Audiovisual Interfaces for Designing and Thinking about Design

A tool for design education

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Abstract. *We propose to use computing technology in order to explore the ideas put forward by the Bauhaus regarding the incorporation of musical thinking in visual design and design education. Five audiovisual interfaces were developed in order to study how basic design knowledge can be naturally conveyed to students using music as an intermediary.*

Keywords. *Design education; music; interactivity; audiovisual interface.*

Introduction

Many innovations, both scientific and artistic, that can in fact be considered creative, result from the overlap and joint research effort of different disciplines. The processing capacity of modern computers has helped straightened the connections between these and thus allowed hypotheses built in the past to be adequately tested today.

The relationship between music and the visual arts, namely architecture, has been widely studied throughout history. Presently, several independent fields of study, such as human-computer interaction or audiovisual design, take advantage of the possibilities put forward by computers to focus on this relationship, both for what it is and for what it may provide. We propose the use of audiovisual computer interfaces for design education. The idea is to use previous ideas on music and visual arts, namely the ones developed by the Bauhaus, in order to design and implement a series of computer programs that relate sound and graphics for audiovisual composition. The main objective of these programs is to support design education by using music as an intermediary that naturally conveys basic design knowledge to students.

First, the relation between music and the visual arts is briefly overviewed. Then, the audiovisual interfaces proposed are described. Five interfaces were developed in the context of the research carried out. However, due to space restrictions, in this paper, only the three most significant ones are presented. The interfaces were tested by subjects with different backgrounds. The purpose of such tests was to understand the meaningfulness of music in design education. Lastly, a parallel with general education is drawn. By analyzing the problems that modern education finds itself confronted with, and how researchers attempt to overcome them, we will try to understand why these interfaces can be of value for design students.

Historical Background

The relationship between audio and visual information within an artistic context is the basis of diverse research paths. Art History has approached it through the notion of style: objects belonging to a specific artistic style share common features with each other whether they belong to the same art or not.

Although a direct relationship between music and the visual arts is not evident, especially before the advent of computers, parallels between the two can be outlined. For example, there are specific concepts that are common to baroque art in general, regardless of whether it is music, architecture or sculpture. The simultaneous presence of overwhelming ornamentation over a well-defined structure – suggesting a dynamic yet classical austerity – occurs both in Johann Sebastian Bach's compositions and in Francesco Borromini's buildings. The works of both are thorough reflections of the epoch's dominant ideas.

In the early twentieth century, the integration of music in visual design started to be explored as a potential tool for design education. Bauhaus scholars, such as Wassily Kandinsky, Paul Klee and Johannes Itten, among others, made large use of musical concepts both in their (visual) art and in design education. They promoted the integration of musical thinking in the visual design process. The potential impact of music in visual art was studied in this school through different perspectives: from direct mapping of audio variables to visual variables (for example, in his publication Point and Line over Plane, Kandinsky proposes a direct interpretation of Beethoven's fifth symphony in lines and points), to the idea of incorporating basic musical structure into the structure and perceptive organization of paintings (Klee's Monument in a Fertile Country suggests the idea of rhythmic decomposition, and Polyphony the idea of simultaneous existence of several distinct "melody" lines in one composition). These approaches are pedagogically significant because they allow a designer to think about a design by making use of a language other than the language of the design. As such, concepts difficult to grasp in a specific language (for example, an abstract visual language), but nonetheless important within it, may become easier to interiorize through the use of another language (for example, the language of music).

However, at the time, this approach presented serious drawbacks because the idea of gaining basic design aptitude by bringing previously acquired knowledge from music into the unfamiliar domain of visual design was limited by the non-existence of systems providing appropriate real-time feedback and interactivity. The emergence of computing technology and the significant improvements in the processing capacity of modern computers have helped overcome these difficulties and yield new possibilities in the exploration of the ideas put forward by the Bauhaus.

