple value contrasts of their black-and-white predecessors.

What would television be if these early black-and-white images had been reduced to line drawings, to wire-frame images? Would line drawings have found the acceptance that greeted the early black-and-white pictures? If today's computer images were built with the contrasting grays of black-and-white imagery, rather than with the stick figures of wire-frame construction, they would find greater acceptance among skeptics in the world of art and architecture. The reduction of a color picture to its component areas of contrasting value is an abstraction that we are readily able to accept.

Contrast of value is fundamentally the contrast between black and white; more specifically, it is a series of contrasts between the stages of gray. While it is possible to imagine the scale of grays as an infinite series of colors, in fact the eye can discern only twenty steps with ease, perhaps forty steps with young eyes and a good visual education. These forty grays comprise the palette of all black-and-white presentations; they are a graphic language which we understand.

A scale of grays in twenty parts, perhaps more, perhaps less, can be achieved on the computer. To be useful in graphics these gray values should contain equal visual steps between each color-there should be no perceived line between two color samples where the eye moves quickly from light to dark. One should experience the visual continuum from white to black. Through Itten's careful instruction at the Bauhaus, his students cultivated an ability to write "music" with the gray scales. It takes only four or five colors. Most of us could play Beethoven's "Fifth" on a piano with only four strokes of a finger, or "Mary Had a Little Lamb" with seven. How many colors are needed on the computer to play a song on the gray scale?

Graphic images depend on the contrast of black and white in order to communicate. Compositions need not be drawn in black and white, nor with shades of gray, for the value differences that are to be found within a particular hue can be equally effective in conveying a graphic message. Yet the essential contrast, the communication of content that any composition offers, is achieved through the contrast of value.

Explorations in the use of contrasting value are an excellent introduction to computer color. Such drawings need not be dependent on extensive color capabilities, as ways can be found to draw a scale of grays on even the simplest of computers. Ideas can be communicated using solid areas of color with a strength that is difficult to achieve in line drawing, even if those colors are but

shades of gray. Technically, no more is involved than turning on or off the phosphors that illuminate the screen.

Contrast of Hue

The idea of "color" is usually associated with the 'hue of an object. A color's hue is the quality that distinguishes one color from another, that distinguishes redness from blueness or yellowness from greenness. To the artist, hue is the pure substance of a pigment; science defines hue as light of a particular wavelength, a part of the visible spectrum.

Changes of hue add diversity to the world, contributing to its richness and to the uniqueness of every object in it. In its simplest form the contrast of hue is a self-evident concept; we drive or stop our cars based on the contrast of red and green. As black and white are the extremes in value contrast, so red and green represent extremes in the contrast of hue.

When we select a color to identify the different pipes in a boiler room, we would not use values-they are too relative. Instead we use hues; hot water pipes are red and cold water pipes blue. This is a comprehensible code within our culture that needs no guidebook or comparison. It draws strength from the unique qualities of red or of blue to distinguish one item from another.

Contrast of hue is the simplest of contrasts to comprehend, a fact which probably accounts for its frequent and recurring use in primitive art. In Itten's words: "The undiluted primaries and secondaries always have a character of aboriginal cosmic splendor as well as of concrete actuality. Therefore they serve equally well to portray a celestial coronation or a mundane still life" (Itten, 1973, 37).

On a simple color monitor contrast of hue may be the only option available to a designer; the colors of a rudimentary electronic palette allow few choices. These limited colors can be used to improve the business graphics that such computer equipment is designed to produce. A well-colored graph can convey several levels of meaning beyond the raw data it illustrates. Appropriate hues can be selected and combined in ways that are appealing, or perhaps upsetting, if that is the intent of the graph. Meaning can be suggested by hue selection; we all know the meaning of "red ink." Hues can be manipulated to suggest a great variety of moods.

The extraordinary palette of color available today provides an ample opportunity to contrast hues in both art and architecture. The circuit of hues is a key to forming color compositions, a chart from which to select colors according to our mood and purpose. With these colors we can form the most elementary of compositions.

Contrast of Saturation

A color is fully saturated when it is at its maximum brilliance. Though often confused with value, saturation is a very different quality of color and its use as a contrasting element produces a very different effect. Any color, that is to say any hue, has a low saturation when it approaches gray in color. Conversely, saturation is high when the coloring element is most pure. In dealing with pigment, color can be lightened or darkened to produce a change in value by mixing it with other colors. Color may also be reduced in saturation through mixing, bringing it closer to a neutral gray, but the mixing process never increases saturation-the mixture of two colors is always lower in saturation than either of its sources. Fully saturated color is an intense, vivid color that should be used sparingly.

