

SYNCHRESIS audiovisiontales

editors **isabel soveral** & **fátima pombo**



universidade de aveiro
theoria poiesis praxis

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The **eaw** – **electroacousticwinds** began as a platform that aggregates artists and researchers from several artistic fields who had the desire to contribute on the advancement of tools that stimulates a new way of artistic creation. The book **SYNCHRESIS** – **audiovisiontales** is a collection of articles from different authors, and is the culmination of the **eaw²⁰¹⁷ international conference**, under the same name. Here we will discuss the symbiotic relationship between sound and image, two different languages within the multimedia art form. The technological tools to improve this relationship are the main focus of the proposed articles which stress multiple perspectives on both technical-linguistic and aesthetic points of view. This audio-vision relationship has become a research focus for different authors in recent decades, namely by discussing on how technology

enables the creation of tools for manipulating and enhancing not only the artist's creativity but also the audience's immersion.

However, in this field, as in others within the digital humanities realm, new assumptions and theories are created every time technology overcomes its constraints and presents a new paradigm. Design and soundscapes aims to discuss and mirror interactions and features between design, sound, silence and the potential to perceive space, place and time.

Intending to enlarge the scope of the debate, this book presents theoretical frameworks and/or empirical studies that address these topics from a variety of inspiring arguments.

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Give us some space

Guilherme Campos

University of Aveiro

This talk explores different notions of ‘space’ in connection to human sound perception and the development of audio and VR technology.

Eardrum stimuli are determined not only by the sound sources themselves but also by their location within the surrounding space and the acoustic behaviour defined by its physical characteristics (size, shape and materials). Recognised and studied for millenia, this observation is especially important in spaces built for speech and/or music. Multiple links can be found between music and architecture. The inter-influence between musical styles and the design of performance spaces is a fascinating topic. Sabine established the field of Room (or *Architectural*) Acoustics on modern scientific grounds about a century ago. It is now quite clear how to achieve good acoustics for both speech and music. Still, room acoustic design is too often neglected.

From the eardrum stimuli, the internal auditory system is able to extract data on the location of the source and the physical characteristics of the space. This spatial hearing ability is vitally important, as evidenced by the pervasive evolutionary traits specifically supporting it, like pinnae and multiple, spaced-apart ears. Directional information is imprinted on sound waves due to their interaction with head and torso.

The main azimuth cues are inter-aural level and arrival-time differences (ILD and ITD); pinnae are key to adding elevation-dependent spectral colouring. All the cues for a given direction can be captured by measuring the corresponding binaural *head-related impulse response* (HRIR).

Conventional stereophony, in which two loudspeakers control the ILD cues determining the perceived source position on the L-R axis,

was the initial step towards integrating the spatial dimension of sound in audio. It can be extended to 3D through the use of loudspeaker arrays. With 3D recording technology (soundfield microphones, *Ambisonics* equipment) increasingly mature and accessible, there is no technical impediment to 3D musical performance, exploration and creation. However, with surround-sound systems largely restricted to cinema theatres, few rooms are appropriately equipped and accessible for that purpose.

Reproduction is the true challenge for high-fidelity 3D sound spatialisation. The effectiveness of loudspeaker- array delivery is restricted to a relatively small listening area (‘sweet spot’) and far-field source simulations.

These limitations are potentially solved by binaural delivery, with spatialisation through HRIR filtering – at the expense of real-time acoustic modelling with head-tracking for each listener and the need to wear headphones (or earphones). Numerous interesting application niches can be mentioned. Externalisation and localisation accuracy with non-individualised HRIR sets can be improved through learning. The research project ‘*Virtual headphones*’ aims at dispensing with actual headphones by using directional ultra-sound beams to carry the audio signals to the listener’s ears.

VR technology is traditionally vision-oriented; the trend to full 360° systems accentuates the hemispheric range limitation of vision and the need to integrate the audio component. Sound is important in its own right but also crucial to support multimodal perception mechanisms. For example, the VR distance compression effect, especially notorious with HMD devices, can be addressed by manipulating audio-visual congruence.

Keywords: Room acoustics, spatial hearing, auralisation, 3D spatialisation, audio virtual reality.

1. Room acoustics

1.1. Motivation and historic perspective

Consider sound transmission from source to listener in an enclosed space. It is clear that the stimuli at the listener's eardrums are influenced by the physical properties of the room (size, shape, boundary materials...), as these determine the wave reflection, absorption, diffraction, refraction and interference phenomena affecting sound propagation. This is the field of study of *Room Acoustics* or *Architectural Acoustics*.

The auditory sensation is subjective, as it also depends on how the eardrum stimuli are processed by the internal auditory system – this falls into the realm of Psychoacoustics. However, from a strict Room Acoustics perspective, objective phenomena being the sole concern, eardrums are the end of the path.

Room Acoustics has attracted interest for millennia. The most remarkable written evidence comes from Chinese scholars several centuries BC, the Bible (it is widely acknowledged that the detailed Tabernacle specifications found in *Exodus* are intended to provide acoustic treatment) and the Roman architect Vitruvius, whose famous 'Ten books' on Architecture (1st century BC) included specific advice on Acoustics.

Acoustic behaviour is particularly important in rooms intended for speech and/or music, notably temples (like the Bible's Tabernacle) theatres (like Vitruvius's Roman amphitheatres), lecture rooms, concert halls and opera houses. But the concept of 'good acoustics' is not clear-cut: what are the criteria for good acoustics?

Speech situations are simpler, as the main requirement (intelligibility), is relatively objective. For music, the answer is highly subjective, as it depends on cultural aspects (type of music, traditions, fashion...). The impact of musical genre on subjective preference regarding room acoustics is reflected in the close relationship between musical genres (and their development over the centuries) and the acoustic characteristics of their usual performance spaces. Take, for instance, terms like *chamber music* or *bandstand* and the almost automatic association between organ music and reverberant cathedrals, *fado* and intimate *fado houses*, rock music and stadium settings.

Assuming some criteria for good acoustics are agreed upon, a second, much more difficult, question, arises: how should spaces be designed to meet those criteria?

Up to the end of the 19th century, knowledge in this area was purely empirical; the complete lack of scientific grounding is epitomised by this classic 1880 citation from Charles Garnier, the architect of Paris Opera:

'It is not my fault that acoustics and I can never came to an understanding. I gave myself great pains to master this bizarre science, but [...] nowhere did I find a positive rule of action to guide me; on the contrary, nothing but contradictory statements. [...] finally I made this discovery: a room to have good acoustics must be either long or broad, high or low, of wood or stone, round or square, and so forth...'

Wallace C. Sabine (1868-1919), unanimously considered the founding father of Architectural Acoustics – the 'Science of Sound as applied to buildings' – realised the prevailing situation. Challenged to try and correct the awful acoustics of a University lecture theatre, he was the first to apply genuinely scientific methods in this area, and solve problems on a solid experimental basis. His meticulous approach is well illustrated by the snapshot sequence shown in Figure 1, obtained using a method of photographing air disturbances (Sabine, 1922).

1.2. Acoustic design

The energy of the soundfield in a room decays through absorption as waves impinge on the boundaries. The rate of decay depends on the percentage of energy absorbed on each impact and the frequency of impacts. The former is determined by the corresponding boundary material: higher absorption coefficients contribute to faster energy decay (lower reverberation). The latter depends on room dimensions: larger volume (V) implies longer mean free path between reflections and contributes to slower energy decay (higher reverberation).

Sabine quantified these observations in his famous reverberation time (T_{60}) formula (presented here in its simplest guise for clarity):

$$T_{60} = 0,161 \frac{V}{\sum_i S_i \alpha_i}$$

The practical usefulness of this formula depends on establishing the absorption coefficient (α_i) for each boundary material (S_i being its surface area). Sabine himself worked tirelessly on obtaining the required experimental data. Tables of acoustic coefficients for an immense list of building materials and finishes are readily available today.

Reverberation time is arguably the most important acoustic design parameter, both for speech and music. It determines the perceived ‘acoustic size’ of a room. Because rigid walls favour reverberation, a very rigid-walled small room can sound large, which explains the well-known ‘bathroom singing’ effect.

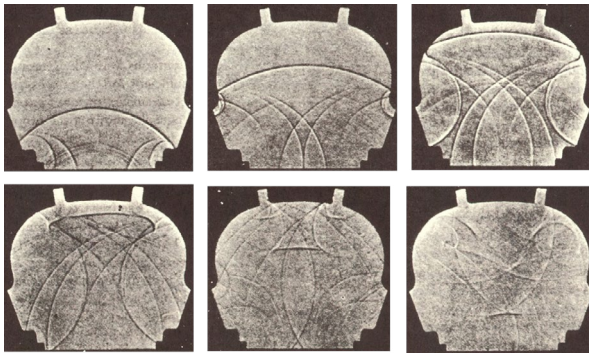


Figure 1. Scale-model photographic investigation of sound-wave propagation in New York's New Theatre.

As a perceptual construct, reverberation relies on the *precedence effect*: successive reflections merge with and reinforce the previous ones. However, this effect breaks down if the time interval between consecutive reflections exceeds a certain threshold (approximately 50ms for speech and up to 100ms for music), in which case they are perceived individually as echoes. In other words, the mechanism of reverberation and echo is the same; the distinction is a matter of time scale which, in turn, depends on room size.

Another important effect determined by room shape and size is modal behaviour. Enclosed spaces exhibit *resonance modes* at particular frequencies. This effect amounts to natural colouration of the sound, normally regarded as a defect. It can be countered by careful choice of room dimensions and use of acoustic diffusers.

Resonance modes can be observed in a reverberant room (e.g. a tiled bathroom) by applying a slow frequency-sweeping signal. Larger rooms sustain lower modal frequencies.

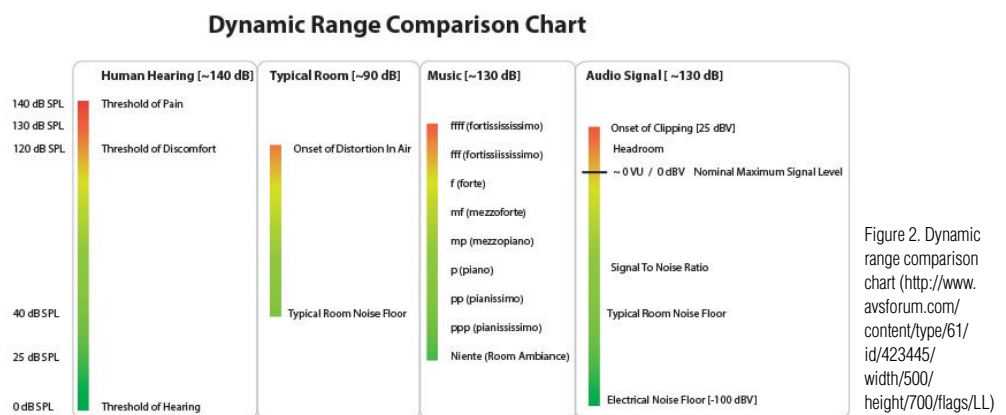
The interference between travelling waves is such that stationary vibration patterns – *standing waves* – emerge at the modal frequencies; points of no vibration are called *nodes* and points of

maximal vibration are called *anti-nodes*. This means the colouration effect is variable depending on listening position. An important practical consequence is that microphone positioning can be used to control live recording equalisation.

Sabine's impulse led to tremendous advances in the last century. It is now quite clear how to achieve good acoustics for both speech and music and, based on this knowledge, comprehensive sets of laws and regulations have been established on the subject worldwide. There is no excuse for poor acoustics today. Excellent acoustic design should be the rule – not the exception. Regrettably, it is not so. In Portugal, for example, regulations are blatantly disregarded.