Audiovisual Interfaces

In this paper, we present three (of five) audiovisual interfaces – VisualScores, KandinskyLines and RecursiveRhythm – developed in the larger context of a M.Sc. research on design inquiry carried out at the Department of Architecture at MIT. The idea was to have several interactive composing environments that provided the mapping of visual data to audio data. For each one, specific mapping rules were developed. The design of these rules was based on the metaphorical interpretation of visual data, i.e. the interpretative reading of a visual composition making use of other senses.

Metaphorical Thinking

Metaphorical thinking is one of the foundations of human communication. Although we frequently disregard it, most of the abstract concepts that we as humans express are in fact based upon the use of metaphors. For example, the literal interpretations of the following expressions, suggested by George Lakoff (1993), are meaningless within the context of psychological difficulty: "He's trying to get around the regulations.", "We ran into a brick wall.", "Get off my back.", and "I'm out of gas."

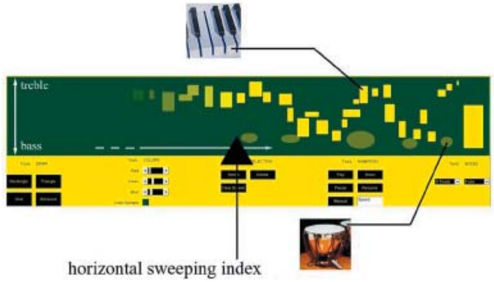

Figure 1. Mapping graphics to sound in VisualScores.

The very nature of abstract concepts makes them (almost) impossible to be expressed literally. Therefore, languages, and in particular the English language, make use of comparisons to literal physical situations in order to convey the meaning of those concepts.

In The Contemporary Theory of Metaphor, Lakoff (1993), referring to the nature of metaphor, claims that "metaphor is the main mechanism through which we comprehend abstract concepts and perform abstract reasoning", and referring to the structure of metaphor, claims that "metaphors are mappings across conceptual domains".

Being the visual language in fact a language, Lakoff's ideas also apply to it. A viewer's interpretation of an abstract painting often refers to exterior concepts that are more familiar to him. As such, it is not unusual for someone to use the concept of gesture in their appreciation of a work of sculpture, or concepts taken from music in order to describe a visual composition.

This theoretical background served as a basis for the design and development of the interfaces proposed in this study. In order to obtain an audio feedback from a composition that was generated by direct manipulation of graphical variables, a mapping from graphics to sound has to be defined. Therefore, as mentioned previously, for each interface, a series of mapping rules was designed in order to support a specific idea of metaphorical interpretation of visual data. Different types of visual compositions yield different readings altogether, so we propose a set of different systems that allow the interpretation of several types of visual structures. The sound outputs generated by each of the proposed interfaces are concrete representations of possible musical interpretations of visual data.

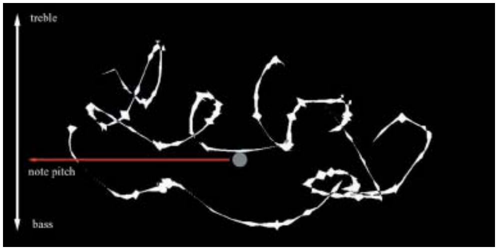

Figure 2. Mapping graphics to sound in KandinskyLines.

The Interfaces

The idea behind VisualScores is to create abstract compositions in the same way that composers write musical scores; this means that information is encoded in the graphical data, and that specific syntax and semantics were developed in order to extract that information and interpret it, much like writing; in this case, that is what the mapping rules will do. Figure 1 shows an example of a composition in VisualScores and its audio characteristics. The metaphor used is that of musical scores.

A user creates a composition by drawing geometric objects against a background. These objects can be of several sizes and proportions, but are always rectangles or ovals. Both the background color and the objects color can be defined by the user. Each one of the objects maps to a specific sound (pitch, volume, duration, etc) according to its characteristics (size, color, shape).

There are two main factors that make this framework metaphorically equivalent to musical scores: the pitch of the note is defined by the y-position of the object and the place of the note within the melody, i.e. the time at which it is played is defined by the x-position of the object.

