THE ROLE OF COLOR IN ARCHITECTURAL PEDAGOGY
Computation as a Creative Tool

Richard B. Norman
College of Architecture
Clemson University
Clemson, South Carolina 29634-0503

ABSTRACT
From among the possible ways of introducing graphic computing in the design studio, it is customary to develop an argument from point, to line, to shape and finally to color. The logic of this process is undeniable as technology and perhaps as history, but it should be questioned as pedagogy. A designer, tuned to the visual focus of the studio and searching for creative self-expression is not overly stimulated by drawing lines, at first laboriously, in imitation of what he can do by hand.

Using color is among the more difficult of traditional studio chores -- it is not difficult on a computer. The manipulation of color can be a simple task if one is given reasonable software and a good graphic computer. Once introduced to students, the techniques for coloring elements on a computer find acceptance as a design tool. Methods can be quickly found for modifying the perception of space and form through the use of color.

Modern architecture is rooted in the study of color as a generator of form. This idea permeated the teachings of its founders. Yet modernist concern for color has over time evolved into a pedagogy of space and form at the exclusion of color, so much so that the modern movement today stands accused by its detractors as being formed in many shades of grey.

Modern architecture is not grey! This paper will illustrate how, using the modern graphic computer, color may be introduced to the studio and discovered as an element of design and as the substance of architectural form giving.

INTRODUCTION
While what composes a proper pedagogy for architectural education may at the moment be an open question, pedagogy -- which the dictionary defines as the art, science or profession of teaching -- must for the architect begin in the design studio. Architectural design teaching has traditionally focused on the studio as a proper place for drawing and as a center of creative effort.
The first year of design studio is for the discovery of what may be termed basic design elements: line, form, space, and color. In the studio these elements are arranged as building blocks into a series of rudimentary designs. From time to time the rational for arranging the blocks changes, driven by current interests in both fashion and philosophy; but while the subject matter may change, the elements remain constant. These studies provide an introduction to design and have traditionally been the backbone of architectural pedagogy.

TOOLS AND TEACHING

The design studio is heavily dependent on tools: pencils, pens, markers, T-squares, whatever media serves best to communicate design ideas. These tools need not be physical; they can also be ideas, attitudes or processes. Model building was probably the original architectural tool; most buildings constructed before and even during the Renaissance were designed with models. A few survive, such as the facade models by Michelangelo for the Church of San Lorenzo in Florence. Models are still commonly used; they are useful in the studio for they offer a particular way of looking at a design problem. Like building blocks on a nursery floor the pieces of models submit themselves well to the study of form and space.

Architectural pedagogy can change with the introduction of new tools. During the Renaissance the techniques of architectural drawing were refined, culminating in the discovery of the mathematics of perspective. Perspective drawing is a powerful architectural tool, a way to look at buildings which is different from model building -- different in technique but also different in the architecture produced. The discovery of this tool both contributed to the development of baroque architecture and profoundly altered the methodologies of conceptual design.

Pedagogy can be shaped by the tools that are used in the teaching process. Marshall McLuhan in 1967 wrote that "Societies have always been shaped more by the nature of the media by which men communicate than by the content of the communication." (McLuhan 1967,8) This is no more true than in the teaching of the arts, crafts and architecture, where what is taught and what is eventually built is strongly influenced by the particular tools that are used. Teachers are becoming fond of referring to computers as tools.

There is a turmoil in the pedagogy of architecture today caused by both the search for design direction and by the introduction of computation as a design tool. As the computer finds a place in architectural education it should become like the well worn triangle, a familiar tool that can be brought out at the proper time to do what it does best. From both observation and historical perspective it is suspected that electronic technology is capable of re-directing design effort. According to McLuhan:
"the medium, or process, of our time -- electric technology -- is reshaping and restructuring patterns of social interdependence and every aspect of our personal life. It is forcing us to reconsider and re-evaluate practically every thought, every action, and every institution formerly taken for granted.\(\text{McLuhan 1967,8}\)

THE ELEMENTS OF DESIGN

As a drawing tool computers can draw lines. They may not duplicate the beautiful lines of a well tempered pencil, but then they have their unique qualities. On the computer it takes a while to organize and draw one line but if you need a thousand more like it, then the computer will out-perform the pencil every time.

The computer can illustrate space and form. Given the proper software and the underlying mathematical model -- a computer can draw perspectives, isometrics, or orthographic drawings. It contains the mathematical lessons of the Renaissance. Once information is entered the drawing can be automatic -- only critical decisions are left to the designer. Computation is not providing a new technique here, though it can profoundly increase the speed of the process and permit a broader range of observations to be made.