Excessive reverberation is the most common problem. Speech intelligibility is impaired and people tend to speak louder. This is an instance of the *Lombard effect* (also observed in other animals) whereby people involuntarily adjust their speech to find 'room' in the communication channel for effective communication. This effect can involve adjustments not only in amplitude but also in frequency (higher pitch) or duration (longer syllables, lower syllable rate). The effort to compensate for reverberation creates a vicious circle of increasing loudness. Sound amplification/reinforcement systems, often used unnecessarily and/or at excessive volume, compound the problem. At the root of this 'loudness war', lack of acoustic design is an insidious cause of noise pollution. Loss of concentration, fatigue and even health problems like stress and premature hearing loss are among its ill effects. Action is urgently needed, as the public are often unaware of the problem; they are affected by it without realising. This is especially true for children. In schools – including nurseries and primary schools, where poor acoustic conditions are particularly harmful – the situation is appalling.

The dynamic range of human hearing is awesome – over 100 dB. Figure 2 highlights how room noise floor is clearly the main limiting factor in our enjoyment and creative manipulation of sound and music (including silence...). It must be kept as low as possible. Otherwise, investing in *hi-fi*, low-noise audio systems is pointless.



1.3. Auralisation and modelling

Advances in Digital Signal Processing have enabled a powerful approach based on the concept of *room impulse response* (RIR) – the response measured when the source is a signal with uniform frequency content (i.e. a Dirac pulse). The RIR completely characterises the acoustic influence of the room for the chosen positions of source and receiver. A Dirac pulse is not feasible, but can be satisfactorily approximated in practice. The influence of the listener's physical presence is

very important. To account for it, a binaural RIR (i.e. a pair of RIR – one taken at each ear) is required. Mannequins equipped with ear microphones are used for binaural RIR measurement.

Through convolution with a binaural RIR, the stimuli at the listener’s ears can be computed for any sound source, provided an anechoic recording is available, and presented through headphones – this is known as *Auralisation*.

A RIR can be easily measured. The real challenge is to work out the behaviour of rooms whose RIRs cannot be measured directly. The answer is to obtain their RIRs from acoustic models (now invariably based on digital computers). Very realistic auralisation results can be achieved. As Figure 3 suggests, room modelling is the key to both Auditoria Design and Acoustic Archaeology.



Figure 3. The double role of room acoustic modelling

Archaeology has traditionally favoured predominantly visual interpretations of the past. Its sonic dimension must also be explored: ‘How did ancient spaces sound like?’

A survey of six Neolithic passage-grave chambers in the British Isles revealed intriguing acoustic properties. Because of their specific layout, the chambers exhibit resonances at infrasonic frequencies. These frequencies could be excited by rhythmic drumming (depending on their intensity, infrasounds can contribute to a range of psychological and physiological effects, from slight discomfort to altered states of consciousness).

The alternating nodes and anti-nodes of the corresponding standing wave are particularly noticeable when traversing the narrow passages leading to the main chambers. Some of the diagrammatic rock etchings found in Newgrange and Loughcrew (see example in Figure 4) could represent the observed standing-wave patterns [Jahn et al., 1996].



Figure 4. Newgrange: kerbstone 52

It is conceivable that the acoustic properties of these monuments may have been not only utilised but also understood and even deliberately engineered. Acoustic modelling is key to test this hypothesis.

2. Spatial hearing

The sound parameters acknowledged in conventional musical scores are *pitch*, *duration*, *loudness* and *timbre*. The spatial dimension (location of the source, qualities imprinted by the propagation environment) is normally not considered. Is it less important?

Images, sounds and smells arrive from all directions. Locating their sources – spatial sensing – is vitally important in the struggle for survival. The sophisticated brain processing developed by animal species for that purpose relies on the availability of multiple (normally two) sense organs (ears, in the case of hearing) as spaced apart as possible. A single ear would be enough to perceive pitch, duration, loudness and timbre. But there is only one single-eared animal species. Spatial hearing is the reason why human beings (and animals in general) evolved to have two ears. There could not be better evidence of its importance.

Directional hearing can be likened to a process of watermarking. The interaction of sound waves with our external auditory system (head, pinnae...) imprints direction-dependent cues ('watermarks') on the stimuli actually reaching our eardrums. Over time, each individual's brain is unconsciously trained to decode her own 'watermarks', as these depend on size/shape of head and pinnae. Based on this training, and making use of its amazing real-time signal processing capabilities, our brain is able to extract the directional information inserted on the received stimuli.

The main cues to detecting the azimuth of a sound source relative to the listener are illustrated in Figure 5.

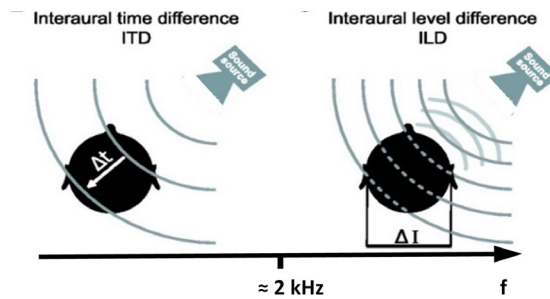


Figure 5. Rayleigh's duplex theory. (Adapted from Grothe et al., 2010)

Our internal auditory system combines the two cues. Interaural time difference (ITD) is only effective for low frequencies, due to spatial aliasing when wavelengths are not sufficiently large compared to head size.

Conversely, interaural level difference (ILD) is only effective in the high frequency region, as the head shadowing effect it relies upon is compromised by diffraction of low frequency components. The threshold between the two regions is typically around 2 kHz.

Sinewaves at the mid-frequency range are notoriously difficult to localise, as both cues are ineffective. Unfortunately, this is too often ignored in the design of alarm signals. Broadband signals (chirps, pulses) are the easiest to localise, as they provide solid cues of both types.

The resolution of human directional hearing is much higher in azimuth than in elevation, as ITD and ILD cues do not work for elevation detection; this relies upon spectral (colouration) cues which are essentially monaural (i.e. their operation principle does not imply the need for two ears). These spectral cues are less robust, partly because colouration may, to some extent, be intrinsic to the source. Familiarity of the sound is an important disambiguation factor; head movements are also very useful (some animals are even able to directly control ear movement).

For a given source direction, all these directional cues can be encapsulated in a single pair of measurements: the *head-related impulse response* (HRIR). This is simply a binaural RIR measured in free-field conditions, so as to isolate the influence of the listener (head and pinnae). In practice, measurements are taken in anechoic rooms, using anthropometric mannequins, with the source made to cover the whole useful range of directions (azimuth and elevation) at constant distance. This yields average (non-individualised) HRIR databases.

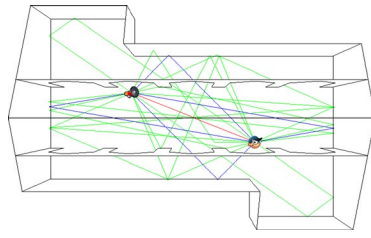


Figure 6. AcousticAVE demo: HRIR-based headphone auralisation with real-time head-tracking (Campos et al. 2014)

‘Ray-based’ room acoustic models (as illustrated in Figure 6) can be combined with HRIR filters to achieve quite convincing binauralisation in dynamic scenarios (source and listener movement tracked in real time).

3. Spatial (3D) audio

The initial step towards integrating the spatial dimension of sound in audio was conventional stereophony. Reproduction is based on a pair of loudspeakers to control the ILD cues determining the perceived source position on the L-R axis (1D). The intended effect is limited to an area around what is known as sweet spot. Stereo reproduction can be extended to 3D through the use of loudspeaker arrays although the sweet-spot limitation remains. Similarly, it is possible to record 3D sound through the use of soundfield microphones.

These combine a number of capsules (typically four in a tetrahedral arrangement – 1st order *Ambisonics*).

In recent years, 3D sound technology (especially *Ambisonics* equipment) has gained acceptance and become increasingly affordable. It seems possible for composers, performers and the public to fully enjoy the spatial dimension of sound.

The exploration of space as a musical parameter goes back a long way. For example:

‘The great 40-part motet ‘Spem in alium nunquam habui’ by Thomas Tallis (1556, circa) would sound stupendous if captured so as to truly surround the listener. [...] Clearly, Tallis exploits “space” and direction. If Tallis were with us today, I do not think he’d want recorded performances of his works distanced from listeners by the ‘proscenium arch’ effect of stereophonic reproduction’ Peter Carbines (in <http://sursound.music.vt.narkive.com/OtGs84iZ/sursound-real-vs-synthesized-ambience>)

Works of this kind, old and new, should be more accessible than ever. But there are hardly any concert rooms equipped with multispeaker systems...

Delivery through headphones/earphones is much less expensive, as it requires less equipment and no room treatment. It also avoids the sweet-spot limitation.

Its main disadvantage is the need for head-tracking devices and associated real-time processing power. There can be externalisation difficulties (‘inside-the-head’ effect), but it has been shown that externalisation and localisation can be improved through active learning (Mendonça et al. 2012).

Binaural systems can be effective and inexpensive for simple spatialisation applications. Numerous interesting application niches can be explored. An example is immersive audio-guiding (i.e. based on virtual sources at tour focal points).

The project ‘Virtual Headphones’ aims at avoiding the discomfort of wearing headphones. It is based on an ultrasonic carrier onto which the audio content is modulated. Because ultrasounds are very directional, the carrier can be steered towards the listener’s ears (tracked by video) and deliver the audio content thanks to a non-linear demodulation effect occurring in air propagation.

4. Audio virtual and augmented reality

Audio should be given proper attention in the context of VR and AR technology. Figure 7 illustrates a project exploring the VR recreation of a Neolithic passage grave (Dias et al. 2008).

The integration of audio is especially desirable here given the genuine interest (discussed in 1.3) of the acoustic properties of Neolithic structures.

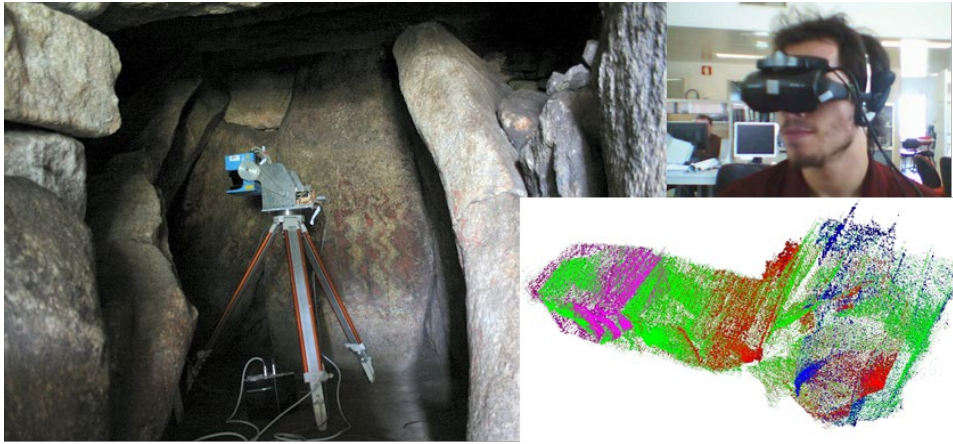


Figure 7. 3D Reconstruction and Auralisation of the "Painted Dolmen" of Antelas

In the general case, it should be noted that sound perception is omnidirectional, as opposed to vision: without audio, VR narratives are limited to hemispheric (visual) prompts. The trend to full 360° systems accentuates the need to integrate the audio component.

Audio is also crucial to support multimodal (especially audio-visual) perception mechanisms. For example, the VR distance compression effect, especially notorious with HMD devices, can be addressed by manipulating audio-visual congruence (Finnegan et al., 2016).

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HASGS [Hybrid Augmented Saxophone of Gestural Symbiosis] Generating Visual and Graphical Feedback

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This paper discusses how an augmented instrument, HASGS in the context of interactive electronic music, motivates the generation of different graphical user interfaces taking in consideration the repertoire being composed for it. New composition aesthetics are deeply influenced by electronic materials and sonic repositories at the same time as new mediums are currently seen as possible extensions of instrumental practice. These mediums are available for creative purposes during composition and performative processes. While the aesthetics of acoustic and electronic sounds are creating mutual influences, composers and sound designers are developing new languages, new gestural attitudes, new extended techniques, new notation methods, new performative paradigms including the creation of graphical interfaces for visual feedback. This augmented system for saxophone was motivated by the need to perform pieces with a common aesthetic that have been written using electronic environments. Those pieces shared the need for the control of

external devices in order to be performed.

