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THE SOUND OF IMAGE MORPHOGENESIS

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SUMMARY. The challenging side of the spectral synthesis is to integrate an advanced and versatile technology into music composition, which brings a twist in computer synthesis, that is, the sound of image morphogenesis. The genesis of the sound object resides in visual forms, by assigning sound qualities – pitch, duration, loudness and panning – to a point or line or surface and to their own brightness and color. As a result, the graphical image is transformed into sounds. In this respect, the author's works *Drones II* (2012) and *Increat* (2003) – the latter inspired by a painting by the visual artist Claudiu Presecan, are examples of music composition positioned on the border of the audio-visual and technology domains.

Keywords: synesthesia, multisensory perception, sound of image, morphogenesis, spectral synthesis, gestural control

Seeing Sound

We begin this study with a paradox which calls into question truths accepted in the name of common sense. The senses, the sensory perception interfaces, are not limited to providing information about the physical reality, but interact to form the multimodal perception. The nervous system is in charge of the integration of the sensory information. *Colour Music* as well as *Sound of Image* alongside *Seeing Sound*, suggests phenomena of sensory fusion of auditory and visual stimuli.

Synesthesia or Sensory Fusion?

On closer examination of the multimodal perception, it can be seen that sounds involuntarily trigger colors, lines and shapes in certain human subjects, unified into unique audio-visual experiences. The synesthetic experience

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tells us about the reciprocal activation of the sensory areas of the cerebral cortex, about the ability to merge different senses into a surprising sensorial compound that seems unimaginable for most of us.

A synesthete can hear colors, taste words and shapes, associate colors with letters and numbers, or even describe the shape and flavor of the human voice. A synesthete has an exceptional memory and unsurpassed intelligence.

If in neurology, synesthesia is understood as "the elicitation of perceptual experiences in the absence of the normal sensory stimulation" (Ward & Mattingley 2006: 130), in arts, it refers to "a range of phenomena of simultaneous perception of two or more stimuli as one gestalt experience" (Campen 2009: 1).

The word synesthesia comes from the Greek language, it has the meaning of blend, association of sensations, σύν (*syn* – together) and αἴσθησις (*aisthesis* – sensation), and it shares the same root with anesthesia, meaning senseless.

Auditory-Visual Perception at the Beginning of the 20th Century

Steeped in theoretical controversy, synesthesia and sensory fusion appeared increasingly often in the writings of musicians and visual artists during the first decades of the 20th century. They provided valuable investigations to science on their emotional and perceptual mechanisms, from an artistic perspective.

In turn, science sharply differentiated synesthesia from sensory fusion, a conclusion that we find in the studies of neurophysiologist Richard Cytowic. He considered that the artistic experiments of Alexander Scriabin (1872-1915) and Vasiliy Kandinsky (1866-1944) were outside the clinical and research domain of synesthesia. In his view, synesthetic perception is primarily physical and involuntary (Cytowic 1995: 5). It is a generic and durable experience, not a pictorial or elaborated one.

The expression of the Russian composer's devotion to the color of sound is *Prometheus: The Poem of Fire* (1910), a composition in the vocal-instrumental genre, for piano, organ, choir, orchestra and *clavier à lumières* or *tastiéra per luce*, as it is mentioned in the score.

With direct reference to the *Colour-Organ*, this is an electromechanical device built at the end of the 19th century to project colored light, from red to violet (ROYGBIV), but without producing sounds. Noticeably, the music was played by acoustic instruments.

E.g. 1

A. Scriabin. *Prometheus: The Poem of Fire* (Breitkopf & Härtel)

Here is how Scriabin evoked his synesthetic sensation: "the color underlines the tonality; it makes the tonality more evident" (Myers 1914: 8). Color was associated with tonality and modulation and carried a strong emotional charge. The F-sharp major tonality, for example, appeared to him as being violet. Composer's synesthetic experiences, reconfirmed by Crétien van Campen after more than eight decades, were involuntary and cannot be considered deliberate mental contrivances (Campen 1997: 1).

Kandinsky explored multisensory perception through his stage composition entitled *The Yellow Sound – Der Gelbe Klang* (1912), an experimental performance that brought syncretic elements of scenography, choreographic movement and music, with the aim of increasing the inner, emotional experiences of his public.

At the heart of his composition is a series of scenes showing kinetic paintings, replacing thus the dramatic scenes, dialogue and narration specific to the theatre and opera. The stage productions saw three variants of the score, written by Thomas de Hartmann, Anton Webern and Alfred Schnittke.

Moreover, the influential Russian painter, famous also for his dictum "Stop thinking!" admitted having had a synesthetic experience while listening to Richard Wagner's opera *Lohengrin* in Moscow: "I saw all my colours in my mind; they stood before my eyes. Wild, almost crazy lines sketched in front of me" (Hass 2009: 42). The colors and geometrical shapes were associated with low sounds and different music timbres of wind instruments and violin.

