ELECTRONIC COLOR IN THE ARCHITECTURAL STUDIO

an alternative strategy for introducing the computer as a creative tool in the studio environment

by
Richard B. Norman, AIA
Professor of Architecture
Clemson University, Clemson South Carolina 29631

ABSTRACT

An alternative strategy is proposed for introducing the computer as a creative tool in the studio environment. It is suggested that computer graphic capabilities, focusing on color as an element of design, be incorporated into basic design studios.

Techniques of color drawing on the computer are discussed, and computer modeling of color systems is recommended as a vehicle through which to introduce color theory. The effect of color on the perception of buildings is explored, illustrating how color selection can affect a building's line, form and spatial quality.

These techniques enable students to develop an appreciation of the use of color in buildings, reinforcing their knowledge of basic design, and introducing them to graphic computing in a visually provocative manner. The proposal recognizes the importance of both color theory and graphic computers to an evolving architectural curriculum.

ELECTRONIC COLOR IN THE ARCHITECTURAL STUDIO

A tradition of design instruction has developed in our architectural schools, which owes its conceptual core to the Bauhaus focus on the basic design studio as the base of design instruction. The basic elements of line, form, space, texture and color are explored visually and intellectually in the studio environment. The design studio is a unique course, emphasizing synthesis as one assembles these design elements. Students work through the list of elements, experiencing their particular qualities and contribution to the design process.

Most of us have experienced a basic design studio and have worked our way through those amazing abstractions which produce a form of art, though more importantly develop in us an intellectual understanding of the design process. We have done contour sketches and various line drawings, we have built demonstrations of space and of mass with cardboard and glue, we have created fields of texture and patterns, we have with paint pots and scissors modeled the world of color.

Are we now ready to fill this studio with computer terminals in order to have these experiences "on line"? We know that synthesis is a good computer task. As architects begin to ponder the road toward the paperless architectural office one can ask: does it begin here?

I. DESIGN BY COMPUTER

Drawing on a mainframe computer is not really different than drawing on a piece of graph paper, although with the present state of the art it is a bit more cumbersome. Once we understand a numbering system we can quickly learn to draw a line from any point "A" to any point "B", and using a coordinate system or a plotter we can enter the information on a computer. But comparing the results to Japanese brush strokes, or to the sketches by Da Vinci which we find in the standard design text leads quickly to disappointment. Unless we have a particularly exotic terminal or some extraordinary plotter, there can be little hope for improvement.

Further frustrations result when the "line" we draw on the computer has only one width, and if we go on the diagonal there are those horrible jaggies. No doubt some artists are proclaiming this as a new art form. For the aspiring architect in a basic studio, however, doing line drawings on the computer as an abstract design experience holds little

promise. A variety of pens, pencils, and crayons produce results that are far more joyous to the eye and stimulating to the mind. When dealing with line work there is nothing in the computers unique and intrinsic qualities to enrich the basic design experience.

Attacking the problems of illustrating "form", or "space" on the computer becomes more complex, and requires a degree of abstraction probably beyond the novice designer, or at minimum technically overcomplicated for the situation. Given a lump of clay we can make a shape, or two shapes and see the space between them. Or we can build shapes and spaces with cardboard models. What can the computer add to this experience? They now create instant perspectives that would rock the soul of the Renaissance artist. The computer is a technical marvel that illustrates designs, even lets us walk through them. As a student advances in architecture this is a tremendous asset, but at the basic level one must ask what the machine can do that is missing in a lump of clay? The programming and data input necessary to these manipulations should not detract from the simplicity of the basic design message or it is only complicating the course.

The manipulation of design elements, line, shape, color and texture is in fact the eternal query that challenges us all. To form lines or shapes by computer, abstractly, is not difficult; nor is it particulary meaningful after loosing its initial euphoria. Texture is certainly the most prolific product of any computers repeat button and is capable of producing endless wallpaper. When the assignment shifts to modeling color, however, the usefulness of the computer drastically changes.

Color is the joy of the computer. On the screen we create an area of color and it is at once alive, vibrant and more importantly flexible. If it is too dark we can make it lighter, if it is too green we can increase the blue. With most design elements in the basic course a computer would be restrictive to the designer's creative efforts. Only in considering color is he liberated from the restrictions of traditional techniques.

