Digital Colour Aesthetic, Music, and the RGB Colour Cube

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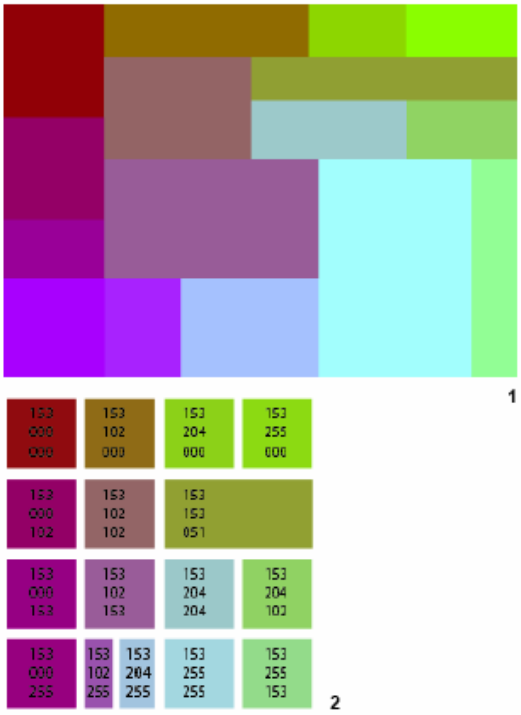
ABSTRACT

Artworks produced for the *Color Digits* series were produced by an international and interdisciplinary partnership of a visual artist/designer and a musician/composer. Both share interests in exploring the expressive potential of digital media. The works speculate expressions that are idiomatic to computer-generated colours. The perceptual structure of the RGB colour cube served as the basis for a 2D computer animation, which led to the creation of a translation model of RGB values into musical harmonic relationships. The works are contextualized with respect to Holtzman's digital expression theoretical framework.

1. INTRODUCTION

In exploring possible parameters for a discourse and practice of a digital colour aesthetic, this project turns to the perceptual structure of the RGB colour cube as a mechanism to initiate a dialog about art in the context of computer-rendered and displayed colour. We view aesthetic expressions that are idiomatic to computers as those in which the creation process and the end product are affected simultaneously by digital and digitally augmented human processes. We also favor a *praxis* that revolves around digital technology but that allows both rational and subjective decision making processes.

The goal of this project was to investigate possible orientations of a digital colour aesthetic grounded in a colour system (the RGB colour cube) that has historically defined how colour is displayed on the computer screen. This project began with a study of the perceptual structure of the RGB colour cube and its potential as a cognitive tool.[1] In 2002, *Color Digits* was created (See Figure 1) based on a color palette (See Figure 2) derived from a possible configuration of the RGB colour cube. In a later phase of this project, Didier Guigue developed a translation model of color codes embedded in *Color Digits* for the domain of digital sound[2]. When RGB notations were interpreted as if they were Hertz values, Guigue obtained a harmonic relationship based on the fundamental A*b*1 (Hz = 51,91) after a conversion process based on approximation.



Figures 1 and 2: (1) Still from *Color Digits* (animation); (2) *Color Digits'* colour palette and RGB values.

Note: Please note that the colours in the jpg images in this paper are not accurate reproductions of the RGB overwritten notations.

For this work, colour selection decisions were augmented by systems of representation of the RGB colour cube. Some of the representations were adapted or custom developed for this project. Donald Norman[3] (p.51) advocates the notion "the ability to represent the representation of thoughts and concepts is the essence of reflection and of higher order thought." He argues "it is through meta representation that we generate new knowledge, finding consistencies and patterns in the

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representations that could not be readily noticed in the world." For this project, visualization methods of the RGB colour cube—whether found in the literature or custom developed[1]—were fundamental to the decision-making process of developing a colour palette for *Color Digits*. The following assumption has guided the first phase of this project: "If artists and designers dealing with electronic color are able to comprehend the RGB color cube and access different geometric structures of the cube, and if those geometric structures support reasoned design decisions, then the configuration of the RGB color cube would serve not only as a place holder for a mathematical structure that generates computer colors, it would also provide a perceptual model to make color design decisions on the computer screen" [1] (p.2).

RGB colours selected for *Color Digits* came from a possible mathematical configuration within the RGB colour cube. This configuration is defined by a possible 2D plane of the RGB colour cube. Figure 3 shows the location of three colours used in *Color Digits* in relationship to a possible 2D section of the RGB cube. Computer-based colours, such as RGB colours, are defined by three decimal values, and each one represents a unit of the additive primaries red (R), green (G), and blue (B). Each value may range from 0 (no colour) to 255 decimal (maximum amount of colour). Pure digital red, for example, is made up of R=255, G=000, and B=000. All the colours in *Color Digits* are derived from a combination of RGB values that are either 0 (zero) or a multiple of 51. This method allows a mathematical precision of the color palette in terms of interrelated RGB values even though it does not address precise perceptual relationships (e.g., colour gradation precision).

