Color, Form, and Motion

Dimensions of a Musical Art of Light

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Abstract

Lumia are an art form that permits visual artists to play images in the way that musicians play with sounds. Though the idea of creating lumia has a long historical tradition, modern graphically-based computers make it possible to design instruments for creating lumia that are more flexible and easier to play than at any previous time in the history of art. In designing and playing lumia, three principal dimensions require attention: color, form, and motion. By organizing the design of lumia and instruments for creating them along these dimensions, it is possible to learn a great deal from art theory and history, as guidelines have been devised for the effective use of each of these dimensions.

Music has always had visual dimensions¾the shape of instruments, the pattern of notes on the page, the movement of the players and listeners, album cover art, stage lighting, even music videos. But seeds of a new, more intimate relationship between hearing and seeing music have been sown over the past two centuries and are beginning to bear fruit. The resulting art has been called by a variety of names, including visual music, color music, mobile color and absolute cinema. I prefer the name *lumia*. Lumia are pieces, like songs, created by visual artists. Some are essentially compositional in their structure, others include improvisational elements. Lumia are the result, in part, of the visual artist's fascination with the impact of music on listeners.

What is it about music that has evoked the envy of painters and other visual artists? In a lecture he gave in 1882, Oscar Wilde suggested that it is because "music is the art in which form and matter are always one, the art whose subject cannot be separated from the method of its expression, the art which most completely realizes the artistic ideal, and is the condition to which all other arts are constantly aspiring" [1].

Lumia are an art form that shares much in common with music. They are dynamic, based on essentially unlimited combinations of simple elements, are capable of expressing a broad range of human emotion and experience, and can be created in real time. With lumia, artists have begun to make paintings move like music, and even to link them with music.

The idea that visual arts and music might be played together really took root in the early decades of the twentieth century, though it appeared as an idea even in the writings of Newton and Leonardo. Attempts to realize this vision can be seen as early as the eighteenth century, with the invention of color organs. Many artists of the early twentieth century wrote about how music and painting could be related, some of them even building machines to explore the movement of color and form directly. In the earliest days of

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film, a small number of filmmakers turned their attention to abstract works that they often designed to accompany musical performances. Computer and video technology now make it possible to achieve what could only be dreamed of then.

Three Dimensions

The early history of this art was driven by an interest in color. In the eighteenth century, a Jesuit priest, Louis-Bertrand Castel, invented the first color organ. Others, including D.D. Jameson, Bainbridge Bishop, and A. Wallace Rimington, created color organs through the next century [2]. These instruments, typically controlled by playing a piano-style keyboard, bathed a screen in ever-changing colored light. By the twentieth century, painters were experimenting with relationships of color and form, creating a new, abstract art. Many of them were also interested in the relationship of painting to music. The Cubist painter Leopold Survage wrote in 1914 that "painting, having liberated itself from the conventional forms of objects in the exterior world, has conquered the terrain of abstract forms. It must get rid of its last and principal shackle-immobility-so as to become as supple and rich a means of expressing our emotions as music is" [3].

By 1930, Thomas Wilfred had coined the word *lumia* to describe the emerging art, and organized the structure of lumia around three factors. "Form, color and motion are the three basic factors in lumia-as in all visual experience-and form and motion are the two most important" [4]. It was with Wilfred's Clavilux that controls came to be organized into three groups.

> The latest type of Clavilux consists of units that broadly correspond to manuals on a pipe organ. Each unit has its bank of sliding keys divided into three groups; form keys, color keys, and motion keys. A neutral white beam of light of great strength is intercepted by an arrangement of lenses and built into form through the form keys. The form, or forms, are made to move rhythmically by means of the motion keys, and either one color or several in any combination are finally introduced from the color keys. The whole instrument is played from a notation book so that any composition can be duplicated exactly, with a margin for personal interpretations by the playing artist [5].

For each of these three domains¾color, form, and motion¾it is necessary to decide what parameters will be manipulated and how composers and players will control them. In effect, one needs to determine what "knobs" will be available.

Color

Color is among the strongest stimuli that our brains receive from the outside world. It has been found to affect heart rate, perceptions of time, estimates of weight, size, and temperature, as well as how we experience loudness and noise [6].