The repertoire for saxophone and electronics is growing in a huge scale, from pieces using stomp boxes or control pedals for different triggering or fading, to pieces requiring the manipulation of knobs. These controllers, by their nature, devices that separate sound production (synthesis) and performer gesture (control), have subsequently generated an increased interest in the study of compositional mapping strategies for computer music. From our experience, we conclude that the graphical user interface (GUI) is fundamental for the understanding of the individuality of each piece, as well as to understand the relation between the augmentation system and the piece itself. If this project started with the idea of contributing to a new performative paradigm regarding the existing repertoire, new repertoire and improvisational performance situations led to the development of a hybrid system contributing to bio-feedback incorporation in the work of art, while creating new graphical user interfaces for visual feedback.

Keywords Saxophone, Augmented Instrument, Gestural Interaction, Live Electronics, Graphical User Interface.

1. Introduction

Artist and scientists have a perpetual interest in the relationship between music and art. As technology has progressed, so too have the tools that allow the practical exploration of this relationship. Today, artists in many disparate fields occupy themselves with producing animated visual art that is correlated with music (Bergstrom & Lotto 2009). In this paper, our interest is to examine the graphical user interface (GUI) generated by the composers and programmers for the performance of the pieces composed by themselves for HASGS. This kind of visual feedback is fundamental for the performer to understand the relation between the augmentation system and the piece itself, and/or how to control it.

The goal of user interface design is to make the user's interaction as simple and efficient as possible, in terms of accomplishing user goals. Good user interface design facilitates finishing the task at hand without drawing unnecessary attention to itself. Graphic design and typography are utilized to support its usability, influencing how the user performs certain interactions and improving the aesthetic appeal of the design; design aesthetics may enhance or detract from the ability of users to use the functions of the interface (Norman 2002). According to the ISO 9241 standard for the organization of information (arrangement, alignment, grouping, labels, location), for the display of graphical objects, and for the coding of information (abbreviation, color, size, shape, visual cues) by distinguished in seven attributes: Clarity, the information content is conveyed quickly and accurately; Discriminability, the displayed information can be distinguished accurately; Conciseness, users are not overloaded with extraneous information; Consistency: a unique design, conformity with user's expectation; Detectability: the user's attention is directed towards information required; Legibility, information is easy to read; Comprehensibility, the meaning is clearly understandable, unambiguous, interpretable, and recognizable.

Augmenting an acoustic instrument places some limitations on the designer's palette of feasible gestures because of those intrinsic performance gestures, and the existing mechanical interface, which have been developed over years, sometimes, centuries of acoustic practice (Thibodeau and Wanderley 2013). A fundamental question when augmenting an instrument is whether it should be playable in the existing way: to what degree, if any, will augmentation modify traditional techniques? Augmented performance can be considered enactive knowledge. The term enactive knowledge refers to knowledge that can only be acquired and manifested through action. Examples of human activities that heavily rely on enactive knowledge include dance, painting, sports, and performing music. This concept will enable a mode of musical/visual performance different from current practice, which is likely to enhance the experience of both the performer(s) and audiences (Bergstrom & Lotto 2009), especially if the audience is receiving the visual information based on the GUI of each piece, in order to understand how the performer is controlling the electronic parameters through the augmented system.

The manipulation of HASGS is directly associated with gestural controls. The notion of gesture goes beyond this purely physical aspect in that it involves an action as a movement unit, or a chunk, which may be planned, goal directed, and perceived as a holistic entity (Buxton and Meyers 1986). Movements used to control sound in many multimedia settings differ from those used for acoustic instruments. For digital electronic instruments the link between gesture and sound is defined by the electronic design and the programming. This opens up many possible choices for the relationship between gesture and sound, usually referred to as mapping. The mapping from gesture to sound can be fairly straightforward so that, for example, a fast movement has a direct correspondence in the attack time or loudness of the sound. However, with electronically generated sounds it is also possible to make incongruent, "unrealistic" links between gesture and sound. The gestural control of electronic instruments encompasses a wide range of approaches and types of works, e.g. modifying acoustic instruments for mixed acoustic/electronics music, public interactive

installations, and performances where a dancer interacts with a sound environment. For these types of performances and interactions, the boundaries between, for instance, control and communicative gestures tend to get blurred. To give enough freedom to the performers, the design of the interaction between sound and gesture is generally not as deterministic as in performances of acoustic music.

2. Prototyping

In our perspective, augmented instruments and systems should preserve, as much as possible, the technique that experienced musicians gain along several years of studying the acoustic instrument. The problem with augmented instruments is that they require, most of times, a new learning process of playing the instrument, some of them with a complex learning curve. Our system is prototyped in a perspective of retaining the quality of the performance practice gained over years of studying and practicing the acoustic instrument. With HASGS was our intention to integrate the control of electronic parameters organically allowing a high degree of virtuosity gained with the traditional acoustic practice (Portovedo, Ferreira Lopes and Mendes 2017).

HASGS was initially developed within a DIY approach, justifiable by the repertoire that motivated the project. It is the repertoire that has been influencing the way this system has been developing. We mention Reduced Augmentation because, from the idea of having all the features of an EWI (Electronic Wind Instrument) on an acoustic instrument, this could lead to performance technique overload, as well as making the acoustic instrument to much personal in terms of new hardware displacement. The proliferation regarding to the creation of augmented instruments in the NIME context is very big, but just a little number of them acquire recognition from the music market and players. As any musical instrument is a product of a technology of its time, augmented instruments are lacking the validation from composers and performers apart from their inventors. Due mostly to the novelty of the technology, few experimental hyper instruments are built by artists. These artists mostly use the instruments themselves. There is no standardized hyperinstrument yet for which a composer could write. It is difficult to draw the line between the composer and the performer while using such systems. The majority of performers using such instruments are concerned with improvisation, as a way of making musical expression as free as possible (Palacio Quintin 2008). In the first prototype of HASGS, we were using, attached to the saxophone one Arduino Nano board, processing and mapping the information from one ribbon sensor, one keypad, one trigger button and two pressure sensors. One of the pressure sensors was located on the saxophone mouthpiece, in order to sense the teeth pressure when blowing. Most of the sensors (ribbon, trigger, pressure) were distributed between the two thumb fingers. This proved to be very efficient once that the saxophonist doesn't use extensively these fingers in order to play the acoustic saxophone. This allowed, as well, very precise control of the parameters assigned to the sensors. The communication between the Arduino and the computer was programmed through Serial Port using USB protocol. This communication sent all the MIDI commands. The computer was running a Node.js program that simulated a MIDI port and every time it received data from the USB port, it sent that data to the virtual MIDI port.

Taking in consideration that this system is still not a finalized system, but a prototype, our third version, used here, started with the substitution of the Arduino Nano by an ESP8266 board. The communication between the sensors and the data received into the computer became wireless due to this fact. Both the computer and HASGS connect now to a Personal Hotspot created by a mobile phone API. This specification will allow much performance freedom to the performer, allowing now space for the integration of an accelerometer/gyroscope. To the previous sensors in the system were added two knobs allowing independent volume control for two parameters.

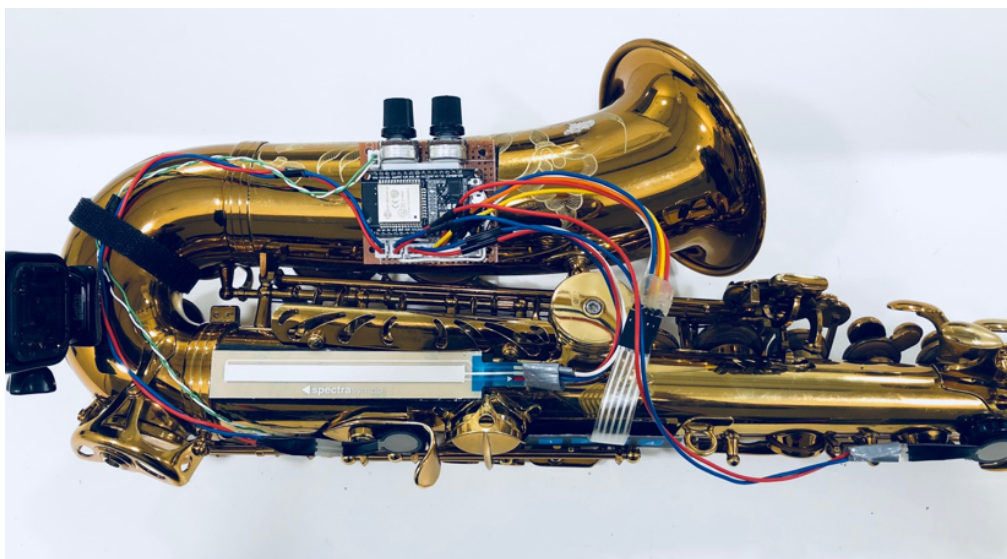


Figure 1. HASGS System

3. Repertoire

In this paper we examine some of the new pieces composed for HASGS with emphasis on pieces with contrasting performative GUI's. These pieces resulted in different ways of using the saxophone's sonic materials, at the same time as using the HASGS. For this reason, it's not surprising that the visual interface of each piece has different configurations and characteristics. The evolution on notation systems and on visual programming has contributed largely for the development of extended techniques and instrumental virtuosity. Yet when acoustic instruments are played or combined in unconventional ways, the result can sometimes sound like electronic music (Roads 2015). One of the things to be considered, regarding to the new repertoire for augmented instruments, and more precisely, to this augmented saxophone system, is the presence of multiple layers of information, something that still not common when writing for a monophonic instrument. This shows, as well, a different approach of programming GUIs when comparing visual interfaces of traditional electroacoustic pieces with pieces for an augmented system.

3.1. Indeciduous

Indeciduous was composed by Stewart Engart and should to be performed as a free blues over an unrelenting drum machine. Durations notated are a suggestion as are gestures/pitches, with the exception of the pitches accented with , these notes are required and must be looped by the performer. Potentiometers on the HASGS control the sax gain (Pot1) and the overall gain of the performance (Pot2). The ribbon controller controls the time of reverb measured in seconds. The thumb pressure sensors control the size of the looping window (Pres1) and the location of that looping window (Pres2). The keypad starts the drum machine [1], stops the drum machine [2], triggers events [3], and stops looping [4]. The trigger button starts and stops recording into the looper. In this piece, all the controls of HASGS are directly visible, providing a minimal but very effective visual feedback for controlling events and triggering.

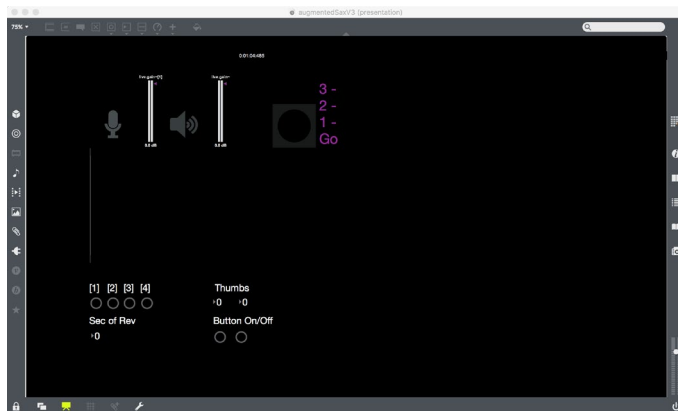


Figure 2. Indeciduous, Graphical user interface.