Technological Experiments

By the time Scriabin and Kandinsky were experimenting synesthetic perception and sensory fusion in their art, the concerts of music, light and color, known as *Colour Music*, were already popular, due to Wallace Rimington

(1854-1918), the inventor of the *Colour-Organ* (1893). In 1895, Rimington presented in public musical works composed by R. Wagner, Fr. Chopin, J. S. Bach and A. Dvorak, using his own apparatus. In the course of time, the *Colour-Organ* has become a generic term for devices designed to project colored light.

The correspondence between colors and sounds is given by splitting the light spectrum on the basis of the musical intervals contained within an octave. Rimington approximated the ratio of two sound frequencies in a proportion of two frequencies of the electromagnetic radiation (Peacok 1988: 402).

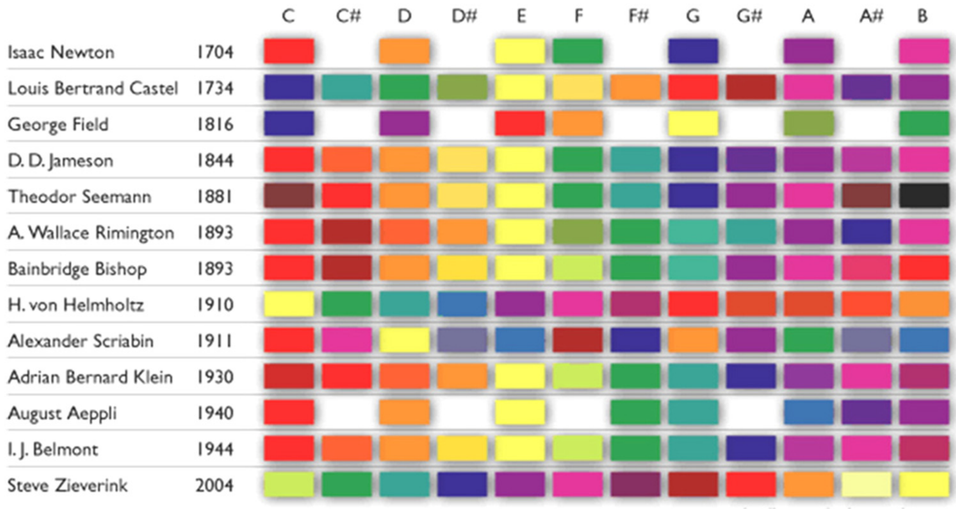
It is interesting that the most elaborate technological experiments belonged to inventors, as long as the artistic incarnation depended on special tools. For instance, *Chromola* (1915), built under the coordination of Preston S. Millar, was a device able to project 12 colored lights, controlled by a keyboard. Thomas Wilfred created a console, called *Clavilux* (1922), which helped him project moving shapes on a screen. Remarkable is also the *Light Console* (1937), designed by Frederick Bentham, an electrical system for motion projection of colored and white light. The experiments led to a new discipline, i.e. the scenic lighting in performing arts.

Although the examples may continue, we emphasize the following aspect: the differences of opinion among inventors and artists, which rarely shared the same beliefs and experiences (see also the famous divergence between Scriabin and Rimsky-Korsakov), led to the difficulty to establish a consistent correspondence between colors and sounds. One and the same sound has been often represented in completely different colors.

As we have shown above, the color organ of professor Rimington from the Queen's College in London had a physical and mathematical basis in the development of its color scale, not a psychological foundation. Scriabin, in turn, did not provide information about the sound and color relation in the color organ part – *Luce* from *Prometheus* (Peacok 1988: 403), since for the composer his synesthetic experience was ineffable. We remind here that the premiere of *The Poem of Fire* in its original version of music, light and color was held at Carnegie Hall in New York, in 1915, and was complemented by *Chromola*.

A confrontation of the different color scales that appeared along three centuries until 2004 is offered by Fred Collopy, professor at Western Reserve University in Cleveland, Ohio.

Fig. 1



F. Collopy. *Three Centuries of Color Scales* (rhithmiclight.com)

Sensory Fusion in Arts

Apparently, many of the devices designed in the first half of the 20th century expressed technical innovation. The discoveries have opened new horizons of artistic experimentation.

During the second half of the 20th century, as the digital technology made its presence felt in art, a number of inventors, programmers, visual artists and musicians encouraged the development of new independent arts that involved multisensory perception, such as Visual Music, Abstract Animation, Video Art, Audio-visual Installation and more.

William Moritz (1941-2004) is probably the best known historian of the Visual Music hybrid art. He is recognized as a passionate biographer of the artist Oskar Fischinger (1900-1967), who is also a researcher in the field of Abstract Animation.