Consider the computer drawing process. We define a point on the screen and a pixel lights up. Then we identify other points and they are connected with lines. Finally these points are closed, returning to the first point. We can do this with a pencil, more simply and probably with a better line quality. But then we give a "fill" command. Suddenly the screen is flooded with color, rich and pure color that fills the shape. Duplicate that experience without the machine if you will! Of the basic design elements: line,

shape, space, texture and color, only the manipulation of color is made easier by today's computer.

The individual that works with color carries in his mind a model of the colors and their relationships. It may be the rudimentary three point color wheel, though more likely it is one of the more sophisticated models which define color in terms of its three intrinsic qualities: hue, lightness and saturation. By these three terms one can precisely define any color. They are terms that give meaning to color choices. The more logical computer systems permit us to input color information in this format. Numerical values are assigned to hues, based on a 360 degree circle. Lightness and saturation can be quantified by percentages. As fast as these numbers are typed, the color appears.

A computer produces colors additively by illuminating red, green and blue phosphers on the screen. In terms of computer technology it is more logical to define color as quantities of red, green and blue phosphers and many systems do this. There is in this more logic for the computer than the designer. The design studio is helped if this "machine language" is translated by the computer to a system which defines the relationship of one color to another. Specifying hue, lightness and saturation can provide this insight into color relations and computer can be programmed to display colors in this manner.

We work with a computer that has this capability. It contains a built-in color model based on 64 discrete colors, defined by entering the desired hue, lightness and saturation. This seems restrictive, considering the terminals available that display literally millions of colors. For sophisticated color graphics these enormous capacities serve good purpose, for the basic design class they may not be so necessary.

I recall one time taking a first course in oil painting. There I was, blank canvass in front of me and ten tubes of paint on the easel. Ten tubes, whatever could I do with them? Put a little cadmium red in one corner and some ultramarine blue in another? It takes considerable experience to achieve on canvass a harmonious whole from the endless hues, values and saturations that those 10 tubes can produce. Why should the student in basic design feel restricted with a 64 color pallette? Colors can be mixed on a computer too!

Mixing colors on the computer can be an exciting experience, It can show you instantly how colors interact. We have developed a program that displays an assortment of eight

base colors in squares across the bottom of the screen, representing the raw palette for a composition. These are selected from the computers color vocabulary. Above this is a field of squares representing the colors of the composition. They are filled with color by selecting any two colors from the base. As base colors are identified, the "mixed" color appears in a square above. We can see what mixing these two colors does, or how the mixture reacts with the other colors chosen. If we don't like the results nothing is lost. We can select other base colors from the screen, or we choose other base colors from the computers palette. It is possible to build a palette of colors for the composition at hand and at any point simply to switch the screen from the palette to the composition in order to see how the selected colors appear.

The proceedure is simple, easily learned and visually informative. For the individual whose motivation is visual, as opposed to scientific curiosity, satisfaction is immediate. One sees and manipulates the color combinations with ease.

As the student's design experience progresses the system of color mixing which we use, with its limitations of two color, 50:50 mixes, soon frustrates him. He will learn, however, that by mixing colors he is in reality manipulating cell patterns. Looking closely at the screen the dot matrix is discernable, each cell has been programmed into alternate dots (pixels) of each color chosen. Curiosity leads into the programming of these cell patterns. By manipulating the cell infill on the editor we can design the pattern of mix within the cell. We can use two colors, or as many as we want. We can create an even mix or form a pattern with the pixels. By controlling cell patterns we control the color, texture and pattern of the evolving design.

The result of this process is threefold. First the student through hands-on experience becomes familiar with color mixing and the properties of color. Secondly he strengthens his knowledge of basic design through applying the principles of basic design to color composition. Thirdly through this design experience he is initiated into the principles of graphic computing. For those people in the design studios whose visual acuity seems to proceed their scientific curiosity when it comes to computers, it can be a simple and stimulating introduction.