3.2 Cicadas Memories

Composed by Nicolas Canot, Cicadas Memories is much more an improvisational process than a piece of written music. It explores a method that eventually introduces a nonstandard musical way of thinking: the present of the live performed music is (at least partially) controlled, altered by the actualization of the past. In the case of CICADAS Memories, this means that the actual gesture of the player will alter (one minute later) the electronic sound-field used as the sonic background for the saxophone's rhythmic patterns (also created by the keypad's « 4 bits » layers of memory). Therefore, the performer has to develop two simultaneous ways of thinking (and acting) while performing: a part of his mind for the present (the patterns imposed by the software but created by the player's past action on the keypads), another one for the future (its gestural connection to the sensors). He has to deal with two temporalities usually separated in the act of live music performance: he writes the future score and improvises on his past gestures, in the present time. CICADAS MEMORIES could be defined as a multi-temporal sensitive feedback loop. Regarding the sonic / musical context, this explores the thinking of the piece as a process (maybe under the influence of Agostino di Scipio's thinking) rather than «written music». Cicada's visual interface is very much obscure, once most of the sensors are not directly producing alterations or triggering events, but collecting data to define the electronic discourse of the piece.

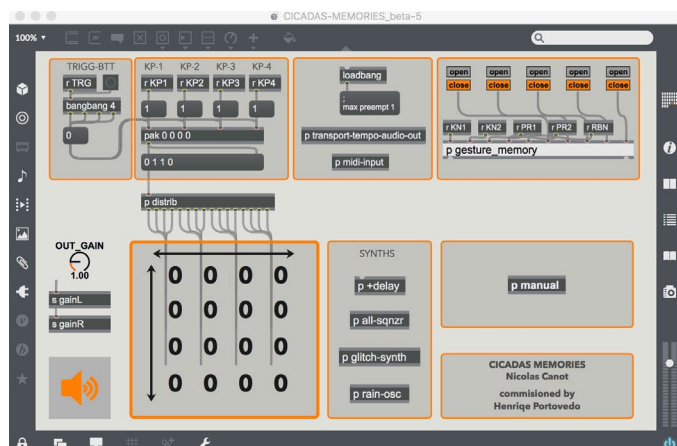


Figure 3. Cicadas Memories, Graphical user interface.

3.3 Verisimilitude

Composed by Tiago Ângelo, the setup for this piece, written for tenor saxophone and the HASGS system, uses a single speaker placed on front of the performer at the same height as the saxophone's bell. A play of acoustic sound source and electronic (processed and generated) sound using computer music techniques is driven in three sections - A, B and C - each with its own specific processors and generators, implementing different mappings and control levels not only from the HASGS controller but also from real-time sound analysis. This performance aims to create a context where both composed and improvised elements coexist in aesthetically relevant interdependency, taking advantage of the possible synergies between a real-time composition and a hybrid acoustic-control augmented instrument. These synergies will enable a high degree of interactivity between improviser and composed response. The interaction flow is completed by the soloist's reaction to the composed response, establishing a dialectical relationship. This GUI is based on a DAW system due to the fact of the main structure is on its front layer programed on Ableton Live. This option allows to have a general vision about the output of all electronic effects and parameters. In other hand, it's not clear the visualization of each specific control mapped to HASGS.

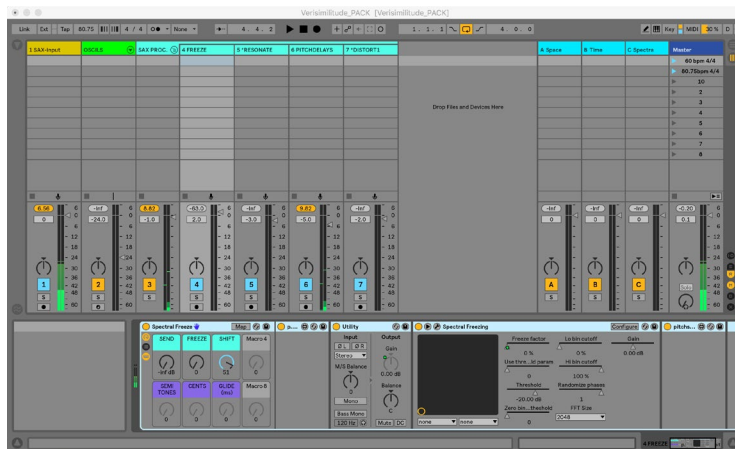


Figure 4. Verisimilitude, Graphical user interface.

3.4 Comprovisador

Comprovisador is a system designed by Pedro Louzeiro to enable mediated soloist-ensemble interaction using machine listening, algorithmic compositional procedures and dynamic notation, in a networked environment. In real-time, as a soloist improvises, Comprovisador's algorithms produce a score that is immediately sight-read by an ensemble of musicians, creating a coordinated response to the improvisation. Interaction is mediated by a performance director through parameter manipulation. Implementation of this system requires a network of computers in order to display notation (separate parts) to each of the musicians playing in the ensemble. More so, wireless connectivity enables computers – and therefore musicians – to be far apart from each other, enabling space as a compositional element. Comprovisador consists of two applications – host and client. In the present “Comprovisação”, HASGS will be used as a musical interface with dual purpose: 1) to feed Comprovisador's algorithms with improvised musical material (acoustic instrument) and 2) to control several of its parameters (controllers and sensors) thus, claiming some of the performance director's mediation tasks for the benefit of interaction flow. A thoughtfully outlined performance plan is attained though presetting of algorithmic parameters and corresponding control mapping. Each preset yields different types of musical

response, ranging from reactive synchronized tutti impacts to intricate micropolyphonic textures. HASGS keypad allows the soloist to navigate through Comprovisador's presets according to the plan and subject to his momentary desire, while other HASGS controllers (such as ribbon, trigger button, knobs, pressure and acceleration sensors) will enable him to control parameters such as dynamics, density (harmonic and instrumental), register and speed, among others. Furthermore, he will be able to trigger certain algorithmic actions and transformations including capture of melodic contours and recall of previous passages. These may include passages that were generated earlier during the performance as well as pre-composed (pre-rehearsed) ones. Like Indeciduous, just HASGS controls are present as visual feedback on the user interface.

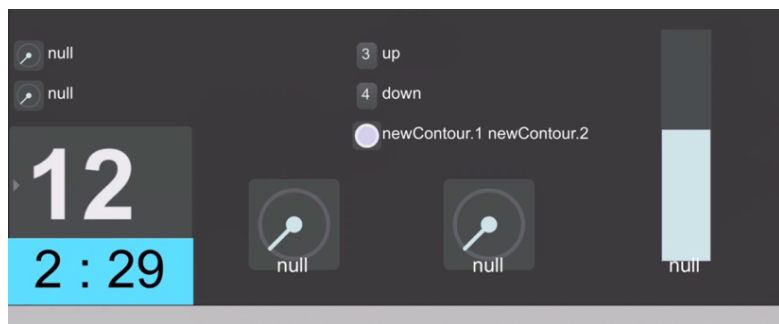


Figure 5. Comprovisador, Graphical user interface.

4. Conclusions and Future Work

Traditional music instruments and digital technology, including new interfaces for music expression, are able to influence and interact mutually creating Augmented Performance environments. The outcomes of the experience suggest as well that certain forms of continuous multi parametric mappings are beneficial to create new pieces of music, sound materials and performative environments, while visual feedback is fundamental to control and to perform this kind of works. Once each piece provides a different use of the augmented instrument, visual feedback plays a fundamental role for practicing and performing each piece into a level of conscious manipulation of HASGS leading to virtuosity.

Future work includes a profound reflection on the performative aspects of each piece, evaluating the mapping strategies of each new piece that is being written for HASGS. The notational aspect of the pieces being created will be, as well, a key aspect of this research, and how it could contribute to new interpretative paradigms. In the scope of this paper we decide to focus on the aesthetic of each piece associated with its GUI, and how it could serve as a motif of musical intention, how to influence the interpretation of each piece.

5. Acknowledgments

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Cinema and Sound Design: Domingo à Tarde (1966) [Sunday Afternoon] from António de Macedo

António de Sousa Dias

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António de Macedo (1931-2017) director, playwright, writer, researcher, is one of the directors revealed by Cinema Novo Português (New Portuguese Cinema) in Portugal and one of the few who consistently approached in his cinematographic and literary work the “speculative fiction” and the fantastic.

The importance that has he always given to sound as an essential element in cinematographic structuration is confirmed in all his prolific

work. I will focus on the film *Domingo à Tarde* (Sunday Afternoon, 1966), adapted from a novel by Fernando Namora (1919-1989). In this film, Macedo, assumes the role of director, scriptwriter, editor and presents himself as sound artist, which evidences his interest in sound. In this particular film the sound conception answers a particular question, namely, what sound possibilities present themselves if you make a movie without incidental music.

Keywords: António de Macedo (1931-2017); New Portuguese Cinema; Sonoplastia; Sound Design.

António de Macedo, Portuguese New Cinema and Sonoplastia

Domingo à Tarde (*Sunday Afternoon*) is a novel by the writer Fernando Namora (1919-1989) written in 1961, winner of the Prize José Lins do Rego, and adapted for film in 1964, by António de Macedo (1931-2017). The film was produced in 1965 and released in 1966. Macedo wrote the script, directed and edited the movie, as well as having designed all sound. Hence, the interest in this film can be perceived as manifold: on the one hand it is one of the founding works of the so called *New Portuguese Cinema* from the sixties, but on the other it reveals an unusual depth regarding sound conception in Portuguese films, which was very rare at that time.

The film *Domingo à Tarde* (*Sunday Afternoon*, António de Macedo, 1965) was produced in the context of *New (Portuguese) Cinema*. This movement is materialized by three films: *Os Verdes Anos* (*The Green Years*, Paulo Rocha, 1963), *Belarmino* (*Belarmino*, Fernando Lopes, 1964) and *Sunday Afternoon* itself. Although there were claims of a “film revolution” starting from the 50’s, according to Ferreira da Cunha (2014: 28) these young movie directors break with normal production norms and succeeded to reach both the public and critics. These feature length movies produced by António da Cunha Telles, neither configure a unified aesthetic movement nor even similar means of production, as we can see that they follow different aesthetical approaches. If *Os Verdes Anos* can be seemed influenced by the French *Nouvelle Vague*, and in fact Rocha studied between 1959 and 1961 in the *Institute des Hautes Études Cinématographiques - IDHEC*, on the other hand, *Belarmino* reflects the influence of a documentary approach (Lopes studied in 1959 in the *London School of Film Technique*) and finally, Macedo reflects a mix of German expressionism and soviet cinema, particularly Eisenstein¹.

According to Fernando Lopes, Macedo was “a very weird, bizarre and outcast character”² (Lopes 1985 *apud* Ferreira da Cunha, 2014: 33), but who was António de Macedo?

Born in Lisbon in 1931, Macedo was an architect, film director, writer, university professor and lecturer (for more developed information, see Mozos 2012, in particular Sousa Dias 2012). In the sixties, since *Sunday Afternoon*, he interrupts his career in architecture (he worked in the city town hall as an architect) to embrace a career in film directing. Indeed, until 1995, the year of his last film, a documentary, Macedo build a large filmography (see e.g. Matos Cruz, 2000), both artistically recognized and controversial at times. Selected for Official Competition, Cannes 1973, among other prizes and distinctions, after 1995 Macedo devotes himself to writing and research (he defended its PhD at 79 years old). Although in 1959-60 he wrote and organized an anthology *A Evolução Estética do Cinema* (*The Aesthetic Evolution of Cinema*) in the end of XX century and first years of the XXI century he becomes one of the most important Portuguese writers in “speculative fiction”.

Macedo has always had an interest in sound and music, as constituting and structuring elements for a film. But why was Macedo so aware, or at least sensitive to this? One possible reason, was that Macedo played piano - he stopped at the age of 24 due to an accident that left him with shoulder problems, and that this interest is due probably to parental influences as his father played violin and piano and there was a conductor on his mother’s side of the family. His membership in the Portuguese Author Society started as a composer (Sousa Dias 2012: 21-22).

1 This relationship with German and Soviet cinema was stated by Macedo himself in personal communications with me, along the years, as, besides father and son relationship, we worked together on a regular basis since 1976.