Objective and Perceptual in Sound Synthesis

The end of the 20th century brought an unprecedented progress in technology. The complex computation processes of the synthesis of sound and graphical image were carried out almost simultaneously in digital format. This fact modifies the paradigm of computer synthesis. The sound morphogenesis is objective, meaning that it can be rigorously described in mathematical expressions and logical operations.

However, there is an aspect that has a greater significance in digital art, which is not the structure itself of a sound object, but the structure in us, the way we perceive an object through senses. The role of auditory perception is therefore essential when an artist conceives original sounds.

From additive and subtractive synthesis to virtual instruments, there are diverse spectral models for sound generation. The sound production constraints are practically eliminated by virtue of the strength of the modern programming languages.

The massive collection of spectral synthesis software includes MUSIC, CSOUND, *Metasynth* and the recent and sophisticated virtual instruments NI Reaktor and VSL Vienna Instruments, to name just a few. MAX (see IRCAM) is *lingua franca* for multimedia.

“The issue is no longer what sound one can produce, but what sound one chooses to produce” (Risset 1994: 258). The main criteria regarding the artistic choice are the listener and the listener’s perception.

The profound change in our relation with the sounds is due of course to the invention of the recording equipment. This made it possible to transform the ephemeral sound into an object that can be reproduced and processed in the absence of its mechanical cause. The object is explicitly manipulated through its perceptual features to fit the specific needs of a musical work. At the same time, the electrical and later electronic instruments unlocked new techniques of electro-acoustic production of sound.

In what follows, we will present various particularities of the sound synthesis by means of the conversion of the graphical image, along with a number of aspects of the audio-visual interaction extracted from our own compositions. We will discuss *Drones II* for violin, nanoKontrol and iFPH, and *Increat* for computer. This last work belongs to a series of compositions entitled the *Sound of Image*, started 16 years ago, in 1999.

Converting Visual Shapes into Sound Objects

Increat (2003), with the meaning of *Eternal*, integrates an advanced and versatile technology which brings a twist in computer synthesis, namely the sound of image morphogenesis. The genesis of the sound object resides in visual forms, by assigning sound qualities – pitch, duration, loudness and panning – to a point or line or surface, as well as to their own brightness and color. As a result, the graphical image is transformed in sounds (Borza 2008: 89).

Increat was inspired by the painting *Peisaj* – *Landscape* created by the visual artist Claudiu Presecan. The painting contains primary colors, surprisingly similar to the RGB additive color model. Red, green and yellow were associated to the stereo sound field according to the following correlation: red – left channel, green – right channel and yellow – both channels, which means that the sound is positioned in the center of the stereo image.

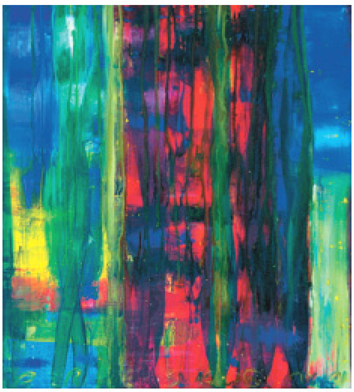
From a structural perspective, the synthesis of the sound object is depicted graphically and presents the relationship between pitch, duration, loudness and panning. These sound attributes are embodied on the ordinate and abscissa of the *Metasynth*'s diagram, in the pixels' brightness and in colors, as previously mentioned. However, the synthesis by visual shapes is highlighting not only the indissoluble relation between the qualities of the sound, but also its inherent visual features.

From a perceptual viewpoint, the dynamics of the transition between colors, linked certainly to the left-to-right playback of the diagram within a very short time of a second, establishes an energetic movement of the object, polarized on the extremities of the sound field. The sound object is characterized by a complex and extremely fast evolution in the pitch domain, preserving a series of harmonic sounds in the lower register. The vitality of the loudness is due to the brightness of each pixel, faded to black.

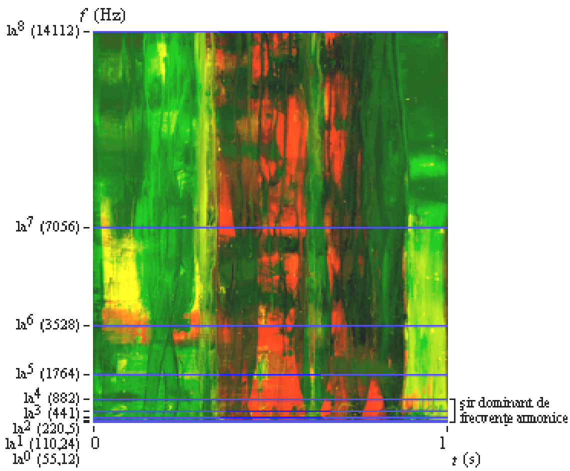
These spectral micro-variations of the sound object demonstrate the effectiveness of the additive synthesis technique.