II. COLOR THEORY IN THE STUDIO

For color work one needs to develop a mental image of a color model. Many systems have evolved which are useful to the designer in visualizing the color relationships. To the color scientist systems provide a key to color matching. For the designer these systems explain his choices, quantifying colors so that they can be manipulated in a composition. The construction of these color models, Munsell's sphere or some of the newer theories can become an essential part of the learning process if we can provide a method of constructing them that is sufficiently simple. Computers are an ideal way to do this as they bring to the colorist the versatility of a word processor. Color samples can simply be processed in order to manipulate hue, lightness and saturation until the proper samples are achieved. The frustrations of building a color model are quickly resolved.

In 1810 Goethe postulated a harmonic triangle which he intended as a visualization of human response to color. If we were to accept Goethe's color postulate, then we could go beyond color modeling into the realm of color psychology. We could predict the emotional impact of our color choices. With this triangle Goethe defines a relationship between color and psychology. Red is a festive color and associated with ceremony, with grace and with dignity. Yellow is the color of light and happiness, it has a serene and exciting charactor. Blue is melancholy and relates to the somber, restless side of our emotions. Each of these colors combine within the Goethe color model to form secondary colors. Here is found a greater latitude and subtlety of both color and psychological response. Gradually the entire vocabulary of color could be developed, along with its attendant human reaction.

Drawing from the Goethe triangle with a computer, the mood of a composition can altered and variations can be explored while reserving the base composition for comparison. To the aspiring designer this study of color could provide insight into the effects of the color choices he makes. Theory and practice can be tested with a depth that was never before practical.

III. COLOR AND ARCHITECTURE

A beginning design student should be expected to inquire how color can contribute to the architecture he is creating. Experience with computers and with color would suggest several things.

1. Line, created with color effects the perception of a building. This simple truth is no where more evident than with curtain wall construction where horizontality and verticality are controlled by the the strength (color) of a line. Cityscapes are full of examples, some buildings appear horizontal while others by their choice of color emphasize a vertical direction. Color changes can effect drastically the appearance of any building.

In working with color, one soon observes that the perception of a color is dependent on the adjacent colors. This is due to the formation of after-images. On viewing continuously a particular color the retina becomes fatigued, desensitized toward a particular hue. The eye experiences instead a complimentary color. This effect can be used to shift the emphasis of a building from horizontal to vertical.

As a basic design exercise the effects of line are easily explored with color. Blocks can be assembled to build a data base representing the elevation of a building. From this base variations in line are explored by manipulating the colors in the data base. The effects of color changes on the mass and scale of a building are quickly seen and modified by processing the color.

2. Form, created with color is quickly grasped and modified using the computer. Today's architects are using color to suggest mass in buildings, by modifying the appearance of the surface. A building can be textured with color just as H.H. Richardson textured his works with stone. Cesare Pelli's new addition to the Museum of Modern Art does this, using a progression from a high saturation of blue to a neutral grey on the exterior panels to achieve a texturing of the surface and a definition of the mass. Color becomes a surrogate texture. These effects are neither accidental nor capricious, they develop from a good utilization of color edges and the way they affect our perception of the adjacent colors. By making appropriate color selections the surface can be modeled and given an illusion of depth.

3. Space, created with color offers probably the greatest challenge to the architect/colorist. The perception of space is dependent on the coloration of the surrounding surfaces. Perspective can be created with color alone causing some elements to be frontal, others to assume background positions. This is understood in art, and has long used to support mechanical perspective in painting. Modern art often explores this principle as a pure phenomena, manipulating objects in space by means of color alone.

As building materials become increasingly synthetic, architects are moved into making ever more complex color decisions. With a good understanding of color principles and color manipulation we can we can use color as a powerful design element to shape our architecture.

One must conclude that through the pursuit of color as a basic design element, far more than color harmony can be accomplished. Line, form and mass, space and texture, the entire basic design vocabulary comes into use. Through color study the computer can provide a means for the manipulation of these elements and encourage the exploration of their potential in architecture. We have not yet realized the paperless design studio, probably at this point in time it is as absurd as the paperless architectural office. But adjunct to the traditional curriculum, as a means of understanding color and its relation to design and to the environment, computers need to be a part of the scene.