The saturated hues are seldom seen in nature. They appear most often as the blooms of flowers or the colors of the rainbow. Maximum saturation can be found in either pure paint pigment or the phosphors that produce the colored light in a computer terminal.

The phenomena of saturation contrast and value contrast are not easily separated. Yellow, fully saturated yellow, is a very light hue; it is a brilliant color which we often think of as representing light. It cannot be made darker without desaturating the color. There is no 'brilliant" dark yellow. Likewise a fully saturated blue is by nature a very dark value. It cannot be lightened without loosing its saturation. Each hue has a value at which its most saturated form is displayed. This is immutable; it is an ingrained quality of the particular hue, a part of the nature of the color.

In developing a graphic composition, or in resolving architectural colors, the control of both value and saturation is paramount to a successful coloration. A room or a building or a painting may be colored in blue or red or green; the ultimate selection of hue is largely an issue of taste, fashion, and psychology. But the selection of both value and of saturation determine readability and establish mood.

Saturation on the computer is achieved directly from red, green, and blue, the colors that form the image and therefore display the highest saturation level; mixing them can only reduce their intensity. If we want a fully saturated yellow, we form this on the computer screen by displaying red and green phosphors at the same time. The result is a brilliant yellow of the maximum achievable saturation. As a mixture it will have a lightness that surpasses either red or green; but its saturation level will be less than that of either parent color. Any color wheel drawn on the computer will show its greatest level of saturation at the color sources. Occasionally it is necessary to gray the

hues of the source so that they may be equal in saturation to their adjacent hues.

The subtle as well as the obvious points of difference between value and saturation are not easily demonstrated using paints. On a computer screen these differences can be seen quickly and dramatically by adjusting the percentages of each factor. Comparative colorations of the same composition, drawn at different levels of saturation, provide an easy lesson in saturation contrast.

In articulating the contrasts of value, hue, and saturation, Johannes Itten has defined the three basic color elements that are at the foundation of human color perception. To complete his image of the nature of perception, four additional contrasts should be explored.

Cold-Warm Contrast
You have a good understanding of cold-warm contrast if you enjoy swimming. A lake can feel very cold in the heat of the day; but if you return at midnight when the air has chilled, the same water will feel much warmer. There is a warmth to this midnight water that could not be found because the heat of the sun. We are constantly exposed to the contrast of cold and warmth as we move from heated to cooled and then to natural environments. It is always a relative experience; one place is always colder, or warmer, than another.

This same contrast can be found in color, for every color is perceived as having a temperature. It is no accident that the hot pipes in a plumbing installation are colored red and cold pipes are colored blue. Red is warmer than blue. It has been proven that a room painted red feels warmer than a room painted blue. But color temperature, like water temperature, is relative. One color may be warm in contrast to another, but cool in contrast to a third.

On the computer, cold-warm contrast provides a good graphic method for indicating depth in an illustration. The color of a surface in sunlight appears warmer than the same surface color in shade. The layering of sunlight and shade, of warm and cool, can create steps in the field of vision which are perceived as depth. A scenario can be built into a graphic composition by looking through a dark frame into a field of sunlight, and then into the shadows beyond.

In the design of buildings, architects can lead people through a series of spaces that derive their qualities from their spatial contrasts-low spaces contrast with high ones, big spaces with small ones. As the coloration is developed for architectural spaces, they too can distinguish themselves by their color temperature. It is always a pleasure to move from a cool hallway into a room filled with sun. One must be careful to discern between cold-warm contrast and contrast of value, for while they often go hand-in-hand, both emotionally and physically they are quite different.
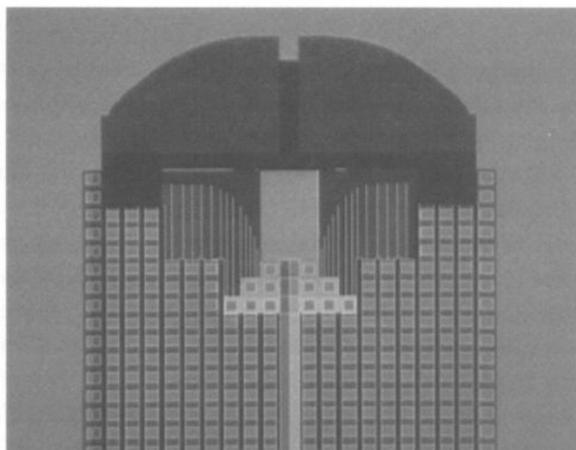
Figure 1
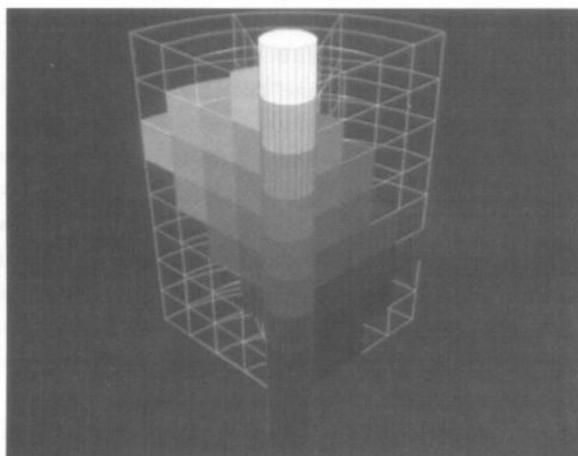Contrast of Value. graphic
design by
Steven Blisnuk