The earliest visual-music instruments often provided little more than general washes of color. As the field developed, so did control of color. Today it can be used to reinforce rhythms in the music. Combinations of colors can be used to create visual harmonies or cacophony. And color is a carrier, perhaps the most essential visual carrier, of expression. It is through controlling color that the lumianist most controls mood.

Two questions about color face a lumianist who wishes to play along with musicians in a way that reinforces and expands on the musical performance. First, how should color and music interact with one another? Second, how can one control color changes in real time to produce emotional responses? Similar questions will be asked about form and motion, but it is about color that the earliest experimenters first asked them, and color provides an amazing range of opportunity in its own right.

The Language of Color

Color is complex. Since Newton, scientists have been developing theories of color vision, and artists have been proposing principles for its effective use. One of the most important assumptions made about color relates to its trichromatic nature. Under this assumption, uniquely specifying a particular perceived color requires use of three terms, such as hue, value, and saturation. Some systems of specifying color actually go beyond three parameters. Winifred Nicholson and others devised scales that underline the fact that surface colors possess additional characteristics. One such feature, identified by Russian artists around the time of the First World War, was texture [7]. For the purposes of the lumianist, working directly with light, a three-parameter model will suffice.

The way in which the parameters are designated and relate to one another defines a particular color model. Color models have been defined for a variety of purposes. Computer video, for example, uses red, green, and blue to specify color. This RGB model defines the percentage from each component that will produce the desired color. Print processes commonly use cyan, magenta, and yellow, the complements of the primary colors used in the RGB model. They typically add black as a fourth process to insure that edges and type are well-defined. The resulting model is called the CMYK model. For our purposes, color models that use dimensions that are more closely aligned to perception will be more useful. One, the HSV model, allows us to specify a color in terms of its basic hue, the amount of white mixed into that hue (saturation), and the amount of light present (value). These are dimensions with which artists are likely to be comfortable.

With computers, mapping between any two specified, quantitative color models is fairly straightforward. Software often allows you to see a particular color represented in RGB, CMYK, HSV, and other model specifications and to convert among them. No matter how they are defined, though, interaction among the three dimensions is not simple, because the dimensions do not have linear relationships to color perception. In other words, at some locations on the scales a small change produces a small change in the perceived color, while at other locations a change of similar magnitude produces a somewhat larger perceived change. Furthermore, how the perceived color changes is often a function of the values of the other dimensions and of other colors nearby.

Hue is the principal way in which one color is distinguished from another. Describing and managing hues is generally taken to be the central problem for color

theory. Indeed the very language we use to denote colors is associated prirnarily with their hues. A hue can be referenced by its angle around a color wheel, for example, red at 0, yellow at 60 degrees, green at 120, blue at 240, and purple at 300. In a well-balanced color wheel, complementary colors appear at 180 degrees opposite. Numerous color wheels have been defined. They all share the objective of making the relationships among hues more accessible. Because hue is a continuous space, naming and distinguishing among hues is somewhat arbitrary. Goethe and Schopenhauer spoke of six distinct hues, Ostwald of eight, Munsell of ten [8].

Saturation describes how pure a particular hue is. It is also referred to as the *intensity*, *strength*, or *chroma* of a color. Reducing the saturation of a particular hue, while maintaining its value, has the effect of adding white pigment, producing what artists call tints.

Value is the quality that differentiates a light color from a dark one. It is also referred to as *lightness*. A particular color moves toward black by a reduction in its value. Low-valued colors are less visible than ones with higher values. Decreasing value while leaving saturation alone has the effect of adding black pigment, producing what are referred to as different shades. Finally, what artists refer to as tones can be created by decreasing both saturation and value. One of the reasons that the HSV color model is so useful is that there is a substantial literature that uses these concepts¾hue, tint, shade, and tone-to describe art history and technique.

