COLOUR AESTHETIC EXPERIMENTATIONS IN THE RGB COMPUTER ENVIRONMENT

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Abstract: Visual designers and artists may benefit from understanding computer colour models such as the RGB colour cube. Such an understanding may foster reasoned colour selection and design decisions for the RGB environment. The goal of this research is to examine the RGB colour cube and to explore its potential as a colour design tool. In order to achieve such objectives, visualization methods were developed for analysis purposes and reference guides produced. RGB colours were examined (1) as planes directly extracted from the RGB cube and (2) as tonal and hue families. Based on the analysis, RGB colours were systematically selected to be integrated in live colour projections for performances, art installations, and several fundamental experimental colour studies. This research provides groundwork for the formalization of a digital colour aesthetics.

Keywords: digital colour, design, RGB cube, aesthetics.

INTRODUCTION

Computer technology has increased the need of visual designers to familiarize themselves with digital colour models, such as the RGB colour cube [1]. There have been advances in graphical user interfaces aimed to facilitate interactions with colour models on the computer screen. However, an understanding of the mathematical structure and the perceptual organization of colour models allows the visual designer to employ purposeful colour design decisions while taking into consideration the intrinsic nature of the colour model—that is, its mathematical structure and perceptual colour organization [2].

Currently, designers may be required to produce design solutions that will remain as digital format, or luminous output in the environment (e.g., airports’ screen-based kiosks, HD screen ads, projections, etc.). This represents a shift from design practice that required visual designers to simulate colour on the computer screen and to convert colours to pigment-based systems or have it applied to materials such as paper, plastic, and metal. From the standpoint of educational technology, we have noticed a major shift in the ways that colour design has been taught in art schools. Traditionally colour was primarily taught using paint. Josef Albers popularized the use of coloured papers [3]. Most importantly, it can be argued that in Albers’ teaching methods, learning colour became mostly a combination of the development of cognitive and perceptual abilities and less a mastery of technical skills mastery (i.e., precisely mixing colour pigments to obtain effects). Albers’ trained his students to be colour design investigators and problem-solvers, as opposed to colour craftsmen. Today, computer-enhanced colour design education takes this approach a step further. It allows unlimited colour design problem-solving opportunities, as new digital files can be created on demand and reworked over and over based on predefined (or undefined) digital colour palettes. The challenge is to develop instructional design solutions that enhance such practices [1, 4].

Because the computer allows the visual designer to access colour in systematic ways (e.g., RGB colour cube, HSV model, swatch-based colour palettes, etc.), the understanding of computer-based colour systems can benefit the reasoned selection of colour [1,5], especially for the computer screen. Because colour on the computer screen is produced based on Red (R), Green (G) and Blue (B) values that obey the structure of the RGB cube, knowing such a system from a colour organization standpoint may allow the visual designer to map traditional colour relationships to the RGB environment as well as to explore possible colour relationships inherent to the RGB colour cube system. A challenge remains: to train visual designers to better understand digital colour models such as the RGB cube. Furthermore, digital colour models must be accessed on the screen in methods (e.g., 3D interfaces, 2D projections of 3D models, etc.) that facilitate digital colour design processes.

METHODS AND MATERIALS

This study examined the visual organization of the RGB colour cube, and adopted a simplified version of it (216 colours, as opposed to 16 million possible colours) in order to investigate fundamental colour relationships in the RGB computer environment. Initially, the RGB cube perceptual structure was analyzed based on a set of visualization methods based on its three-dimensional structure and several planar views (Figure 1) [2, 6]: six slices of the cube (Fig. 1A); slide-tray view (Fig. 1B); side-views (Fig. 1C); planar view (Fig. 1D); and finally, the reconstruction of the cube into its 3D structure (Fig. 1E). At first, this method allows the visual designer to access several colour blending structures available in the RGB environment (e.g., Yellow, Red, Magenta, and White) based on geometric cuts.