The goal of KandinskyLines is to translate one line into a melody. Unlike VisualScores, the main

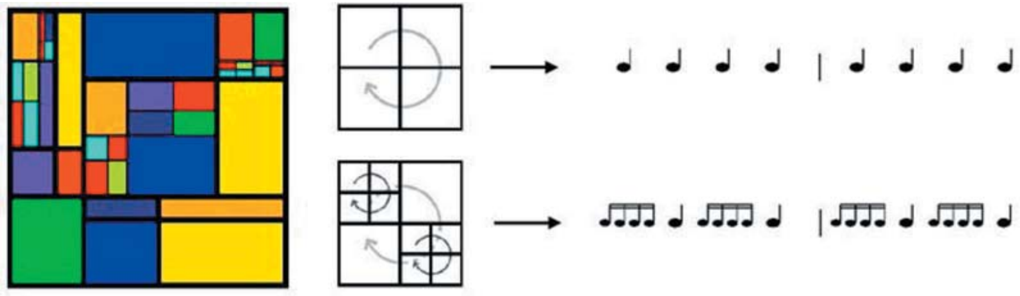

Figure 3. Example of a composition in RecursiveRhythm, and its rhythmic mapping.

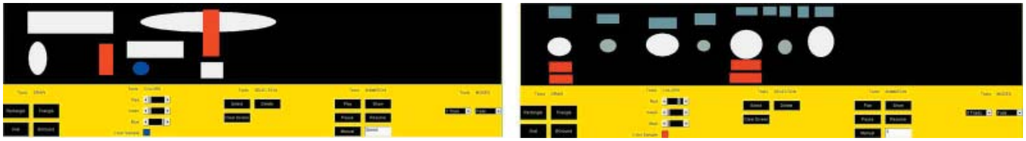

Figure 4. Compositions in VisualScores: without (left) and with audio feedback (right).

Figure 5. Compositions in VisualScores: without (left) and with audio feedback (right).

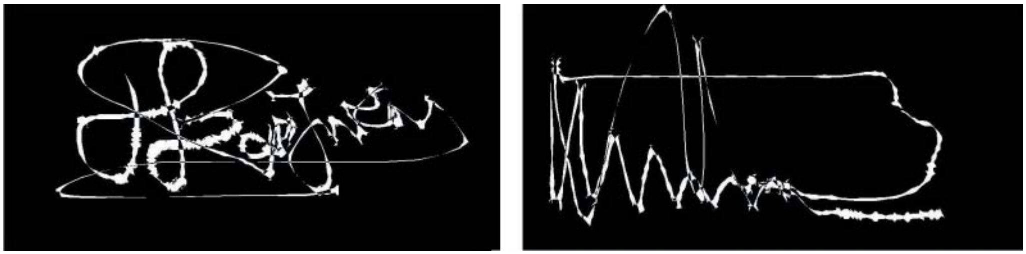

Figure 6. Compositions in KandinskyLines: without (left) and with audio feedback (right).

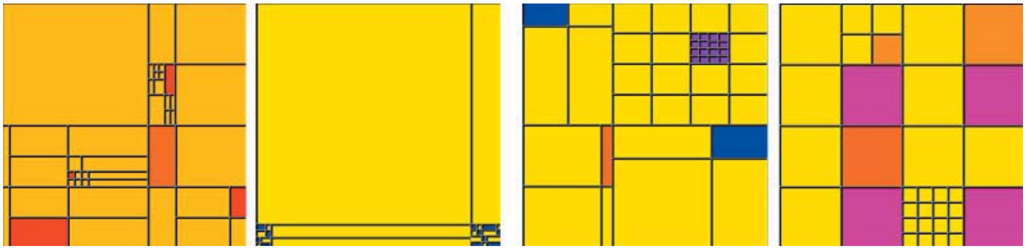

Figure 7. a) Two leftmost and b) two rightmost compositions in RecursiveRhythm: without (left of each group) and with audio feedback (right of each group).

idea is to produce sound as the line is read from beginning to end, and not from left to right. The line is defined by the user as he scribbles on the display of the interface, therefore the line can be straight, curvy, edgy, etc. Moreover, the thickness of the line is defined by the speed at which the scribble is made: the slower the stroke, the thicker the line (Figure 2).