Mapping Colors to Music

Like color, musical tones can be also defined by three parameters: frequency, amplitude, and overtone or timbre. Whether and how these might correspond with the three dimensions of color has been of some interest over the centuries. Perhaps the most persistent association of color and music has been the effort to correlate discrete hues with specific tones. Newton associated the seven colors he identified (red, orange, yellow, green, blue, indigo, and violet) with the seven notes of the Western scale (C, D, E, F, G, A, B). Dividing the visible spectrum into seven distinct colors is, as we have seen, somewhat arbitrary. Some have suggested that Newton saw seven colors in the rainbow because there were seven natural tones in the musical scale [9]. Other writers have proposed other mappings. Though over a dozen different ones appear in the historical literature, there is little consistency among them.

There are many problems with these tone-hue correspondences. Our experience of musical notes is closely related to their physical existence. Small numbers of oscillations per second are perceived as deep notes. Tones become higher as the number of oscillations increases. A regular and identifiable pattern results from increasing the frequency of oscillations. When the number of oscillations doubles, we hear the same note, but an octave higher. Color does not have a lowest and a highest perceived hue, and changes in the number of oscillations do not produce consistent changes in the perceived color. At some places on the color spectrum, a given change in frequency is readily detected; at others it is not noticeable at all. When two or more notes are blended in a chord, their identities are retained by the ear. When two colors are blended, their identities are lost to the eye [10].

There is a more subtle and, I think, fundamental problem with assigning hues to tones. It is a problem that afflicts almost any attempt to map numbers onto the hue portion of color space. The resulting images end up containing too many unrelated hues. Take a walk through an art gallery. One of the things that is most striking about so many of the objects we judge to be beautiful is the restraint that has been exercised in the range of color used. Rarely does a work of art use the full range of hues available. Then look at the numerically constructed images that are used to illustrate such things as the densities of populations, the geometry of fractals,the flow of air through a wind tunnel, or the notes used in a musical composition. You will find representatives of yellow, blue, purple, red, green, magenta, and cyan all present. It is a rare artist's work that will use all of these in a single composition. A lesson that keeps coming back as we develop instruments to play with graphics as musicians play with sound is this: there is no reason to assume that structures that create beautiful sounds will in and of themselves produce works which look beautiful.

This is not to say that all approaches to using hue in relation to melody are doomed. Brian Evans took an approach that seems promising. He proposed combining some basic principles about color interactions with an idea that occurs frequently in the temporal arts: tension-release. He characterized color frames as neutral, balanced, or weighted, depending upon the relative amounts of various hues in the frame, and he demonstrated how the three resulting domains could be used compositionally in combination with the tension-release idea to produce a color grammar [11].

The extent to which color may be used to support, reflect, and otherwise interact with melody in music remains to be seen. My guess is that it will be less important than experimenters and writers have assumed. Mappings that are very direct will, in general, use too many hues and will quickly appear trivial and repetitive. But there are other possibilities. Color is defined by three parameters, as are musical sounds. The interactions of these sets of parameters produces nine possible one-to-one mappings, and of course numerous others could be contrived through combinations of parameters. And beyond these there are such musical parameters as tempo, interval, and mode and such visual ones as texture, shape, and movement.

As early as 1944 John Whitney, one of the most influential visual music artists, wrote of color as providing a large textural vocabulary to audiovisual artists, much as orchestration serves the symphonic composer [12]. For the modern artist Paul Klee, who was also a musician, color was secretive, irrational, and suggestive. He felt that it could take on myriad possible shades, much in the manner of musical tones. At the same time, he was cautious about making mappings between color and music that were too literal or direct [13].

Ann Driver thought of the use of color as like that of accent in music. "When strong colors are used to provide impulse to graphic movement they are like the accents which give music its life" [14]. And because it is the alternation of colors that

most affects us emotionally, Survage saw it as like the alternation of sounds, or rhythm.

Color changes can be used like almost any changes in the painting of the graphic image: to draw attention to the rhythmic structure of the music. A change in color can signal each beat, each downbeat, the beginnings of bars, or accents. Color changes can be associated with particular percussive elements. The many opportunities for using color as a rhythm instrument can be glimpsed in dance clubs or in the use of stage lighting in musical performances.