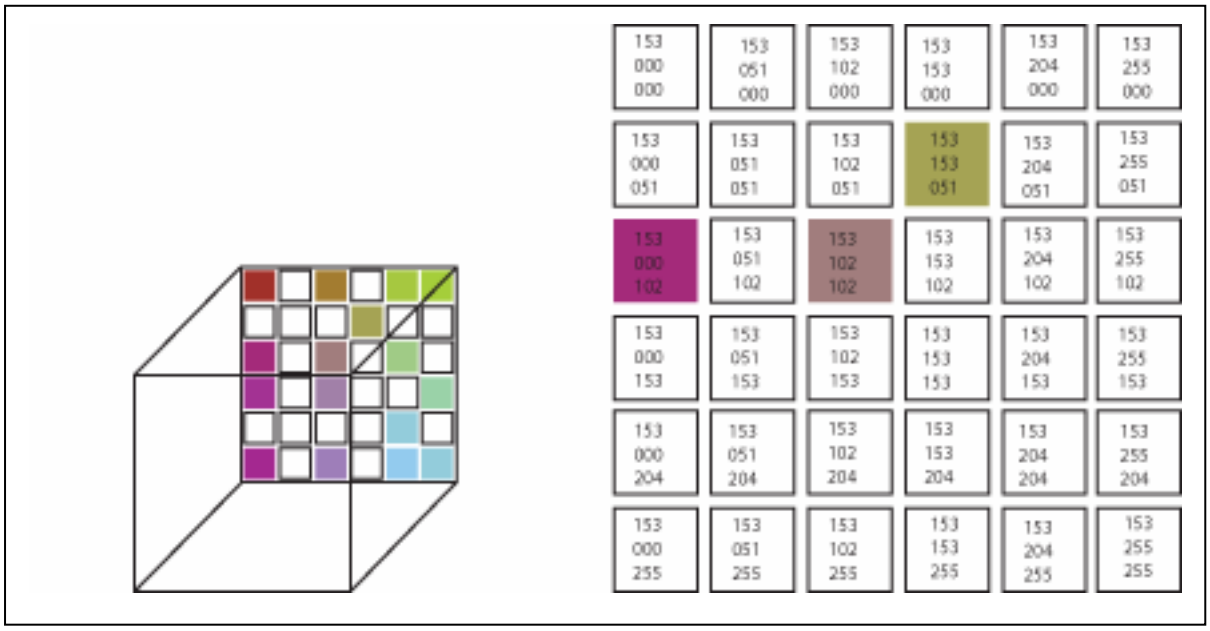

Figure 3: Diagram produced to explicate colour parameters in *Color Digits*. Representation of a possible secion of the RGB colour cube and the selected colour palette (left) and three colours from the palette with their respective RGB values (right).

Despite its digital oriented methodology, this project was also greatly influenced by Albers, Itten, and Birren. From Albers[4] *Color Digits* imparts the knowledge that colour is perceptually constructed based on a system of tangential interaction. This was especially important for the animation component of the work, in which change of colour parameters occurs optically, instead of by changing RGB values. Itten[5] informs the representation of the essence of colour relationships in simplified color fields; and, the sense of tonal relationships (e.g., color, tint, tone, shade, black, white) are greatly derived from notions advocated by Birren[6]. From Chevreul[7], Ostwald[8] and Munsell[9], the understanding of color properties guided the development of representations of digital colour relationships.

2. COLOR DIGITS: MANIFESTATIONS

The first manifestation of *Color Digits* (Figure 1) was created in 2002 and was a 2D computer animation of a slowly moving grid of RGB colours. Colour fields move horizontally and vertically using a non-linear "push" and "pull," contraction and expansion visual approach. As a few colour fields grow, the others that surround them may shrink in space. *Color Digits* was displayed on a flat-screen LCD monitor when first exhibited at Purdue University's Beelke Gallery, 2002, USA, as part of a solo show entitled *Technology Side Effects*.

Figure 4: A view of *Color Digits v. 2.0* at Galeria da Usina Cultural da Saelpa, João Pessoa, PB, Brazil, 2004 (Photo by Adriano Franco).