2 “um personagem estranho, bizarro marginal”. All translations from Portuguese texts are my responsibility “

This is perhaps a reason why Macedo always tackled sound and music issues in a very personal manner. For example, prior to Sunday Afternoon, Macedo had already directed a 13 minutes short movie, *Verão Coincidente* (*Coincident Summer*, 1962-63) based upon a poem from

Maria Teresa Horta. The music for this movie was composed by Álvaro Cassuto (1938-), with orchestral composition and musical direction from Joly Braga Santos (1924-1988). According to Macedo's observations added to the film credits as published in Matos-Cruz (2000), "Observations: - Absence of background noise, compensated with a melody in female voice, twelve-tone music and some touches of concrete."³ (Matos-Cruz 2000: 95) these tracks represent, perhaps, the first recorded example of portuguese *musique concrète*.

The recordings Macedo privately made from radio (festivals, improvising sessions) as well as other recordings he possessed, support his interest for new forms of jazz, free jazz, electronic music, *musique concrète* and contemporary music. He was very aware of new directions in music, as among his recordings and list of recordings I could find mention to Berio, Boulez, Henry, Lopes-Graça, Schaeffer, Stockhausen, among others.

Macedo always argued that the one Portuguese movie director who was totally aware of the importance of the sound in movies was Jorge Brum do Canto (1910-1994), saying that he had learned a lot from his experience regarding Brum do Canto's sound recording, editing and mixing, in particular from *A Cruz de Ferro* (*The Iron Cross*, 1967). In fact, he stated that, at that time, *sonoplastia* was an odd subject to his colleagues, as in general they disregard sound conception as an important point. In the sixties there was no Sound Design role, but in Portugal there was already a sound design occupation, through the concept of *Sonoplastia*⁴, a Portuguese term applied to a specific professional role, carried by the *Sonoplasta* (a direct translation could be the "sound plastician artist"), before Sound Design became more usual, but still not officially recognized.

In Portugal, the *Sonoplasta* professional was more related to Theater and Radio. In the National Classification of Occupations of 1980, it is still named as "Sonoplasta - Theatre" (1-73.35). In the 1994 revision of the 1980 Classification, it becomes *Sonoplasta* and its role is defined as:

"The Sonoplasta (profession 3.1.3.1.30) selects, individually or in collaboration with the "Director" (2.4.5.5.50) or "Director" (2.4.5.5.15 / 25/40), songs and other sound effects in order to introduce them in theatrical, television and other shows, after the text or the planning of the show to be performed; reads texts and shows plans and / or attends rehearsals in order to realize the type of show desired and the environment to be created; selects the music, noises and other sound effects according to the environment and genre of show; records the moments of entry of each song or sound effect and proceeds to the respective assembly; gives instructions to the "Sound Operator - Cinema, Television and Radio" (3.1.3.1.35) regarding the sound cues as well as their volume and provides the scheme to be used in the integration of the recordings in the text."⁵ Grande Grupo 3, Técnicos e Profissionais de Nível Intermédio, cf. CNP/94

3 Observações: - Ausência de ruídos de fundo, compensados com uma melodia em voz feminina, música dodecafónica e alguns toques de concreta.

4 I keep here the Portuguese term to stress its use.

5 "3.1.3.1.30 – Sonoplasta. Selecciona, individualmente ou em colaboração com o "Encenador" (2.4.5.5.50) ou "Realizador" (2.4.5.5.15/25/40), músicas e outros efeitos sonoros a fim de os introduzir em espectáculos teatrais, televisivos e outros, a partir do texto ou da planificação do espectáculo a realizar: lê textos e planos de espectáculos e/ou assiste a ensaios a fim de se aperceber do tipo de espectáculo pretendido e do ambiente a criar; procede à selecção da musica, ruídos e outros efeitos sonoros de acordo com o ambiente e género de espectáculo; regista os momentos de entrada de cada musica ou efeito sonoro e procede à respectiva montagem; dá indicações ao "Operador de Som - Cinema, Televisão e Rádio" (3.1.3.1.35) quanto à localização das saídas de som e respectivos volumes e fornece-lhe o esquema a utilizar na integração, da gravação, no texto."

In the revision of 2010, CPP/2010 it is integrated in the Audiovisual Recording Technician (3521.3), stating that this occupation applies to *Sonoplasta* as well as other related professional occupations.

Domingo à Tarde (Sunday Afternoon)

Sunday Afternoon is based on the homonymous work of Fernando Namora, a doctor who worked at the Portuguese Institute of Oncology in Lisbon, which he left in 1965 to devote himself entirely to writing.

The film is a feature length movie, 97 minutes long, and it is composed of 59 scenes. Macedo was enthusiastic to adapt and direct a play from Bernardo Santareno (1920-1980), *A Promessa* (*The Vow*, 1957), forbidden by censorship at the time. As Macedo wanted to shoot in color and there was no money to afford the production costs, he agrees to direct *Sunday Afternoon* in black and white, despite the middle scenes (Scenes 23 and 24), which are shot in color for dramatic purposes, approx. from 0:32:02 to 0:37:16⁶.

Presented at the Venice Festival's Official Competition in September 1965, it wins a Diploma di Merito, and, in Portugal, in 1966, the House of the Press' Prize and the Prizes Plateia for Best Director, Best Actor (Ruy de Carvalho) and Best Actress (Isabel de Castro) (Figure 1).

According to the movie synopsis:

“A doctor, Jorge directs the hematology department of a hospital. One day, Clarisse arrives, suffering from advanced leukemia. They fall in love, and Jorge seeks, for the first time, to save a sick man. Clarisse dies, despite all the efforts of Jorge - who, increasingly disenchanted, continues his work, with routine experiences, which he knows to be useless ...”⁷ Matos-Cruz 1999: 127-128



Figure 1. *Sunday Afternoon*. Still. Jorge (Ruy de Carvalho) and Clarisse (Isabel de Castro).

6 Time cues refer to the DVD version edition available. See Macedo 2016.

7 “Um médico, Jorge dirige o departamento de Hematologia de um hospital. Um dia, chega Clarisse, que sofre de leucemia em estado avançado. Apaixonam-se, e Jorge procura, pela primeira vez, salvar um doente. Clarisse morre, apesar de todos os esforços de Jorge que, cada vez mais desencantado, prossegue os seus trabalhos, com experiências de rotina, que sabe serem inúteis...”

The Sound in Sunday Afternoon

As stated before, the interesting aspect of this film is that Macedo signs not only the Direction, Adaptation, Dialogues and Editing, but also the Sound mix alongside Hugo Ribeiro and the *Sonoplastia*.

For Macedo one of the movie's main issues was: how to create a film, claiming new directions in cinema? One possible answer would be: through sound. In fact, this idea would be stated by Godard in 1970. In *Godard in America* (Ralph Thanhauser, 1970), he claims that a revolution in cinema against a Hollywoodian cinema style should be done through sound and not through image. In this direction, one of the strategies taken by Macedo relies upon the absence of incidental music. As Macedo states:

“*Sunday Afternoon* (1965) is a *sui generis* film for several reasons, one of which is that it has no background music. Early on, I realized that the best way to overwhelm the dramatic atmosphere of the film was to abolish any kind of ‘accompaniment’ music: without music, the whole hospital environment, already oppressive, is much more suffocating. Of course, the counterpart is that one is forced to do much more effort in the elaboration of the most varied sounds that are intermingled, diluting, intensifying, etc., along the “skeleton” of the film, and how they relate.”⁸ Macedo 2007: 17-18

In fact, all ambient sound in the film is thoroughly composed as we will see, providing continuity and mood, hence fulfilling functions of music. As Areal states:

“It should be noted that the director does not use ‘enunciative’ music, which is a remarkable formal novelty (there is only music when it comes from the scene: the nightclub, etc.), thereby refusing one of the main conventions of cinema in terms of subliminal message. Instead of provoking dispositions and emotions through lyricism, he constructs a prosaic soundtrack, from the direct sounds worked on the editing table. This device is a remarkable trait of vanguardism in the cinema of the 60s.”⁹
Areal 2011: 469

At the same time, for Macedo it was important to keep the spectator immersed and engaged with the film. This implied another challenge: how to address an average Portuguese spectator regarding sound, particularly how to tackle the habitudes in subtitles reading (it was forbidden to dub films) introducing a paradoxical discomfort with the earing of our own language in movies, particularly in dialogues.

Three examples in sound structuring and design

To show how Macedo tackled these problems, I choose three examples: the relationship between the beginning and end of the movie, a moment of environment sound design, and finally the “short film inside the film”.

8 “*Domingo à Tarde* (1965) é um filme *sui generis* por vários motivos, um dos quais é que não tem música de fundo. Logo de início me dei conta de que a melhor maneira de sobrecarregar a atmosfera dramática do filme era abolir qualquer espécie de música de «acompanhamento»: sem música todo aquele ambiente hospitalar, já de si opressivo, resulta muito mais sufocante. Claro que a contrapartida é que se é obrigado a um apuro muito maior na elaboração dos mais variados sons que se vão entrecendo, diluindo, intensificando, etc., ao longo da «ossatura» do filme, e de como se relacionam.”

9 “Note-se que o realizador não usa música ‘enunciativa’, o que é uma novidade formal assinalável (só há música quando ela provém da cena: a boate, etc.), com isso recusando uma das principais convenções do cinema no que toca à mensagem subliminar. Em vez de provocar disposições e emoções pelo lirismo, ele constrói uma banda sonora prosaica, a partir dos sons directos trabalhados na mesa de montagem. Este dispositivo é um traço assinalável de vanguardismo no cinema dos anos 60.”

The initial and final sequences

Regarding the initial scenes, Macedo knows that the average movie spectator at that time is used to subtitles. When she goes to cinema, she expects a “serious” movie to be subtitled, as foreigner films in Portugal were not dubbed. According to Art.13 of the Law 2077, of 18 February 1948,

“In order to guarantee the genuineness of the national cinematographic spectacle, foreign feature length films that are dubbed in Portuguese language are not allowed, except those produced on a reciprocal basis, highly authorized.”¹⁰

According to the same law, only *complement films*¹¹ as documentaries and similar movies as well as actuality movies were spoken in Portuguese. Therefore, Macedo knows that the spectator will react negatively if the movie presents itself in Portuguese, with characters talking to each other in Portuguese. Hence, after the third whistle of a train passing, the first words in the beginning are spoken in voice-over, as if we were watching a documentary. We hear the voice of Jorge saying:

JORGE (Voice-over): That same afternoon, the oldest patient in the infirmary had died. She was pregnant, and only thinking about the unborn child. The outcome was predicted with an insignificant margin of error. Even though it was a comfortable solution, definite, to calm my night turns, I did not cease to feel ... deceived ... although I knew that, in the specialty I had chosen, every patient admitted, was virtually a case closed ...¹²
Screened Example 1.a) Sunday Afternoon, from 0:00:00 to 0:01:33.
Scene 1 (Exterior - Twilight). Scene 2 (Hospital- Jorge's office - Night).



Figure 2. *Sunday Afternoon*. Still from Scene 2. Jorge (Ruy de Carvalho) and Lúcia (Isabel Ruth).

- 10 Art.º 13.º: “Para garantir a genuinidade do espectáculo cinematográfico nacional, não é permitida a exibição de filmes de fundo estrangeiros dobrados em língua portuguesa, salvo os produzidos em regime de reciprocidade, superiormente reconhecida.”
- 11 *Complement films* was a category referring to short movies (under 1800 meters) included in cinema programs and presented before the main film.
- 12 CENA 2 (Hospital - Gabinete de Jorge - Noite). JORGE (narração): Nessa mesma tarde tinha morrido a doente mais antiga da enfermaria. Estava grávida, e só pensava no filho que ia nascer o desfecho pudera prever-se logo de início com uma insignificante margem de erro. De qualquer forma, embora fosse uma solução cómoda, a aquietar os meus sobressaltos nocturnos, eu não deixava no fundo de me sentir... escarnecido... apesar de saber que, na especialidade que escolhera, cada doente, admitido, era virtualmente um caso arrumado. (...)