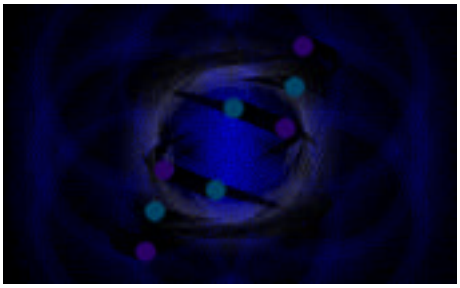

Fig. 1. Adjacent hues reflect a calm. harmonious moment in the author's lumia Blue Glass. Images courtesy Fred Collopy.

The central role of color in lumia is probably in support of musical harmony. It is possible to use color combinations to create a variety of moods, much as chord structure and other elements of harmony in music are used to establish moods. Indeed such uses in music are sometimes even referred to as "coloring" the music. Creating various types of harmonies represents a task that color is particularly well-suited to doing.

Controlling Color in Real Time

The second major question for the lumianist who wishes to play color improvisationally relates to controlling it. It is through achieving control of color combinations and changes that the lumianist can achieve expressive power like that of musicians.

One approach to controlling color is suggested in the work of some of the color theorists, for whom it is the relationships among hues that provide the greatest potential for evoking a response. Ogden Rood, for example, argued that harmonious color combinations are found in pairs separated by 90 degrees on the color wheel, as well as by triads of colors that are about 120 degrees apart [15]. Josef Albers noted that strong complementary colors (those separated by 180 degrees) produce afterimages and vibrations [16]. Faber Birren observed that people find pleasure in harmonies of color based on analogy (adjacent hues) and on extreme contrast (complementary hues) [17]. When adjacent colors are used, the effect is to produce color schemes that are predominantly warm or cool in feeling. When complementary colors are used, the result is more startling and compelling. The use of adjacent colors is illustrated in Fig. 1.

Form

The importance of form in visual music is not self-evident. Clearly there must be changing color (even if only monochromatic variation). But what of form? The ambivalence of early experimenters is evident in this observation from Rimington, writing in 1911:

> The author has made many experiments with regard to the introduction of form, as the painter understands it, in the colour projected upon the screen, and has come to the conclusion that if used at all it should be indefinite or merely decorative and not in any sense realistic. The kind of form, for instance, which we see in cirrus clouds, while very beautiful in itself, has no definite meaning and is not calculated to distract the mind from the beauty of the cloud colour and yet is sufficiently interesting in itself. This kind of form introduced into the colour perhaps gives an added interest to it in slow compositions, but in rapid ones the eye and the mind have quite enough to do to appreciate and enjoy the color itself without the addition of form, which would seem to be an unnecessary complication [18].

While remaining generally subordinated to color, form did come to play an important role in the design of color instruments. As successive generations of instrument makers created new designs, they often addressed the problems associated with expressing form in the work of their predecessors. One example is Klein's evaluation of a performance by Thomas Wilfred:

> Wilfred's compositions make frequent use of a series of forms which owe their structure to the geometrical formation of the tungsten filament of the gas-filled projector lamp used in the "Clavilux"; and the initiated could not avoid being irritated by observing the obvious fact that so many of the forms were merely the image of a familiar illuminating contrivance.
>
> If we are to have form in colour-music, that form must be as much the intention of the artist as it is in painting, and not dependent on chance circumstances [19].

Where Should the Forms Used in Lumia Come From?

Color is a bounded universe. As the Swiss artist Karl Gerstner puts it, "no one expects to find new colors-except those we see with closed eyes" [20]. But the universe of known forms continues to grow, and we have almost no idea about how various systems of forms are structurally related. For much of the history of painting, knowledge of form was used to solve problems of representation. But with the birth of abstract painting, the interest of many painters moved to color and form for their own sake. In his seminal book *Point and Line to Plane*, Wassily Kandinsky endeavored to establish a basis for an abstract art of form and color itself, rather than merely as a means of representing other objects [21]. Other artists have undertaken similar exercises. Paul Klee's *Notebooks* and Gyorgy Kepes' *Language of Vision* and related volumes are notable examples. These works provide deep veins of ideas about form for lumianists to mine.

