8.1
A Study of Color

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Color courses are traditionally based on exercises carried out with either water color or colored paper. Use of the computer as a tool for teaching color theory and analyzing color in architecture was the topic of a course given at the School of Architecture and Planning at the State University of New York at Buffalo, USA where I was an exchange faculty in the academic year 1993/94. The course was structured into 3 topics: color theory, color perception and application of color.

Introduction
Most color courses deal with either water color or colored paper, as materials for doing exercises that illustrates color theory and visualize aspects of how we perceive color. The struggle to blend the right colors or having collected paper in exactly the shade you are looking for, becomes an important issue. Using the computer for color studies and color exercises seems to offer possibilities to avoid these difficulties.

One of the main points in any color course is that our perception of a color is always influenced by the conditions under which we look at the color. This of course raises the question whether the color impression and perception is also affected by the media.

During the spring semester 1994 I taught a color course at the School of Architecture and Planning, State University of New York at Buffalo where computers were used for all exercises and projects in order to investigate whether it is a suitable way of teaching and studying color. The course was structured into 3 major topics: color theory, color perception and application of color, and the paper follows this structure.

Color theory
The principal goal for the first part of the course was to teach the basics of color theory in order to create a vocabulary and knowledge that enabled the students to communicate color impressions in spoken language and images. This part of the course was dominated by reading and exercises redoing and illustrating issues from the readings.

RGB color and YRB color
As a result of using computers instead of paint and paper we are dealing with light as the color source and not pigment as usual. This offers different conditions of mixing colors having red, green and blue as the basic colors, although everybody has experienced that the 3 basic pigment colors are yellow, red and blue. Anyway, the blending of pigmented color can also be illustrated, because the software used actually deals with 2 different ways of blending color. One blending light by using "meters" and another using the brush tool blending light almost as if it was paint.
Subtractive color: Yellow, red and blue are the primary hues, their blending make the secondary hues: orange, purple and green.
Additive color: Red, green and blue are the primary hues, their blending make the secondary hues: Yellow, cyan and magenta.

Additive and subtractive color
To illustrate on the computer that light is additive color is simple: when there is no light, it is dark, and there is no color impression either. The more light you add of one color, the stronger the color, and if all 3 colors are at their full hue, the result is bright white light.

The topic that couldn’t be illustrated was the principle of subtractive color, but that is even difficult to illustrate using paint.

Lighter and darker shades of the same hue.
A basic criteria for doing well in a traditional color class is a great deal of patience, especially when making diagrams showing all shades of a particular hue changing from white or black to the full hue in equal steps. It took hours and hours of careful work. The learning from the exercise was quite simple, and did not at all relate to the amount of care, desperation and time spend on the issue: in order to create equal steps you have to blend color in a progressive rate. If the eye sees 10 equal steps from white to red, you add significantly less than 10% red in the shade next to the white, and the difference between the color in its full hue and the foregoing shade is much more than 10% white pigment. This exercise can be carried out rather quick on a computer and without any desperation at all. A slight eye fatigue might be the most severe problem.

The color wheel
Making a color wheel on a screen is almost as difficult as making it with watercolor or perhaps even more difficult. The main problem is to achieve colors of the same brightness, but the difficulty expresses very clearly the difference in the brightness of the various hues, and in general the screen colors are much brighter than the colors one can achieve from using watercolor or printed color.

The traditional color theory deals with 4 different color impressions from pigmented color: yellow, red, blue and green plus black and white, the use of light color tends to add 2 more colors being the cyan, not being neither blue or green and the magenta, not being neither red or blue. But if the colors in a color wheel are carefully selected having the same brightness the cyan and the magenta should not appear, as they rather belong to a selection of lighter colors.
The 7 color contrasts of Johannes Itten.
The intention of keeping up speed during the course rather than contemplating like painting with watercolor almost
deserves, led to the idea of having groups of students dealing with different topics and presenting their work to each
other as part of the input in the course.

Johannes Itten who is known from Bauhaus and who later founded his own art school organises the main hues
in the color wheel with the 3 primary colors and a total of 12 hues and shows how the difference between various colors
can be described as 7 basic color contrast that have each their characteristics. Itten who taught painters used paintings to
illustrate the color contrasts. In this color course each group of architecture students had the task of explaining a contrast
and illustrating it with examples found in the environment.
The exercise was mainly based on slides or scanned images and didn't challenge the use of computers in any particular
way.

**Color perception**
Joseph Albers is well known as a very disciplined painter but is also estimated for his studies of how our perception of
a particular color is influenced by the surrounding colors. In his book, Interaction of Color, Josef Albers describes a
series of exercises he developed using colored paper in order to illustrate how we perceive color.

These exercises are difficult to carry out, simply because one generally don't have all the needed shades of color unless
having collected paper for years. One of the objectives of the course was to do the exercises that Albers describes on the
computer. Each student did one of the exercises and described to the rest of the class what the intention was.

The computer showed up to be a very good media for these exercises, not only was it quite easy to do the
exercises, but it was also interesting to do several examples of the same exercise and find out why some worked out
better than others. The access to a large screen projector facilitates participation of students in the discussion during the
class and creates a stimulating ambience for studying.

After finishing this part of the course I became aware that a similar project has been carried out at Harvard
University and, that you can buy a disk with all the exercises described by Albers.