In a second phase of this research, several studies were conducted to project the 3D structure of the RGB colour cube in planar views based on tonal families (Fig. 2, top) and hue relationships (Fig. 2, bottom) [7]. The works of Birren (e.g., colour, tint, tone, shade and consequent colour schemes) [8,9] and Kobayashi (tonal families) [10,11] were the most influential in the conversion process. Tonal families allow the visual designer to access colour based on colour communication strategies (e.g., active, soothing, etc.). The organization of colour based on hue relationships allows the designer to systematically access and produce colour schemes while taking into account the aesthetic and evocative potential of hue, value and intensity (e.g., chroma) combinations in a design solution.
Reference guides, such as the one shown in Figure 3, were produced to direct several RGB colour experimentations. The advantage of using guides is that digital colour effects can be systematically compared for analytical purposes or the selection of effective colour schemes. The guide shown in Figure 3 was employed to explore both a monochromatic colour scheme as well as multiple colour schemes.

### RESULTS AND DISCUSSION

Several applications have been derived from this research: (1) the development of a software that was used to teach colour design principles on the computer screen in higher education [1,4]; (2) colour design strategies for digital art and live performances [12,13]; and (3) hundreds of experimental colour studies based on systematic colour relationships. These studies were either based on colour Masters...
or initiated by the researcher. Below is an illustrated highlight of a few results and applications of the research.

**Hue Contrast of Similar Intensity:** For a live dance performance, in order to produce a visual effect of hue contrast of similar intensities, pure RGB Magenta (R 255, G 000, B 255) and Green (R 000, G 255, B 000) were selected systematically based on their locations in the RGB cube (Fig. 4). The result is a dramatic vibrant effect of unusual vividness. Lesson learned: Colours from the outer edge of the RGB colour cube are the most intense (e.g., highly saturated) when viewed on the computer screen or when projected in the environment (or on dancers, in this performance).

![Fig. 4. A possible view of the RGB Cube and its use in the colour selection for the performance Projections (concert: Dances We Don’t Know Yet, 2005). Colour design by Petronio Bendito.](image)

**Blending Structures Based on a Section of the Cube:** For *Color Digits* and *Color Digits 2.0* (Figure 5), several colour palettes based on sections of the RGB cube were explored to produce an animation that was further translated into sound. Sound was produced based on numeric values of each RGB colour. Because the chosen colour palette was inherited directly from repurposing structures of the RGB cube, an argument has been made towards the “digital colour aesthetics” nature of the work [12]. Figure 5 (left) shows the location of the selected colours used (dark squares) in *Color Digits* and *Color Digits 2.0* and their placement in the RGB cube. Because of the blending structure of the colour scheme (which is not well captured in the photograph of Fig. 5), among other attributes, the work’s overall effect has been informally described as one of order and meditation. The sharp contrast of hues in the work is smoothed by the blending structure inherited from the RGB Cube.

![Fig. 5. Color Digits 2.0 Installation view, 2005. Colour design and animation by Petronio Bendito. Music by Didier Guigue. Copyright © Petronio Bendito.](image)
**Colour Experiments Based on Systematic RGB Colour Relationships:** Birren’s division of the colour space [8,9] was adapted as shown in Figure 6A (left). He advocated principles that revealed the “beauty” of colour schemes based on relationships derived from his model. By adapting his principles to digital colour, this research allowed the observation of Birren’s principles in a digital environment, and consequently allowed the researcher to map them in terms of RGB values. Other experiments have been conducted in order to observe and map other effects in terms of RGB colours as shown in Figure 6B and Figure 6C.

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**Fig. 6. Systematic mapping of RGB colours based on 2D projections of the RGB Cube.**

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CONCLUSION

This study showed that the understanding of the RGB colour cube allows the visual designer to employ purposeful colour design decisions in the RGB environment. The application of such understanding was three-fold, as reported in this paper. It ranged from custom software design to empirical observations of RGB colour relationships based on systematic observation methods. It is the understanding of digital colour systems by artists and visual designers, and the works produced as a consequence of this comprehension, that will further advance the notion of a digital colour aesthetics—an issue I raised, with Didier Guigue, in a previous writing [12], and that will certainly be a focus of interest for the colour community in the 21st Century.

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