An issue that interested Kepes, for example, relates to achieving "rhythmical patterning of the picture surface." He proposed that rhythmic patterns can be achieved at several levels. On one level are the relationships of objects subdividing the picture plane. A higher level of rhythm is reached as the optical units are related to their virtual movement to and from the picture plane. "Finally we might have orderly changes or repetition of more complex configurations of visual experience; rhythmic order of tension and repose, con-

centration and rarefaction, harmony and discord" [22]. That these are similar to ideas explored by composers was not lost on Kepes:

> Music suggests an excellent analogy. A musical unit played by an instrument is repeated contrapuntally on other instruments, on the strings, on the brasses, on the woodwinds, even on percussion instruments. Each plastic unit with its specific sensory quality echoes the previous one; light, dark, color, shapes, forms, all mutually help one another, one taking over the movement where another stopped, leading toward complete unity [23].

As with color, artists have devised principles that link relatively low-level entities such as points, lines, and planes to higher-level constructs like tension, balance, harmony, and discord. There are many examples. In his book *Basic Design: The Dynamics of Visual Form*, Maurice de Sausmarez describes how the orientation of lines can be used to create feelings.

> Horizontals and verticals operating together introduce the principle of balanced oppositions of tensions. The vertical expresses a force which is of primary significance-gravitational pull, the horizontal again contributes a primary sensation-a supporting flatness; the two together produce a deeply satisfying resolved feeling, perhaps because together they symbolize the human experience of absolute balance, of standing erect on level ground [24].

He proposes similar principles to guide the use of diagonals, curves, and shapes. The relationships among even simple elements such as lines can be used to represent complex ideas such as tension-release. Fig. 2 shows the moment just before the last line joins a cluster of lines to produce a harmonic structure. The tension in the alignment of the diagonal lines reflects that in the music of that moment. And of course there is a vast literature by painters exploring such relationships. This literature is particularly relevant given some of the excesses (such as the widespread use of mirror and axial symmetries) that have become so typical of computer art. Rudolf Arnheim noted, for example, that the use of ornamental patterns (those based on a simple formal principle) are rare in works of art. "Strict symmetry, for example, is as rare in painting and sculpture as it is frequent in decoration and the applied arts, such as ceramics or architecture" [25]. Even minor deviations from perfect symmetry can be used to substantially alter the emotional impact of an image, as is illustrated in Fig. 3.

Motion

The third dimension-motion-is the one that has changed most with the introduction of temporality to painting. While painters and sculptors had long attempted to suggest movement in their static works, the development of a true visual art of movement awaited the invention of film. Some important painters were ready as soon as film appeared on the scene. We have already encountered Leopold Survage, who was extremely interested in introducing movement to his painting. He produced more than 200 watercolor sketches that represented key ideas for an abstract film, though it was never produced.

The Dadaist and Constructivist painter Hans Richter had been making paintings that suggested music with titles such as *Cello, Prelude, Fugue, Rhythmus 23,* and *Orchestration of Color*. Many of the works were long scrolls in which forms were developed along thematic lines as they move from one end of the scroll to the other. Working with Viking Eggeling in the years between 1919 and 1922, Richter focused on developing movements from simple elementary patterns through all kinds of counterpoint variations. As from they worked on making elementary forms and colors dynamic and on orchestrating them, they became aware of the possibilities of cinema. "We had arrived at a cross-road, the scroll looked at us and it seemed to ask for real motion. That was just as much a shock to us as it was a sensation. Because in order to realize movement we needed film" [26].

Early attempts to convert *Prelude* into a film left Richter unsatisfied. "After our, as it appeared to me, unsuccessful attempts to set scrolls into motion, I recognized that the problem of film lies essentially in the articulation of time and only very secondarily in the articulation of form. The more I delved into the phenomenon of film, the move convinced I was that articulated time, namely rhythm, is to be regarded both as the elementary dimension of film and its inner structure" [27]. So with film, rhythm took on added meaning for the visual artist.