Figure 2
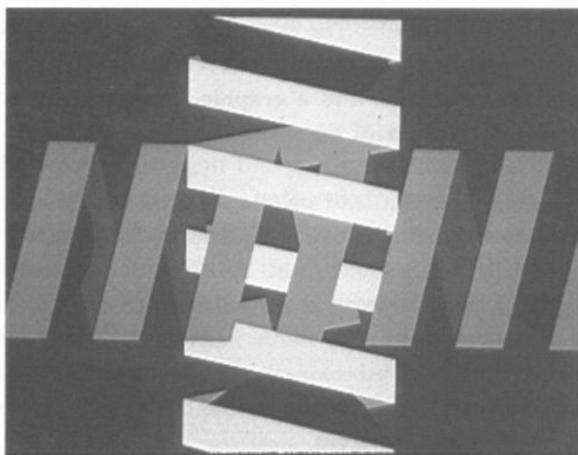Color Space
graphic design by
John M. Young, Jr.

Figure 3
Contrast of Saturation
graphic design by
Paul Meyer

Complementary Contrast

Complementary colors appear on opposite sides of the color wheel. They are contrasting hues; often one is cool and the other is warm. There are an infinite number of complementary pairs arranged around the wheel.

If the colors are true complements, truly opposite colors, then they combine to neutralize each other and form a middle gray. This can be proven using the computer to draw a simple checkerboard of color. If the colors are complements, pure red and pure cyan for example, they will be seen as gray. If the scale of the checkerboard is sufficiently small, this gray will be apparent at arm's length; if the board is sized for a game of checkers, then you may have to back up across the room for this to happen. But when the scale of the color mixture becomes small enough so that it is seen as one color, the perception of the mixture is gray. On a computer this provides a good test of whether two colors are actually complementary.

The definition of two colors as complements and the visual effect achieved by their contrast are entirely different from that of a cold-warm contrast. When the scale of mixture is sufficiently small, the colors cancel each other; but when the scale is adequate, then the colors intensify each other to their greatest brilliance. As Itten describes them: "Two such colors make a strange pair. They are opposite, they require each other. They incite each other to maximum vividness when adjacent; and they annihilate each other, to gray-black, when mixed-like fire and water" (Itten, 1973, 78).

The eye seems to require a balance of complements, and it is probably the best understood of all color principles. It is a common method of color harmony in interior design; and when faced with a problem in color selection, architects are well advised to begin the search for harmony by turning to complementary contrast, though many a freshman color scheme has been devastated by an overdose of fully saturated complements. Well used, the demand of one color for another can be a forceful design tool.