As mentioned above, the line is read from beginning to end, and the point at which, at a specific time, it is read is marked by a gray dot. The y-position of this dot determines the pitch of the note that is produced at that moment: the higher the dot is, the higher the pitch produced. The x-position of the dot has actually no impact on the sound output. As such, when the animation is played, the dot moves along the line, somewhat like a roller-coaster, and it is accompanied by the respective melody. In this case, the metaphor consists of gravity. An important factor that enhances the gravity effect is the fact that the dot's speed decreases when the line is tilted upward and increases when it is tilted downward. The speed also depends on the thickness of the line (which was related to the speed of the stroke): the thicker the slower.

RecursiveRhythm suggests yet another way to interpret visual data and map it to sound. The process through which a visual composition in this interface is reached is based on the recursive division of the initial frame into smaller squares, followed by the adjustment of the proportion of the squares created. The color of each square can be chosen from the twelve colors of the color wheel. The visual composition thus obtained is interpreted according to specific mapping rules.

The musical sequence is built by reading the composition rectangle by rectangle in a clockwise depth-first manner, starting with the upper-left rectangle (Figure 3). Therefore, as the user builds a composition, there will be real-time feedback. In terms of rhythm, as the composition begins to take shape, so does the structure of the musical sequence. In the example shown in Figure 3, each measure corresponds to one loop. Circular rhythm is the metaphor used.

The color of the rectangles maps to pitch: each of the twelve colors of the color wheel maps to one of the twelve notes of the chromatic scale, such that closeness of colors (electromagnetic frequency) maps to closeness of sound frequency.

Experiments

In order to demonstrate that a musical feedback can be meaningful for visual design purposes, specific experiments were made. Four test subjects with different backgrounds were asked to create two visual compositions in each one of the proposed interfaces. The first should be wholly visual, whereas the second should take into account the audio feedback. The results of these tests are not meant to be considered as statistical proof because the universe of subjects is somewhat reduced. They should rather be taken as indicative of the potential of music in design education and a start point for future research.

Observations

Because of space limitations, we only show a small sample of all the design solutions studied in this research. However, these allow us to observe some of the characteristics that are common in compositions designed with an audio feedback. A brief analysis shows that concepts such as contrast (Figure 7a), structure and rhythm (Figures 4, 5, 6 and 7), variation and melody (Figures 4 and 5), beginning and ending (Figures 5 and 6), are much more enhanced visually when the audio interpretation is taken into consideration. According to the testimony put forward by the test subjects, the audio feedback allows such concepts to be naturally incorporated in the visual composition.

Although basic and fundamental within the discipline of music, these concepts are just as important in architecture and architectural thinking, which makes the interfaces particularly meaningful for design education.

Design Education

In the previous section, we observed that the interfaces proposed allow basic abstract concepts to be conveyed to a user in a somewhat natural way. In this section, we will draw a parallel with general education in order to understand why this can be pedagogical for architectural design education specifically.

How People Learn?

In Mindstorms, Seymour Papert (1993) explains why people have problems in learning mathematics and tend to be what he refers to as mathofobic. For him, the degree to which learning something is problematic or not has to do with how embedded that something is in the involving culture. For example, a child who lives normally in some society has no problem whatsoever learning the dominant language of that society. However, children usually have a hard time understanding mathematics. And according to Papert, it has to do with the fact that we do not live in a math culture. Children do not really experience mathematics the way they experience communication: they are taught mathematics, whereas they are both communicative beings and taught how to communicate.

To a certain degree, the same reasoning can be applied to music and the visual arts. In western culture, people in general are much more exposed to music than they are to the visual arts. One might argue that people are constantly exposed to architecture, but not every building can be considered architecture; in fact, most of what is built in cities nowadays does not go beyond the denomination of construction. In the case of music, for better or for worse, people are in fact constantly exposed to it; the most basic pop songs are built upon a certain structure and theory.