Of the design elements -- line, form, space, and color -- color has been the most difficult to approach in the studio. Who has taken a design studio without experiencing the frustrations of mixing pigments? Or of buying colored pencils that were the wrong color when applied to a drawing? Until the advent of graphic computation there has never been an adequate tool in the design studio for the exploration of color as a design element.

Louis Sullivan once said that "ornament is of the surface and not on the surface". His ornament was in fact integral to both surface and design, a texture conceived as a part of the design. As with texture, so can it be with color. We hear reference often to someone "coloring their design!" Color is an element of the design. It is far richer to design with color, than it is to color a design. With the computer we have a tool to make this possible. Color is both the joy of the computer and its most difficult challenge. Color graphics require at once a screen of considerable sophistication and a memory capable of storing vast amounts of information. On the screen we can create an area of color that is at once alive, vibrant and, more importantly, flexible. If it is too dark we make it lighter, if it is too green we make it more blue. In no way does a computer restrict creative coloration. It encourages exploration. The exhilarating colors of the computer screen can liberate a student from the restrictions of traditional techniques for coloring.
Successful instruction in architectural design should use color graphic computers as an electronic tool in a manner which focuses on the strengths and unique capabilities of the instrument. This paper therefore hypothesizes that color as a design element is a logical focus for the studio, one which takes maximum advantage of the computer and permits the creative exploration of its full potential as a tool. It proposes a pedagogy for architecture that maximizes the unique strengths of this tool through the study of color as an element of design. "Our time is a time for crossing barriers, for erasing old categories -- for probing around. When two seemingly disparate elements are imaginatively poised, put in opposition in new and unique ways, startling discoveries often result." (McLuhan 1967,10) "Color" and "computers" appear to be two such elements.

**ELECTRONIC COLOR AS TEACHER**

It is not difficult to do color drawings on a computer. Given a logical software package and an hour or so of instruction, just about anyone can draw color pictures. It is a bit like using the sticker kits that were popular before toys developed their current level of electronic sophistication. On the computer you select a shape from among those available, decide which color it should be, and paste it on the piece of "black paper" called the computer screen. For a student with a visual orientation, a person that is comfortable in the environment of the design studio, this is both a simple and enjoyable exercise. It is made more enjoyable on the computer because one is not limited to a given pile of polygons -- a few triangles, some rectangles and an assortment of circles -- that were made available with the old sticker kits.

Shapes can be invented with the computer and proportioned as needed. You can make them a little larger or smaller, or even invent your own shapes. The introduction to computation need not be mathematical, technical, nor laden with complexity of any kind. As a freshman task the creation of a color graphic drawing on the computer is an exhilarating experience, uninhibited and usually full of the joy of exploration that a new toy can provide. It is a good beginning to design.

**Color Contrasts**

Computer drawing should begin with pure exploration, experiencing how colored shapes are made and how they combine. After an hour or so of such play, one should probably stop to look and to see what has been produced. Step back and discover that the screen has become a composition of shapes that interact to form a figure/ground pattern. Some shapes appear as a background, some are frontal, depending on the way that each color interacts with the adjacent colors. Colors are not usually seen in isolation, they are experienced in relation to other colors. Color is the most relative of the design elements. With a computer the colors of a composition can be changed easily. Multiple copies of the composition can be made;
computers are excellent at duplicating anything. Alternative color selections could be developed for each copy, producing an entirely different color selection for each of several versions of the same composition.

Johannes Itten has said that our perception of a visual image is dependent on the contrast between the various colors which form the image. We experience the world by seeing contrasting colors, the black and white of the printed page or the red and green of a stoplight. There are three contrasts: contrast of value, contrast of hue and contrast of saturation. Each can form a visual composition; each can provide the subject for a separate composition. With the computer we create three copies of the same shape arrangement and produce a color map for each copy to illustrate a particular contrast. Color is the only variable in the process.

How easy this seems. Quickly we are able to discuss and to demonstrate the meaning of value, of hue, or of saturation, and to produce an example of each as a contrasting composition. Without the computer this is a difficult lesson to teach. It could be done with paint, carefully mixing each color and applying it to the composition. It could be done with collage, finding all these color samples and pasting them in place. But these methods provide neither the ease nor the flexibility with which this study is achieved on the computer. Because we are able to use the computer we are able to eliminate all other variables and focus on the contribution of color as an element of the design.