The second manifestation of *Color Digits*, titled *Color Digits v. 2.0* (See Figure 4), was conceived to be projected and experienced as an installation work. This version was created between 2003 and 2004 as part of a collaboration with computer and electro-acoustic music composer Didier Guigue. Thus far the work has been exhibited at the Festival Internacional de Linguagem Eletronica (FILE), São Paulo, Brazil, and as an installation piece at Galeria da Usina Cultural, João Pessoa, Brazil. Both exhibitions occurred in 2004. During the opening night at Usina Cultural, Guigue performed live interpretations of his translation method.

For this project Guigue investigated relationships between digital colour and music and created a translation methodology as shown in the diagram below (Table 1). Based on this translation method, each RGB color specified in *Color Digits v. 2.0* corresponds to a spectral structure originated in the Fundamental A*b*. For example, the RGB color defined as R= 153, G= 000, B= 000 corresponds to the musical note E*b3*. Since all of the colours in *Color Digits v. 2.0* contain the value R=153, every sonorization contains the note E*b*3.

Table 1: Translation method developed by Didier Guigue.

RGB	HERTZ	Hz →Note (approx.)	MIDI
0	0	0	0
51	51,91	A*b*1	32
102	103,82	A*b*2	44
153	155,56	E*b*3	51
204	207,65	A*b*3	56
255	261,62	C4	60

Another interpretation of the RGB values was utilized to generate the sounds of each color. Each RGB value corresponds to a parameter of synthesis, in terms of: 1) number of oscillators; 2) wave forms; and 3) curve of the envelope for sound filters and amplitude, among other parameters. Figure 5 shows programmed variables in the synthesizer for the color 153/000/000 (note E*b3)*. The interpretation of visual movements in *Color Digits v. 2.0* was based on a systematic structure. Horizontal movements (stereo sound lateral pan, left to right) had the following parameters: MIDI pan (from L64 to R63) in synchrony with the image. Vertical movements (scanning of band-pass filters) had the following parameters: up and down movements impacted on the filters' opening width.

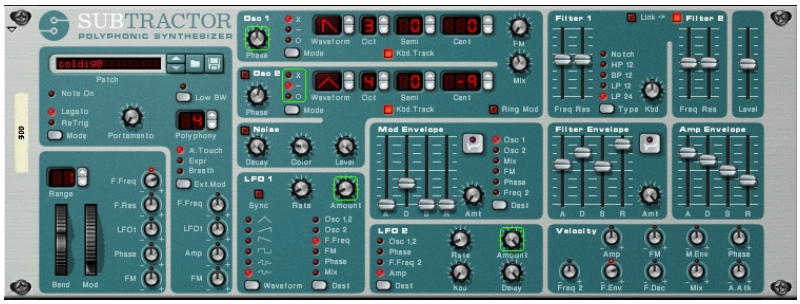

Figure 5: Variables in the synthesizer for the color 153/000/000 (note E*b3)*

3. DISCUSSION AND CONCLUSIONS

Holtzman[10] reflects on the means of expression that are idiomatic to computers and provide a clue that digital expression is "expression that could not have been conceived of without digital technology" (p.241). *Color Digits* and *Color Digits v 2.0* explore this theoretical framework.

In order to define colour parameters for *Color Digits*, the first step was to access a section of the RGB colour cube based on the multiple of 51 and 0 value parameters and from there, extract a colour palette capable of creating a subjective colour sensation. The sounds of Guigue followed a process of translation that was intrinsically involved with digital colour notation. Despite its mathematical precision during the developmental phase, during interpretation of the work, Didier also allows intuitive processes to inform his music making processes, which are triggered by interpreting vertical and horizontal movements in the work. This approach not only allows the creation of several compositions, but also affords live improvisation performances in which he articulates the structures derived from the colour palette of *Color Digits 2.0*.

The processes involved in creating both versions of *Color Digits* are ones that take into consideration logical, reasoned, as well as intuitive and subjective thinking processes. However, it is very unlikely that the colour palette of *Color Digits* and the sounds of Didier Guigue would have emerged without the support and the understanding of the perceptual structure of the RGB colour cube. It is this duality that defines the process used to create the colour palette and overall compositional structure of *Color Digits*. In the end, this work is an attempt to transcend mathematical structures and create a subjective aesthetic experience for the audience/participant. As it has been argued, in *Color Digits* "the mathematical configuration of the RGB color cube is replaced with aesthetic contemplation"[11]. Digital colour aesthetics is about the artist, the work, and the audience—as opposed to technology *per se*—functioning as common denominators of a formula where computational and intuitive processes are variables of the same equation.

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