Basic Concepts in Architectural Design

Therefore, from an early age, people tend to get familiar with basic and intuitive music concepts (such as rhythm, consonance, volume, etc) whereas their knowledge of the visual arts is somewhat reduced. Nevertheless, the concepts referred to are not specific to music. They are concepts that are constantly used in design education by innumerable schools, namely the Bauhaus, in the early twentieth century. So, by getting a musical feedback, a user automatically associates important concepts to the visual composition. He necessarily thinks about concepts that are fundamental in design activity and therefore thinks about the nature of design.

Thinking about Designing

In the first chapter of Mindstorms, “Computers and Computer Cultures”, Papert (1993) states that “in the Logo environment the relationship is inversed: The child, even at preschool ages, is in control: The Child programs the computer. And in teaching the computer how to think, children embark on an exploration about how they themselves think. The experience can be heady: Thinking about thinking turns the child into an epistemologist, an experience not even shared by most adults.” Epistemology studies the nature of knowledge, therefore by becoming an epistemologist, a child gains expertise in dealing with knowledge, which means that he actually gains knowledge and learns how to organize and structure that knowledge, i.e. he learns how to think.

As mentioned above, by using the interfaces proposed, one inevitably thinks about the nature of design. If a parallel between general education and design education is drawn, then a user of the audio-visual interfaces gains expertise in dealing with design concepts, and therefore not only learns the essence of those concepts but also learns how to relate them to each other. At a high-level, that is what design consists of. By thinking about design, one is inevitably embarking on a learning process: that of how to design.

Pedagogical Characteristics of the Interfaces

Several concrete characteristics turn the interfaces into such educational objects:

Immediate feedback

Passive learning makes learning non-efficient and painful. By dealing interactively with knowledge traditionally taught in lecture format, people have more fun and learn faster and better. The interfaces here proposed provide (almost) immediate feedback, and therefore yield a more natural way of interiorizing concepts.

Design concepts

By using these interfaces, one deals from an early stage in their design learning process with basic concepts that are fundamental to design activities. Some of these were referred to in the previous section: abstraction, contrast, structure, variation, beginning, ending, and metaphorical thinking.

Multiple variables

Design activities, and in particular architectural design, imply the control of multiple variables in relation to each other. By learning to manipulate the reduced number of coexistent variables in the proposed audiovisual systems, one also develops important skills for dealing with real-world design variables.

Critique

One of the key-features of good designers is the capacity to be both critical and self-critical. The fact that the interfaces provide a graphical and musical feedback forces the user to naturally build an evaluation of his design: sound and music are difficult to be perceptually avoided, whereas a visual composition alone is more easily disregarded.

Design learning

As mentioned previously, a natural way in which people learn is by bringing previous knowledge into unfamiliar domains. When composing in one of the interfaces, one does it by means of metaphors that relate musical structure and graphics; consequently, he brings previous acquired musical knowledge into the work of learning design, and by doing so, learns about design in a more natural form.

Debugging

According to Seymour Papert (1993), in education "the question to ask is not whether it is right or wrong, but if it's fixable." Computer programmers ask it consistently. Although the composing environments of the interfaces are not programming environments, they do allow the user to gain control over what he composes by trial-and-error.

Conclusion

In the 1980's, Seymour Papert had already foreseen the potential of computation in general education. Design education can also benefit from it: flaws difficult to overcome with traditional pedagogical methods (such as lack of interactivity or immediate feedback) can be diminished with the use of computers. These can and should play a gradually increasing role in design schools, not just as drawing tools, or even design tools, but as means to explore the basic design concepts and especially new ones related to the very existence of computers themselves, i.e. as tools to learn about design theory and design thinking.

In the specific case presented in this paper, this was done by exploring the advantages provided by the computer to support the use of previously acquired knowledge in an unfamiliar domain: musical knowledge in visual design. There is yet much to be done on this subject, and future research could be concerned with further exploring the possible relations between graphical and audio variables, improving the user interface systems so that natural interactivity is enhanced, or strengthening the link between musical and actual architectural design.

Different approaches that take advantage of previous knowledge in order to support design learning, other than that of relating music and visual design, can be foreseen. The questions to ask are: what domains are people in general naturally familiar with? And, how can they be utilized so as to improve one's design skills?

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