The Color Solid We have always named colors, just as we name people. There is much objection now to the omnipresent ID number that computers want to attach to people, probably with good reason. But colors are much more impersonal, much more prone to the arithmetic of classification. Names like sky blue, umber or teal, the traditional names given colors, often work against the understanding of their relationship to each other. If we comprehend the meaning of value, hue and saturation as differing aspects of color, we can define a color solid that will organize color just as books are organized in a library. Who, after all, objects to a library giving books a number? The properties of color, the hue, value and saturation, can become like axes in a three dimensional graph: x, y & z. Many color solids have been devised. They are beautiful objects themselves, just as the molecular structure models defined by biologists. Collectively they illustrate the search for color logic. Individually, they all have their technical flaws just as do the systems for classifying books, but they are capable of giving an address to each color so that it can be found as needed.

Most computer systems have a color solid, either in hardware or in software, that numerically describes a three dimensional model. The computer system provides a way to identify a color by numerical definition of these three properties. If you do not
like the one which has been incorporated into your equipment, then you can define your own color solid. As pure mathematics they have the potential for being among the more beautiful models in nature. Munsell, Ostwald, Gerritsen, each has devised a solid, based on these properties. Each is different in arrangement as it begins with a different presupposition. There is no right or wrong here; color is the most relative of the design elements. One only learns to distinguish between colors, as between fine wines, by knowing how they differ one from another.

The Dynamics of Color

Color has a dynamic quality to it. Like the forces on a railroad bridge which change as a train passes over, a color's appearance is always modified by the colors which surround it. The color studies by Josef Albers demonstrate this with clarity and are subject to easy duplication on the computer screen. One color can be made to look like two different colors, or two colors made to look like one. What sounds like prestidigitation is no slight demonstration of color magic. Rather it is a careful illustration of the extent to which environment determines the appearance of a color.

Albers was an artist not averse to mathematics. The sketches for his paintings were meticulous in their numerical definition of proportion. His color choices, however, would be based on what he saw, rather than what he would calculate. Color to him was relative, to be analyzed; but in the end to be felt and in that way judged good or bad, appropriate or inappropriate. Imagine an object as transparent, he would say, and select a color for the second object when observed through the first. By rendering transparency, by placing one object behind another, depth is rendered with color alone. In this way color can be used to define space.

The interaction between two colors is what determines their positions in space. By controlling the relationship between colors we can determine which colors will be glued together to define the surface of an object, and which will separate in a figure/ground relationship to define spatial position. Color is at the heart of visual composition. It is the means by which we visualize the shape, the form, and arrangement of an architectural composition.

The Relativity of Color

Color is the most relative of the design elements. If one color is placed on the black of a computer screen there can be no basis for judgement good or bad except for our own personal color preferences. Two colors on a screen, however, can interact and develop relationships between each other.

Design relates to context. This can be demonstrated on the computer by moving a design from context to context. With even the most rudimentary display of alternative environments the relation of an object to its context, of figure to ground, is apparent on the computer screen. The computer provides a place
for color judgement and for the selection of the colors essential to good design.

A group of colors, a particular color harmony, can be placed in several environments using a computer. The colors of an object can be changed to agree with a new environment, while maintaining a constant relationship of the parts to the whole. There is nothing unique about these transpositions of color, no new magic that is electronically generated. It has always been possible, though now the speed of electronics makes it feasible to creatively explore color variations, experiencing color as an element of the design.

ELECTRONIC COLOR AS PEDAGOGY

With the introduction of the electronic media to the design studio, the manipulation of color as a design element becomes feasible. The practice of designing and then coloring can end, but old habits need to be broken. As long as the computer is seen as a line drawing tool, we will continue to color designs which have been conceived as linear compositions. By recognizing the computer screen, like the world, as a field of color we can direct attention to the effects of one color on another. We can use color as an essential element of the design -- as the substance of architectural form giving.

These exercises could form a syllabus for the introduction of color to the studio. In reality they are capable of transcending that syllabus. They go beyond introducing a new tool and developing appropriate studio applications. What begins as a reaction to a new tool produces a result which would not have been possible before the computer, or at best would be difficult. By pursuing the strengths of computation what develops is an opportunity for creative expression as a result of the tool.

In the design studio the architectural pedagogy which pursues color as an element of design will find a strength in using the computer. There need be no apology for what is displayed; foreful new images can be created. A powerful new way to look at design is discovered which parallels our own visual experiences. Like with perspective drawing, we will see the old familiar world once again, through a new pair of glasses.

REFERENCES