As the movie evolves, the voice-over fades away and is replaced gradually by the actual dialogues and ambient sounds. But at that moment, the spectator is already familiarized with Portuguese language sound.



Figure 3. Sunday Afternoon. Still from Scene 58, from 1:25:00 until final credits. Jorge (Ruy de Carvalho) and Lúcia (Isabel Ruth). Dialogue over Jorge's voice over. Note also the different setting regarding camera angle and setup. (cf. Figure 2)

In the end, the sound balance is reversed, as well as the events. One hears a bell crossfading from the end of scene 57 (Subsequence 2) as we move to Scene 58 in Jorge's office, hearing the train in the exterior, which constitutes the reverse order of events when compared to Scenes 1 and 2.

Screened Example 1.b) Sunday Afternoon, from 1:25:00 until end and final credits. Scene 58, Jorge's voice over superimposed over the dialogue of Lúcia and Jorge. Scene ends with train sound and whistle. Final credits with Sunday Afternoon theme, swing music from the discotheque.

SCENE 58 (Hospital - Jorge's Office - Night). Sound of Bells from end of Scene 57 ("Short film's Subsequence 2)

LUCIA (speaking on the telephone): Yes. Surely, as soon as I know anything, I'll let you know immediately.

JORGE (off-screen, voice-over fading away): "That same afternoon, the oldest patient in the infirmary had died. She was pregnant and only thought about the child to be born. The outcome could be predicted from the beginning with a negligible margin of error (...)

LUCIA (voice heard over the voice from JORGWE): It's this file to solve as soon as possible.

Jorge's voice over continues.

LUCIA: I was waiting for you: it's an emergency transfusion.

- 13 CENA 58 (Hospital - Gabinete de Jorge - Noite). (Ouve-se em fundo Repicar de Sinos do final da Cena 57 "Pequeno filme", Subsequência 2). LÚCIA (ao telefone): Sim. Com certeza. Assim que souber qualquer coisa comunico imediatamente. Sim. Com certeza. Pois... Boa noite. Sim... JORGE (narração, fora de campo): Nessa mesma tarde tinha morrido a doente mais antiga da enfermaria. Estava grávida e só pensava no filho que ia nascer o desfecho pudera prever-se logo de início com uma insignificante margem de erro. (...) LÚCIA (voz claramente ouvida acima da voz da narração de JORGE): É este caso por resolver já. JORGE (narração contínua) LÚCIA: Estava à sua espera: é uma transfusão de urgência. JORGE: Está bem. Eu já lá vou. (Narração de JORGE continua em fundo, apito de combóio). LÚCIA: Toma um café primeiro? JORGE: "Hei-de querer sim daqui a um bocado. (apito e som de combóio a passar) CRÉDITOS FINAIS Música: tema "Domingo à Tarde"

JORGE: Alright, I'll go there.
 (JORGE's voice off continues fading away, train whistle).
 LUCIA: Do you take a coffee first?
 JORGE: Yes, I'll want to.
 Whistle and sound of train passing.
 End credits: "Sunday Afternoon" Theme¹³

"The whistle of the train, which starts the film and the anguish of its protagonist, is here a metaphor of this pain of not being able to escape to death, and constitutes as sound image, as well as many more that occupy this universe and express feelings that cannot otherwise be transmitted. Thus, in this film, the material dimension gains more importance than that of oral narration or visual narrative."¹⁴ Areal 2011: 468-69

The music heard in the final credits (Figure 4) is the only music heard in the film, the theme Domingo à Tarde composed and performed by Quinteto Académico (musicians credited in the main end title: Daniel Alves Gouveia, piano; José Manuel Fonseca, sax; sax; Mário Assis Ferreira, guitar; Alexandre Barreto, bass; Fernando Mendes, drums). This music plays a specific role in the movie, as it is not background or incidental music.

0:56:08, it is music you expect to belong to the actual action, screen music or diegetic music and still it contributes to the mood of the scene.

As Macedo reports, he wanted the sax to play some strident sounds instead of a real melody to disrupt a well-formed environment. So, he directed the sax interventions. In my opinion, the interventions of the sax solo in stressed isolated notes, provide not only a disturbing mood for the night-club sequence, but through the morphology and spectral color content, it makes a clear link with the train whistles one hears all over the movie.



Figure 4. "Domingo à Tarde" Theme: opening bars (transcribed by A. Sousa Dias)

14 "O silvo do comboio, que inicia o filme e a angústia do seu protagonista, é aqui uma metáfora dessa dor de não se poder escapar à morte, e constitui-se como imagem sonora, assim como muitas mais que ocupam este universo e exprimem sentimentos que não podem doutro modo transmitir-se. É assim que, neste filme, a dimensão matéria ganha mais importância que a da narração oral ou a da narrativa visual."

Environment sound design

Regarding environmental sound, Macedo constructs soundscapes based loosely on sounds recorded in the hospital but gives them an aura of unreal place. As Areal states:

“The sound, worked on an autonomous plane, overlaps with the realistic description of everyday hospital life, its spaces, routines, laboratories, machines, treatments. Sounds - voices, mechanical noises, footsteps, voices, fragmented conversations of meaningful phrases - turn this reality into cries, silences and fears. Through sound, António Macedo creates a subconscious dimension, dreamlike and crude, almost surreal in the sensations that induces the viewer.” Areal 2011: 469¹⁵

Besides their complexity in track overlaps, the hospital environments articulate at least three clear layers: foreground, middle ground and background sounds. Normally present in the foreground are sounds that we may attribute to the characters, such as footsteps or other bodily sounds; in the background there are sounds, as well as their reverberation, of a distant continuous hum and rumble from “mysterious” machines or equipment; and in the middle ground we can find sounds that are more difficult to assign clearly, either to a foreground character or prop, or to a background noise as it emerges from the background. One example can be found in Scene 26, from 0:39:00 to 0:40:00 a clerk carries a female body through the corridors of the hospital, takes a service lift and transports the body to the morgue. The crackling sounds assigned to the hospital stretcher wheels are accompanied by sounds reminiscent of electronic music or the “menacing” sound of the service lift arrival.

Screened Example 2. Sunday Afternoon, from 0:39:00 to 0:40:00.

Scene 26. Example of sound environment ambience.



Figure 5. Sunday Afternoon. Still from Scene 26, from 0:39:00 to 0:40:00: sound environment ambient.

15 “O som, trabalhado num plano autónomo, sobrepõe-se à descrição realista do quotidiano hospitalar, seus espaços, rotinas, laboratórios, máquinas, tratamentos. Os sons — vozes, ruídos mecânicos, passos, vozearia, conversas fragmentadas de que se recortam frases significativas — transformam este real em gritos, silêncios e medos. Através do som, António Macedo cria uma dimensão subconsciente, onírica e crua, quase surreal nas sensações que induz no espectador.”

The “short film” inside the film

In *Sunday Afternoon*, Jorge and Lúcia go to the cinema to watch a movie, hence called “short film”. This “short film” assumes a particular role in the movie. This film appears three times in three subsequences that have continuity, although their order of appearance in the movie is changed. The manner in which Macedo gets the spectator acquainted with this movie and willing to “accept” its weirdness is fascinating and deserves some consideration.

“When *Sunday Afternoon* was released, this short film [evidently an aberrant little movie] made sensation, as some people thought that it was the excerpt from some famous Swedish or Polish director, a mistake reinforced by the fact that I had reversed the soundtrack of the dialogues, the actors becoming speakers Contrary-Portuguese, which looks like a sort of Ostrogoth dialect grafted on low-Scandinavian.”¹⁶

Macedo 2007: 7

In the first subsequence appearance, Scenes 6, 7 and 8, images of the movie are inserted between shots of the spectators really watching the movie on screen. These initial shots act as establishing shots: this is a movie screened on a movie theatre (Figure 6).



Figure 6. *Sunday Afternoon*. Still from Scene 6. Short film inside the film, Subsequence 1, from 0:10:07 to 0:13:10: Screenshot: establishing shot. Jorge and Lúcia in the cinema, Priest (Frederico Berna) and Vicar (Gomes de Sousa) in the “short film”.

The initial scenes we see are taken from a mass, something well known for Portuguese at that time. So, the words heard are from the communion: the Priest is repeating “Corpus Christi”. These are the only words you hear but they contribute to the general setup which provides a ground for plausibility: a movie seen on a movie theatre, the plot eventually related to religion as we watch a mass, the words in Latin, a dead language, familiar for the average spectator.

16 “Quando saiu o Domingo à Tarde esse pequeno filme [pequeno filme manifestamente aberrante] fez sensação, houve quem pensasse que se tratava do excerto de algum famoso realizador sueco ou polaco, equívoco reforçado pelo facto de eu ter posto a banda de som dos diálogos em sentido inverso, donde resultou ficarem os actores a falar em «português-ao-contrário», que parece mesmo uma espécie de dialecto ostrogotho enxertado em baixo-escandinavo.”



Figure 7. Sunday Afternoon. Still from Scene 32. Short film inside the film's Subsequence 3, from 0:44:43 to 0:46:00: Screenshot: dialogue between the Impostor (Serge Farkas) and the Old Woman in the Pitt (Constança Navarro).

Screened Example 3. Sunday Afternoon, from 0:44:43 to 0:46:00.

Scene 32, "short film" Subsequence 3. Example of sound editing to create foreigner origin feeling.

In Scene 32, the Subsequence 3, it starts with the voice-over from Jorge, and only after, starts a dialogue, sound in a foreigner language as the characters' voices are heard in reverse (Figure 7).

Scene 32:

JORGE (off screen, voice over): (...) I remember perfectly this scene and it is relatively easy to evoke it in all its details. "

IMPOSTOR: It's brackish water!

OLD WOMAN: It's the only we have.

IMPOSTOR: It causes all sorts of diseases and deadly fevers, such as madness, oblivion and typhoid fever.

OLD WOMAN: Maybe that's why we're so few here!

IMPOSTOR: Are there many children?

OLD WOMAN: There are less and less ... since the water started to look like this.

IMPOSTOR: It's a long way, but you could pick you up at the well behind the parish. It is a light and pure water.

OLD WOMAN: And you're sure it did not get bratty as soon as we started using it? (...)17

The synchronization respects voices character and word rhythms and because of the incomprehensibility of the "spoken language", Subsequence 2, and 3, later on, are mandatory subtitled.

17 CENA 32. JORGE (voice-over, narração): (...) Lembro-me perfeitamente desta cena, e é-me relativamente fácil evocá-la em todos os seus detalhes. IMPOSTOR: É água salobra! VELHA: É a única que há. IMPOSTOR: Provoca toda a espécie de moléstias e de febres mortais, como a loucura, o esquecimento e a febre tifoide. VELHA: Talvez seja por isso que somos tão poucos, por aqui! IMPOSTOR: Há muitas crianças? VELHA: Isso há cada vez menos... desde que a água começou a ficar assim. IMPOSTOR: É um bocado longe, mas podiam ir buscá-la ao poço que fica atrás da paróquia. uma água leve e pura. Plano aproximado da Velha: VELHA: E tem a certeza que não ficava salobra, logo que começássemos a usá-la?

As a final remark on this “short film”, one must notice that in the original novel we don’t know what film Jorge and Lúcia actually watched. I believe this also represents a subversive note from Macedo as its thematic could be very controversial in the Portugal of the sixties: the passage of the Devil (the Impostor) corrupting the world through the same church that should prevent it. In any case its setup also represents an element that contributes to the “fantastic realism” present in Macedo’s work.