Simultaneous Contrast

Sometimes the complement for a color is not to be found in a composition, in which case the stage is set for that most mysterious of color phenomena, simultaneous contrast. The psychological demand for the complementary color, like the demand for balance in all composition, is compulsive-it seems to be a rule of vision that the eye, seeing one color, will demand its complement. If it is not there the mind will generate the color spontaneously. "The simultaneously generated complementary occurs as a sensation in the eye of the beholder, and is not objectively present. It cannot be photographed" (Itten, 1973, 87).
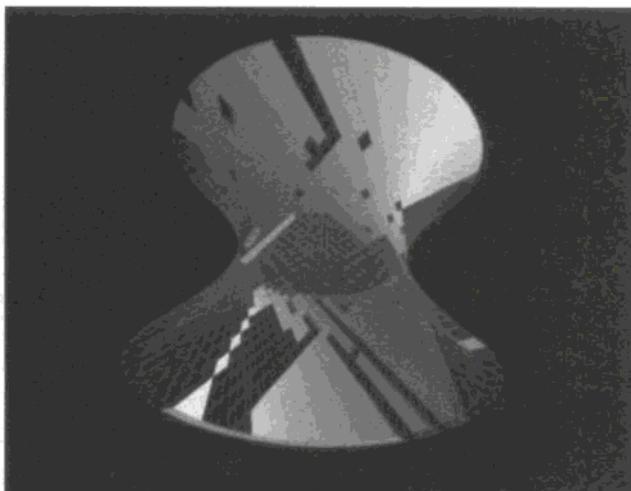
**Figure 4
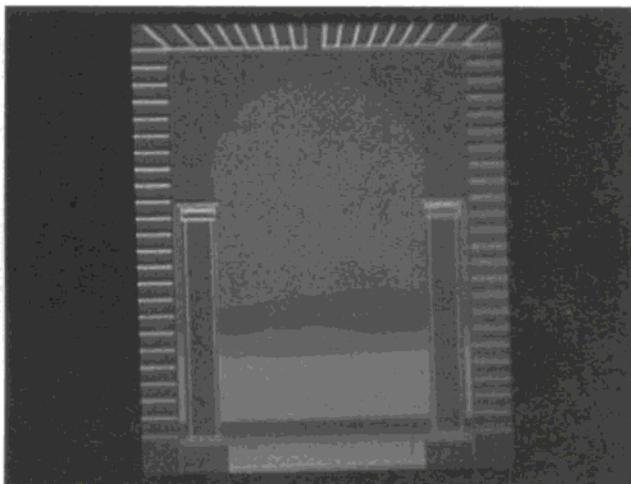Parabolic Villa graphic
design by
Steven Blisnuk**

**Figure 5
Simultaneous Contrast
graphic design by
John L. Ciccarelli** *Jr.*

The spontaneous generation of color is explained by your eyes ability to develop and retain afterimages. If you look intensely at an area of color, a portion of the receivers in your eye will become fatigued, and you will temporarily lose the ability to see that particular hue. If you then change your gaze to a white surface, the image you have been looking at will appear, ghosted, in its complementary color. This is called an afterimage; it results because you can no longer see the original color. The white surface, robbed by your eye of this one hue, appears for a while as the remaining hues-the complement of the original color.

This phenomena occurs when you look at any drawing; the colors that you experience quickly fatigue portions of your eye. Afterimages appear that change the way you see the other colors in the composition. Computer images, because of their intensity, form afterimages very quickly.

Simultaneous contrast is generated in a drawing by using two major hues that are not complements and do not create balance by the rule of complements. Each color will cause an afterimage, generating its complement. The interaction between the afterimage and the opposite color produces a vibrancy in the eye a color tension that comes from the simultaneous generation of a complement. The colors seem to dance with activity as each is intensified by the absence of the other.

These simultaneous contrasts can draw attention to compositions, or to portions of compositions. They can either damage or enhance the message a picture conveys. By understanding the mechanism of simultaneous contrast, it is possible to select colors that anticipate its effect.

Contrast of Size
There is one more contrast in this long list-the contrast of size, or in Itten's words, 'contrast of extension... the contrast between much and little, or great and small" (Itten, 1973, 104). It is the architect's greatest friend, for it applies as much to the design of space as to the selection of color. The facade of Chartres Cathedral is often cited for the contrast of its two towers, one big and transparent, the other smaller and more solid.

Contrast of size has been essential to several of the contrasts already mentioned, for no composition can be called balanced without a consideration of the size of its elements. One could develop a general rule calling for a small amount of strong color to balance a larger quantity of weak color, defining 'strong" and "weak" as contrast of either value, hue, or saturation. Coupled with simultaneous contrast, a contrast of size can effectively give emphasis to a particular color. Likewise a large, cold space can contain a small area of warmth, all achieved with color.

It could be concluded that the contrasts of Johannes Itten seldom stand alone; in virtually every example there are elements of another. But in color design as in any art there is a focus, a theme, to every composition. In teaching the art of computation, the seven contrasts can provide that color theme. Simple exercises can be structured that focus on design basics and are expressed electronically with color. To attempt an isolated example of each contrast, as a learning experience, is a task that can be achieved relatively quickly using the computer. It is an excellent way both to develop a color vocabulary and to learn the fundamentals of design.

The unique advantage of achieving color studies with CAAD is the comparative methodology that the computer provides. Iteration of a design is a simple task, and the colors of copies can be quickly changed. Comparative color study is made easy and accessible. Both colors and the effects of each color contrast can be tested with an efficiency that makes the procedure feasible.

The successful colorist will understand each of these contrasts, orchestrating them to advantage by occasionally featuring the "flutes, sometimes the "violins," as each is called upon to do what it does best. With the development of color graphic computers, the color tool that was needed by Johannes Itten now exists. Color studies that once took days can now be done in minutes. Itten's theories can now be tested with a persistence that was not feasible before the availability of electronic color. Once these fundamentals of graphic communication are learned, they quickly find their place in the design studio.

References

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