In whole, the one-second-long object is emotionally perceived on the **tension** scale of the *Profile of Mood States* (POMS). The listener's feelings might be as follows: tense, shaky, panicky, restless, nervous and anxious.

Fig. 2



Claudiu Presecan. *Landscape*



Adrian Borza. *Increat*.
The Genesis of the Sound Object from Visual Shapes.

Audio-Visual Interaction

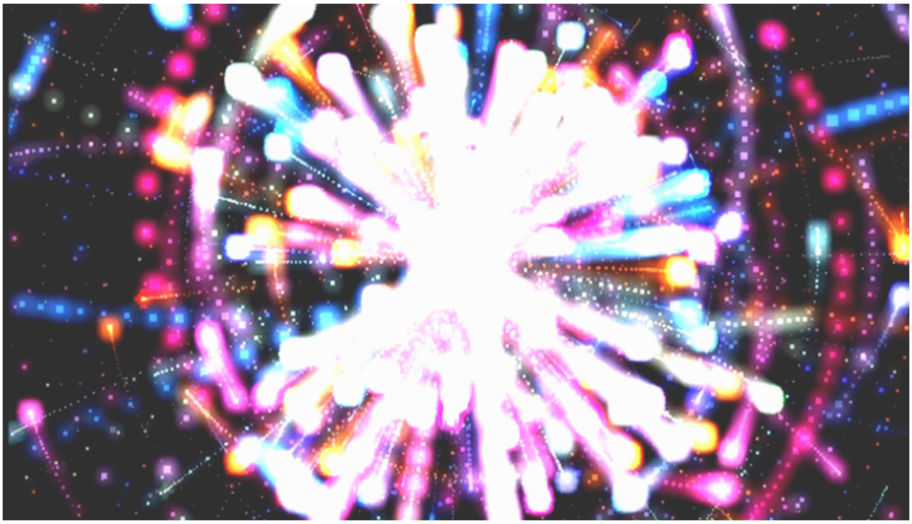
Drones II (2012) is a work in the Interactive Music genre, if we consider that iFPH – *Interactive Freezer Player Processor Harmonizer* software (2011) promptly reacts to the performers' actions, during an ongoing performance on stage. Our software written in MAX is coordinated by one of the performers, by using the *nanoKontrol* control surface (see Korg).

As an immediate reaction to the sound of violin captured by microphone, iFPH puts into practice its diverse processing abilities. The interaction therefore involves the violinist and the computer. The performer holds, for example, a complete control over the overall envelope of the sound produced by the computer. In other words, the computer reacts to the changes in loudness of the sound, imposed by the soloist. The loudness level is constantly monitored in the software (Borza 2012: 42-43).

One year later, *Drones II* become the subject for the development of a software product for processing various geometric shapes, which we called it VJ – *Vee-Jay Music Visualizer* (2013). The software computes the subtle changes of loudness in real-time; consequently, the data obtained are intended to modify the size of the visual shapes, their position, blur level and color.

It is also important to note that any type of music can be visualized within the VJ software. Our purpose was to synchronize music and abstract animation.

Fig 3



Adrian Borza. *Drones II.* Modifying Visual Features by Loudness
A Discrete Path: Sound Morphogenesis through Gestural Control

Historically, computer music has dissociated the sound synthesis produced in studio, without involving a performer, from computer systems that allow onstage human interaction, such as the augmented musical instrument, controlled by sensors.

In the first decade of the 21st century, the control of augmented instruments by gesture became an important area of interdisciplinary research. However, the initial experiments began with the *Theremin* created by de Léon Theremin, *Lightning* built by Don Buchla and continued with *Big Eye*, a project coordinated by the Steim Institute, and with *EyeCon* conceived by Frieder Weiss.

Many of the alternative interfaces for musical performance have tried to liberate the artist from the physical constrains of touching the instrument (Rovan/Hayward 2000). Surprisingly, they had an impact on the performing arts, too. The old frontier between dancer and computer has been removed, paving the way towards a hybrid world in which the human body interacts with the scenic light (see *EyeCon*).

We conclude this study by asserting that, at present, our artistic and research direction envisages exploring the benefits and highlighting the typical problems in composition and performance regarding the instruments for synthesis controlled by natural gestures which appeals to the proprioceptive sense. We will also consider our *Hot Hand Rocket* system (2014) – an augmented instrument, without touch control, which uses the wireless communication and a gravitational sensor, alongside a MIDI-controlled analog synthesizer and a computer programmed in MAX to produce sounds.

The emerging technology will shape our music, just as the creative aspiration will influence the development of our own interactive systems for sensory fusion.

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