A final note

Along these lines I tried to show the importance of sound in Macedo’s film conception. The case of *Sunday Afternoon* represents a clear example. Areal summarizes it, stating

“one of the dominant narrative devices throughout the film: an extremely elaborate sound design to create gaps between what we see and hear. Sometimes it is the external noises that impose themselves excessively, translating a subjectivized point of view into a character, sometimes they are muffled by others, that select portions of the environment, or even by inner voices (the story of the narrator, for example) or just silences becoming interior silences. There is an overlap of different layers - several sound layers, successive visual layers, subjective layers and objectives, time layers, reality layers (a film within the film) -which, succeeding and disappearing, create sensations of mismatching and defining the atmosphere of the film. This climate, created in terms of expression, also comes, at diegetic level, from the main scenario - the hospital, which is not hospitable, totally inhospitable - and the scenes that take place in it.”¹⁸ Areal 2011: 466

Macedo’s contribution to sound and considerations on cinema sound studies deserve to be deepened. His views on sound remain rather actual, which provides another differentiation factor from movie directors of his generation. As he states,

“I wish I had been more helpful and to be more helpful, but the environment doesn’t allow that.”¹⁹ Bénard & Mozos 2012: 75

May we contribute now to realize this wish from António de Macedo.

Biographic Note

António de Sousa Dias (Lisbon, 1959). Composer, multimedia artist and researcher Antonio de Sousa Dias holds a Ph.D. in Aesthetics, Sciences and Technologies of the Arts - Music (Paris 8). He graduated in Composition and divides his work between creation, research and teaching. An associate Professor at the Faculty of Fine Arts of the University of Lisbon, he also composed music for films, documentaries and animation, as well as for works exploring various formations and genres. Performance and musical theatre also play an important role in his work. His research work in the field of musical creation and virtual environments lead him to the areas of multimedia, installation and visual creation.

18 “um dos dispositivos narrativos dominante ao longo do filme: uma sonoplastia extremamente elaborada de modo a criar desfasamentos entre o que vemos e ouvimos. Ora são os ruídos exteriores que se impõem excessivamente, traduzindo um ponto de vista subjectivado numa personagem, ora eles são abafados por outros, que seleccionam parcelas do ambiente, ou ainda por vozes interiores (o relato do narrador, por exemplo) ou tão só silêncios tornados interiores. Há uma sobreposição de diferentes planos — planos sonoros diversos, planos visuais sucessivos, planos subjectivos e objectivos, planos temporais, planos de realidade (um filme dentro do filme) — que, sucedendo-se e desfasando-se, criam as sensações de desajuste e de clausura definidoras da atmosfera do filme. Este clima, assim criado a nível da expressão, advém também, a nível diegético, do cenário principal — o hospital, nada hospitaleiro, em tudo inóspito — e das cenas que nele têm lugar.”

19 “Gostaria de ter sido mais útil e de ser mais útil, mas o ambiente não deixa.”

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Seeing with One's Own Ears: Soundtrack as Interface for Theatre

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Much has been written about the primacy of the visual in modern culture. Theatre is similar to numerous other art forms in that it is heavily reliant on visual information, for instance to convey narrative, scene and context. However, this reliance on visual information can present significant access challenges for blind and visually impaired people. Audio description for theatre attempts to increase the accessibility of performances by translating the visual elements of a performance into a spoken commentary that fits between on-stage dialogue. It is now relatively well established in the United Kingdom, but has been little tested empirically, and raises a number of human and technological issues.

In this paper we describe our exploration of an ambiently diffused soundtrack as an alternative to audio description for theatre. Drawing on the theoretical basis provided by Chion and Deutsch, the soundtrack is an artificial assemblage of literal (i.e. informative) and non-literal (e.g. emotive) sounds that cumulatively acts as a kind of “interface” to the performance (i.e. a way in). Similar to audio description, the soundtrack attempts to supplement or replace ‘lost’ visual

information. However, it does not present or imply a rigid interpretation, and meaning is left open to the individual. The soundtrack also provides the same auditory information to all and thus offers a far more unified audience experience: it does not require some audience members to adopt specialised and potentially othering equipment.

Using *Bert*, a play by Dave Pitt, as a testbed for the soundtrack model, we describe the initial findings and audience feedback from two March 2017 performances at the Arena Theatre, Wolverhampton (UK), for an audience of 25 blind and visually impaired people. Informed by these findings and our experiences as composer/producer and director/theatre manager respectively, we discuss some possible implications of the soundtrack model. Finally, we outline some possibilities for future work. These include the creation of props with integrated and locally diffused sound effects, the use of virtual reality and supplementary haptic feedback to create a more accessible touch tour, and fuller consideration of the performance space in light of sometimes complex audience needs.

Keywords: soundtrack, interface, Chion, visual impairment, audio description.

Introduction

The barriers to participation faced by people with disabilities are often considered in terms of the medical model of disability or the social model of disability. The medical model is rooted in linear notions of restoration to “normality” (Fisher and Goodley, 2007) and its primary concern is the condition rather than the person. The social model of disability was a direct response to the medical model (Shakespeare, in Davis, 2017, p.196) and situates disability in the broader environment. It asserts that the main barrier for disabled people is not disability itself, but the failure of society to act appropriately (Lang, 2007).

Sensory impairments are amongst the most common types of disability, and there are more than two million blind and visually impaired people in the UK alone. All ages are affected but older people disproportionately so (RNIB, 2017). If theatre was initially vococentric (and therefore primarily aural), since 1800 it has relied increasingly on the visual to convey narrative and to set context and scene (Dalglish and Reading, 2017; Bratton, 2014; Baugh, 2014, p. 20). However, this visual-centricity can be problematic for visually impaired people: it can compromise their experience, or exclude them entirely.

Audio Description for Theatre

The notion of assistive technology (Ladner, in Oishi et al., 2010, pp. 25-26) has become closely aligned with the social model of disability. For instance, technology is seen to dissolve barriers related to social interaction (Kerr et al., 2002) and increase independence (Berry and Ignash, 2003).

To date, the most widely adopted attempts to make theatre accessible for blind and visually impaired audiences relate to audio description (AD); the provision of which has been a legal requirement in the UK since 1996 (Fryer, 2016, p.14). AD for theatre usually consists of three complimentary elements (Fryer, 2016, p.37):

- touch tour;
- pre-recorded notes;
- audio-described performance.

The touch tour takes place around an hour before the performance. It provides opportunity to access the stage in order to explore its dimensions and layout, and handle tactile objects such as costumes, props and furniture.

Playback of pre-recorded performance notes occurs shortly before the performance starts. This provides service users with background information but also opportunity to test the operation of equipment.

The description of a performance may be partially planned and rehearsed in advance but is delivered live so as to respond to performance nuance. A major constraint is that description must fit into the gaps between on-stage dialogue (Holland, in Díaz and G. Anderman, 2009, p.170). The description is then transmitted wirelessly to user headsets.

While four out of ten theatres have recently offered at least one audio-described performance (Cock, 2016), Fryer (2013) notes that AD for theatre has rarely been tested. In addition to the cost of equipment, describers and technical support, there are also issues of (Dalglish and Reading, 2017): describer objectivity limiting opportunities for alternative interpretation; the need to fit between gaps in dialogue restricting the amount of detail that can be provided; the shifting of attention from on-stage to in-ear hindering immersion; the “othering” effect of AD technologies.

Alternatives to AD for Theatre

There is a substantial body of prior work directly and indirectly relevant to this paper. For instance, the use of a simple sound effect in Eugene Walter's 1922 radio drama *The Wolf* substantially predates recorded film sound (Dibbets, in Nowell-Smith, 1996, pp.211-219; Hillard and Keith, 2010, p.31). While the popularity of radio drama has declined since its 1930s heyday (Stanton and Banham, 1996, p.302), the form continues today, for example on BBC radio in the UK.

Clearly influenced by radio drama, Fuel Theatre's *Fiction* (Rosenberg and Neath, 2016) is a touring production described as a "surreal, immersive experience taking place in total darkness." Most sound (dialogue, music and some sound effects) is binaural and played through headphones, but the house Public Address system and visual projections provide additional ambience and effects. At a larger scale, Complicite's *The Encounter* also employs binaural audio to build the world of a photographer lost in the Amazon rainforest (Fry, 2015).

Less directly related but notable is the Enhancing Audio Description (EAD) project by Mariana López and colleagues (2016). The EAD project explores how sound design can improve the experience of film and television for visually impaired people. In particular, they aim to transform provision of audio-described soundtracks "from a compliance exercise into an intrinsic part of the creative process."

Other efforts have expanded beyond the auditory modality. For instance, the use of haptics to augment audio description is explored by audio describer Louise Fryer (2013). A related device is the Animotus developed by Adam Spiers et al. (2015). This handheld object uses vibration motors to provide navigational cues, and has been incorporated into a site-specific performance of *Flatland*. However, the use of haptics to convey visual information has its roots in the concept of sensory substitution proposed by neuroscientist Paul Bach-y-Rita in the late 1960s. In order to test the concept, Bach-y-Rita et al. (1969) created a device that translated a live camera feed into haptic information on the back of a seated user.

Soundtrack as Interface for Theatre

The needs of visually impaired audiences and the limitations of AD for theatre have led us to explore alternative types of interface. There are numerous definitions of "interface", but the definition of an interface proposed by Bert Bongers (2006) – as a line that spans two domains and joins them together – is most appropriate here.

Sound is only comparatively rarely employed as a primary interface: usually in an informational capacity such as sonification or auditory icons. While these techniques are a poor fit for a theatre context that has prominent affective and emotive dimensions, the broader properties of sound (and ambiently diffused sound in particular) are pertinent. These include the ability to fill space and envelope an audience, communicate multiple messages or types of message simultaneously, support multiple levels of attention, and fine spatial and temporal resolution.

These properties are integral to the film soundtrack. Although "sound film" did not arrive until the 1920s, the subsequent development of the soundtrack transpired relatively quickly. If initially a series of separate sound elements, Rick Altman (in Buhler et al., 2000, p.341) notes that by the mid-1930s, the soundtrack had become a multi-dimensional construct "capable of carrying and communicating several different messages simultaneously."

Related to this, Stephen Deutsch (2007) contends that "a soundtrack comprises of two different (but not mutually exclusive) elements: literal sounds and emotive sounds." Literal sounds are informational and help to convey physical properties and causality. They are key to the

believability of the audio-visual relationship. Emotive sounds are more subjective and help to influence the mood of a scene.

A more extensive categorisation of film sound is provided by composer-theorist Michel Chion, who makes distinctions between diegetic and non-diegetic sound, and between empathetic music and anempathetic music (Chion et al., 1994, p.29). Diegetic sound emanates or is implied to emanate from the story world of a film. Examples are typically sound effects, but can also include music. Non-diegetic sound is where the sound source is neither present nor implied in the film-world. Examples usually relate to voiceovers and narration. There can also be crossover between diegetic and non-diegetic sound (Hunter, 2009). Empathetic and anempathetic music relate to two ways music and sound effects evoke emotions in film (Chion et al., 1994, p.13). Empathetic music and sound effects actively participate in the mood and emotion of a scene. Conversely, anempathetic music and sound effects are indifferent to the pace of the scene. Nevertheless, by contrasting with the visual, their juxtaposition can intensify emotion.

For Chion, sounds facilitate three different modes of listening: causal, semantic and reduced (Chion et al., 1994, p.25). Causal listening gathers information about the sound source and can enhance information available from vision when causes are visible or provide the principal source of information when the cause is not seen. It is common but also easily tricked. Semantic listening interprets codes, usually relating to language. Reduced listening (Chion et al., 1994, p.29) is focussed on the properties of sounds themselves, rather than their cause, source or their meaning.

Chion subsequently outlines additional subcategories of film sound: ambient sound, internal sound and on-the-air sound. Ambient sound relates to sound that envelops and inhabits a scene. The source of ambient sound is identifiable but not seen. Ambient sound is closely related to territory sound that helps to identify a specific location (Chion et al., 1994, p. 75). Ambient sound and territory sound are particularly relevant to the theatre context as their ability to delineate the identity and character of a place offers a potential equivalent to how AD for theatre conveys information about site and setting. Moreover, ambient sound can be layered and is able to support varied approaches. For instance, literal, site-specific information can be provided, but also fuzzier atmospheres (Eno, 1978), or more speculative imaginary environments (Chattopadhyay, 2017).