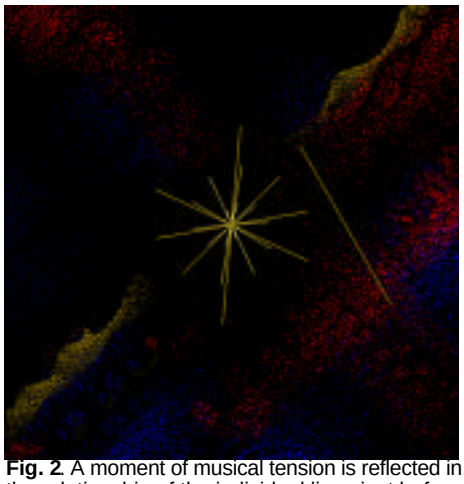

Fig. 2. A moment of musical tension is reflected in the relationship of the individual lines just before they join to form the resolved structure of Fig. 4.

Guidelines for creating visual rhythms in time are less developed than are those for color and form, although choreography provides one point of departure. One example of a very general principle from composition in dance and film is stated by Arnheim, who notes that "at any particular

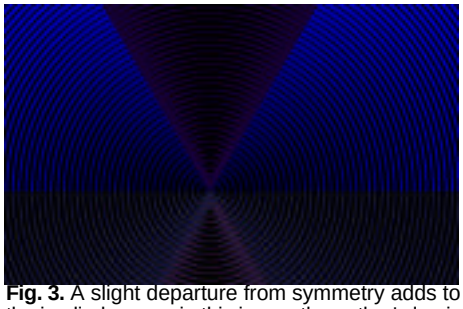

Fig. 3. A slight departure from symmetry adds to the implied energy in this image the author's lumia *Film for Music*.

moment we may not know what will come next, but we must not dismiss from our consciousness what we have heard or seen before" [28]. It is only through memory that we experience movement, and in con-

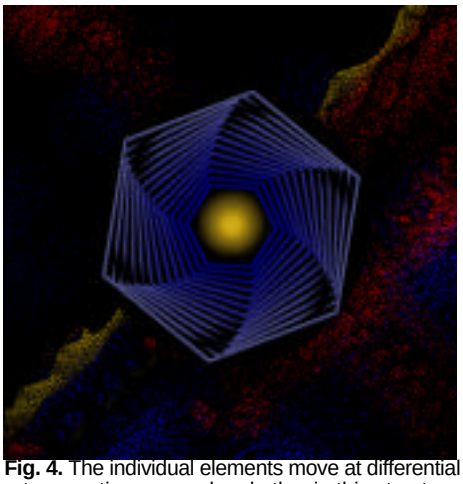

Fig. 4. The individual elements move at differential rates creating a complex rhythm in this structure from the author's lumia *weDDDing*.

structing a coherent experience in time the artist must aid the viewer in making sense of the many successive images.

Abstract filmmakers also turned their attention to the problem of rhythm. John Whitney noted that what works in music does not work in film. What is "often referred to as the *drive* of a piece of music, is almost automatically enhanced with metrical or cyclical consistency and repetition. Rock musicians know this-perhaps too well. On the other hand, the most difficult visual quality to compose into a composition, as every abstract filmmaker may know, is the same driving propulsive thrust with a visually rhythmic metrical cycle" [29]. In his films, Whitney used what he called "differential dynamics" to achieve the desired rhythms. He used graphic harmonics to affect rhythmic patterns. When the nested polygons in Fig. 4 move, each at a different speed, they create rhythms.

Conclusions

Lumia are an art form that allows visual artists to play images much as musicians play with sounds. They can be structured in terms of three primary dimensions-color, form, and motion. Painters have a long history of interest in these, particularly color and form. They have formulated principles for using them to achieve particular psychological and emotional effects. More recently, kinetic artists and filmmakers have developed similar principles for the use of motion. Together with ideas developed by composers, these principles can provide artists with certain jumping-off points as well as with solutions to problems encountered when integrating visual and musical performances.

Rhythm has played a particularly important role in the thinking of painters who have been interested in the relationship of music to their work. There is a rhythmic element to each of the three dimensions. The changing of colors is rhythmic, the ways in which forms are arranged (even in static images) is often described in terms of rhythm, and movement in time is inherently rhythmic. This suggests that rhythm constitutes a particularly rich point of entry for the design of instruments and for the development of technique for playing visuals in performance with music.

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