![Fig. 3](image)

*From Joseph Albers: One color look like many colors. The small grey squares are all of the same color.*

3 colors make several colors
Particular attention was paid to an exercise which has been practiced in a previous color class. The task is to use dots of
3 colors in different patterns and quantities letting the eye blend the 3 colors into other colors. The principle is known
in the pointilistic paintings of ???, and has been practiced with watercolor.
allowing several days to carry out the exercise. The computer facilitates the demonstration of the principle rather easy using a simple bitmapping technique in combination with the zoom tool and a colorprint of the work will make a beautiful image.

Anyway the principle is familiar to everyone working with color photos on a monitor which shows only 256 colors, but the limitation to the use of only 3 different colors make the idea very clear.

Palettes
The perception of color is not only visually defined but also dependent of cultural and psychological aspects. As part of the course the student studied how color appeared in different environments and ...

A particular range or selection of colors is named a palette, and one task was to study the palette of vehicles, being private cars, trucks and vans, busses etc. Another issue was clothing, being women's and children's clothing, sportswear etc. Looking at the different topics the students discovered an interesting relationship among the colors of clothing and private cars, being the same range of rather subtle shades, and that the underlaying principle for coloring vans and sportswear was the visibility, stressed by the use of only the bright hues, the signal colors, most often contrasted by choosing complimentary colors.

A group studied the colors of food and discovered how food and beverages are pictured in different palettes not as a result of the product itself but of the impression the customer is supposed to get of the product. Healthy products are shown in cool green and white colors, whiskey has soft warm colors, and food meant to attract children is pictured in bright vivid colors.

Advertising directed towards children uses bright hues.

Showing palettes brings up the need of a particular method for notation of color in order to facilitate comparisons. The colorpicker tool is a gift for that purpose.

Tools and methods for color notation and color analyses.
The simplest way of color notation is to pick up color in the image and display the colors in a diagram or matrix. This method was used for the study of palettes in different environments and gave an easy possibility of comparing palettes from different environments.

The swedish color system NCS, Natural Color System, uses the color circle to notate hues and a color triangel to notate the saturation and brightness of colors. These systems can be transferred directly to the computer and combined with the color picker. The color system in Photoshop and the possibility of changing mode from displaying color to only displaying shades of grey makes it simple to define the saturation of different colors, a task that can be very difficult to consider by the eye only.

The collection and display of materials is a way to represent the colors of a particular environment. The method is often used in restoration and reconstruction projects. The French architect J. P. Lenclos has developed the method and
used it as a base for suggesting color schemes for restoration of historic sites. The method can be transformed and used when working with scanned images.

**Application of color**

The last part of the course was dedicated to application of color. In the first exercise the students each choose an architect and analysed how this architect used color in their architecture. One student studied works by Bofill and showed how the colors used were mainly the natural colors of the building materials and how the light changed the colors of the buildings appearing very different on a grey day and a sunny day.

Frank Loyd Wright also mainly uses the colors of the building materials to give color to the buildings. He is aware of the texture of the surfaces as means of getting many different shades of a color.

A student showed work by the Argentinian architect Manuel Rocca. Rocca paints his buildings and uses strong colors which have a relation to the region where the building is situated. In the Florida Park in Bolivia the student found that the applied colors were the same as the colors seen in the traditional folkloristic clothes.

Colored drawings by John Heidjuk was showed together with slides from the Bronx, where Heidjuk grew up, and the student showed a striking similarity of colors in the paintings and those found in the Bronx.

The projects gave material for interesting comparison among the architects and their use of color as well as it opened for a dimension in architecture which is rarely focused at.

**Revitalization of Main Street, Buffalo**

The final project carried out by the student was a project for revitalization of a part of Main Street that has historic buildings used for commercial activities. Main Street has deteriorated over the last 10 - 15 years, and the overall impression of the street is rather sad. Anyway, the buildings are in good conditions and it seems possible to turn the street into an attractive place with rather simple means. The students photographed the street, scanned the images, and made proposals for signing and for a color scheme that could give a new identity to this particular part of Main Street.

The project is very traditional, but the sensibility of color developed during the course was expressed in the discussions of the proposals, and color was considered an important and integrated part of architecture and streetscape.
**Conclusion**

The overall aim of the color study was to make the students aware of color in architecture and in the environment. Make them see and experience color.

When architecture is used to market firms and products, when it is used to create identity, color gets a new importance like in advertising commercial products.

Modern technology has made colors inexpensive, colors are numerous, syntetic, long lasting and independent of the natural occurrence. Technological development of paints and colored building materials offer totally new possibilities of color in architecture. All this is a reason for rethinking an old disciplin and reintroducing color study in the education of architects.

Studying color on a computer is different from working with paint and doing your own blend of color. But like architects do visualization of non existing objects, they should also be able to visualize virtual color understanding how the color impression of a computer image is going to be if realized in full scale and real life. Understanding color and how we perceive it is not dependent of knowing how to blend colors. The important understanding is about the relativity of color. How the color is influenced by the surrounding colors, how a color is influenced by the changing of light, and how the same color is different when seen on a small card, a drawing or a screen, or it is extended to cover a large wall. This understanding is not dependent of a particular media being watercolor or a monitor, but is a question of sensibility and seeing color where ever it is.

**Literature:**
Johannes Itten: The art of color
Caspar Heiberg: Den Europæiske palette (The european Palette)
Sven Limkilde: Farvelære (Color Theory)
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