The relationship between ambient sound and attention is also relevant, particularly Brian Eno's (1978) concept of Ambient Music as "able to accommodate many levels of listening attention without enforcing one in particular; it must be as ignorable as it is interesting." This potential for "disappearance" is important as, for the most part, film sound should influence or "complete" the image, but not be "noticed" itself (Dima, 2017, p. 139). If, then, more extreme use of sound to capture audience attention at important moments may appear contradictory, it is also notable that their power is rooted in their contrast with silence.

Related ideas are present in the notion of calm technology developed by Mark Weiser and John Seely Brown (1995) in response to the information overload of the Personal Computer era. In particular, they describe an attentional periphery that "we are attuned to without attending to explicitly" but "could come quickly to attend to it" if anything unusual is noticed.

Theory into Practice

The properties of ambiently-diffused sound are appealing from the perspective of an interface for theatre: it is able to carry different types of information, be simultaneously informative and emotive, grounding and evocative. There are also potential benefits to immersion that come from a single, unified sound space, and the ready availability and familiarity of equipment may

reduce cost and setup time. To start to test the viability of the soundtrack as an alternative to audio description, an evaluation study was carried out. This had three elements:

- the creation of a soundtrack for Bert, a semi-autobiographical play by writer and comedian Dave Pitt;
- two performances of Bert for visually impaired audiences;
- group interviews held immediately after each performance.

The soundtrack was conceived as a series of linked ambient sound spaces that outline the environments described in the script. These atmospheres are initially literal and largely descriptive (i.e. causal); and therefore essentially disappear as sound and image appear to exist “naturally” as one. However, they slowly transform into more emotive and ultimately fantastical sound spaces that imply a drift towards a more ambiguous domain.



Figure 1. The set for the 3rd March 2017 performances of Bert.

The set for the performance is simplified to create a bold and easily readable visual outline (Fig. 1): all scenes therefore make extended use of Foley to convey what might ordinarily be visual details. To enhance the sense of three-dimensionality, Foley sounds were captured from multiple perspectives then assembled into multi-faceted objects panned around the sound field. The intention is for the sonic environment to unfold around the audience; in the periphery as well as the centre.

Two performances of Bert were held on 3rd March 2017 at the Arena Theatre in Wolverhampton. 13 participants attended the first performance and 12 attended the second performance. These include 14 men and 11 women, aged between 35 and 81 years. All self-reported as blind or visually impaired. 16 participants were accompanied by a companion who did not participate in the study.

An accredited audio describer attended rehearsals and described both performances. All participants had the opportunity to participate a touch tour half an hour before their performance started. The performances lasted 40 minutes and were structured so that participants could experience both AD for theatre and the new soundtrack. The first half of performance one and the second half of performance two featured the ambiently diffused soundtrack only. The second half of performance one and the first half of performance two featured audio description only. Both the audio description and the soundtrack used the theatre's usual systems: a wireless AD system and a six-channel (5.1) sound system respectively.

At the end of each performance participants were interviewed in a group by an experienced facilitator. The interview questions aimed to discover participants' prior experiences of theatre, and their experiences of the performance specifically.

Conclusions and Future Work

There is only scope in this paper to summarise participant responses: more details can be found in other work by the authors (Dalglish and Reading, 2017). We were nevertheless particularly surprised that only three participants described themselves as frequent or occasional theatre-goers, and only two participants had previously used an AD for theatre service: all other participants reported very little (less than occasional) or no previous experience of theatre.

Participants complimented the quality and content of the audio description, but more than a third made comments around the perceived or actual operation of the AD for theatre equipment. For instance, one participant noted that “it took ten minutes of the play for me to be sure that all of the description was coming through”, while another mentioned an echo in the description feed. The soundtrack was also positively received. However, the language used to describe the experience of the soundtrack was noticeably more emotive: one participant commented that the soundtrack was “eerie” and another described it as “atmospheric.” The latter participant also noted that “It made the experience more colourful.” Overall, nine participants expressed a preference for audio description, nine participants expressed a preference for the soundtrack, six participants had no clear preference, and one participant provided no answer. Interestingly, one participant commented that “the ideal would be a combination of audio description and soundtrack.”

Participants did not comment about any spatial aspects of the soundtrack, and thus these many need to be made more explicit. For example, small loudspeakers could be integrated into props in order to create localised points of sound that appear to emanate from specific locations on stage.

Also unexpected was that all participants chose not to participate in a touch tour. Further investigation started to reveal the issues involved. Nine participants commented that they used the time before the performance to chat to friends, or enjoy a drink. Moreover, ten participants commented that they had a mobility difficulty concurrent to their visual impairment, and that they avoided the touch tour for fear of needing to stand or move around for an extended period. While multiple disabilities are relatively common, their consequences are not often considered in terms of theatre access. We therefore believe this to be a productive direction for future work. In particular, the qualities of the architectural space that houses the performance will be more fully considered (and considered from multiple perspectives), and a combination of virtual reality and haptic feedback will be explored as a way to create a more accessible and engaging touch tour.

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Sonic landscapes, visual environments

Interaction and synchronicity in composition and live performance

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Combined creative workflow in audiovisual performance implies the design of a system which allows for interactivity and reactivity on the sonic and visual fields. An internal logic, language or code must be created and implemented in order

to develop performative pieces that allow for live interaction of the artist, and a live connection and relationship between both worlds: the visual and the sonic.

Keywords: Synchrony, Audiovisual Performance, Synchronicity, Live, Composition.

Introduction

Audiovisual sync has been a concern since the early beginnings of technological art. The work in two separate realms, the visual space and the sonic world, can coexist in different formats and proposals. This coexistence establishes technical difficulties, but mainly opens questions on meaning, narrative, semiotic and linguistic phenomena and pragmatic problems on the mechanics of performance and interface.

The simultaneity of visual and sound elements establishes always a relationship between both media contents, even if it's an undesired one, as the theories on cinema montage have established. Sounds over an image modify it's content, and images on sound or music alter it's meaning as well.

Synchronicity

Synchronicity is defined as a non-causal connecting principle. The phenomenon of synchronicity implies the occurrence of two events at the same time that are somehow related but not in terms of cause and effect. It is related to Jung's theories of a common psychic field that connects everything in the world. When confronted to two separated events that seem to be generated by unconnected facts, we tend to find a meaningful parallelism.

“Jung's understanding of the I Ching was tied to his idea of 'synchronicity,' or the occurrence of two events that are somehow related but not in terms of cause and effect. He also referred to this notion as an 'acausal connecting principle' or 'meaningful parallelism.' Synchronicity is not just random coincidence; rather, it is a phenomenon that expresses both in the mind and in the outer world, in a way that reveals a meaningful but not causal tie between these expressions”

Dennis McKenna (1)

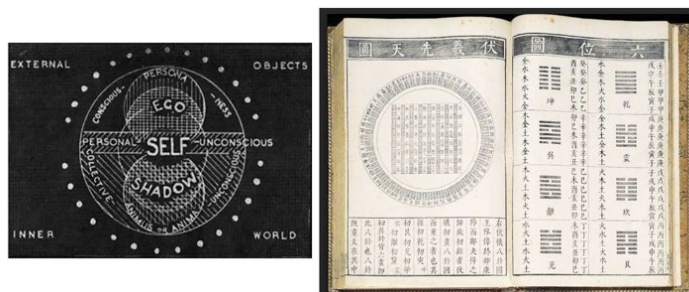


Fig. 1 Jung's concept of synchronicity and the I-ching

The human mind is good at finding patterns, and it tends to establish relationships of cause and effect on any events that happen simultaneously. Visual and sonic events can be connected in this way to establish a personal creative code or language that takes advantage of associations and connotations formed by the juxtaposition of differentiated elements in both perceptive fields.

Synaesthesia

The idea of synaesthesia is often associated with this kind of connections between the visual and the sonic in the audiovisual arts. We can understand this relationship in a metaphorical way, as an immersive condition in which we connect images and sound in a perceptual whole. Synaesthesia is in fact a physical condition only present in some individuals, characterized by

a cross functioning of the senses. Sound is perceived as colors, or some images trigger music tones. It is not something that can be induced in individuals not affected by this particular physical anomaly (without psychedelic drugs), so the term is usually used too lightheartedly. It sounds suggestive, and can be understood only in a metaphorical way in this context.

Synaesthesia may be used as an inspirational form, for artists trying to get similar reactions from humans not affected by this condition, but we must be aware we are not dealing with the real physical condition, but with an artistic approximation to it's symptoms.

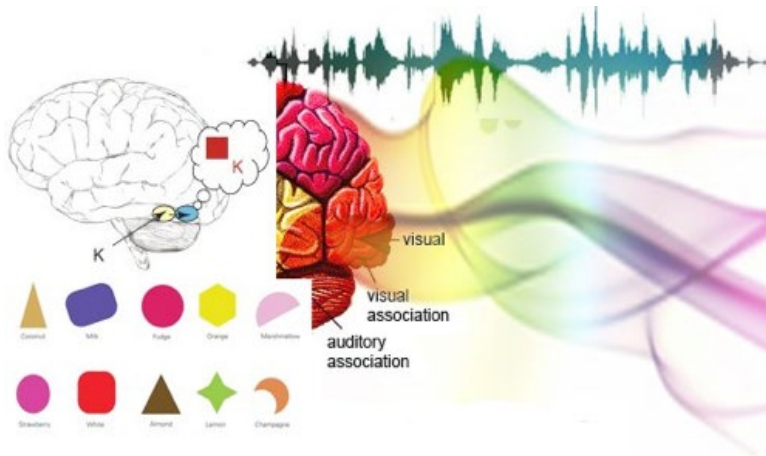


Fig. 02. Synaesthesia

AV performance: aesthetics

This relationship between visual and sonic layers can emerge from contrast, affinity, formal similarities, cause-effect relationship or any other connection between it's elements. In audiovisual performance artists tend to establish associative dialogues, subtle plays between both media, constructing a whole from different sets of materials.

As VJ works mainly tries to enrich the music with fancy visuals, Live Cinema and Audiovisual Performance create poetical worlds, intertwining images and sound in a complex sensorial experience. From the fields of New Media Art emerges an exploration on the essence of digital data, with transcoding practices that create visual and sonic layers as a direct translation of raw data. Artists work on associative narrative, derivative immersive assemblages or digital artifacts as strategies for dealing with this confrontation of visuals and sound.

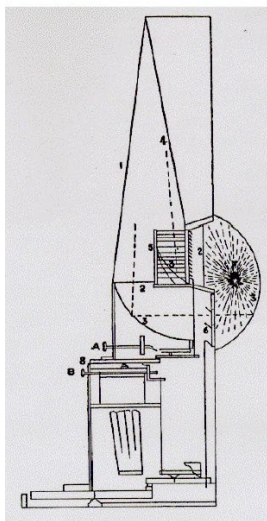
History

We can trace this subject into the idea of total art work (Gesamtekunstwerk), the first visual organs, the Bauhaus and other avantgarde experiments, the liquid light projections of the psychedelic era, total art and environments in the 70s, to get to digital technology and the invention of the digital projector.

Color organs, in development since the 17h century, allowed for a live performance using a keyboard in order to control the colors, shapes and images formed on a surface. Ingenious methods were used, combining mechanical and optical systems. We can trace it's origins to the early eighteen century, with Bertrand Castel's "Clavecin pour les yeux" (1725), Bainbridge Bishop's "Color Organ" (1877) or Rimington's "Clavier à lumières" (1893).



Fig. 03 Bertrand Castel's "Clavecin pour les yeux" (1725).



1. Ground glass tablet.
2. Ground glasses to diffuse light.
3. Reflectors.
4. White screen.
5. Upper sash.
6. Lower sash.
7. Electric light.
8. Keyboard.
- A. Color-stop for keyboard.
- B. Color-stop for pedals.

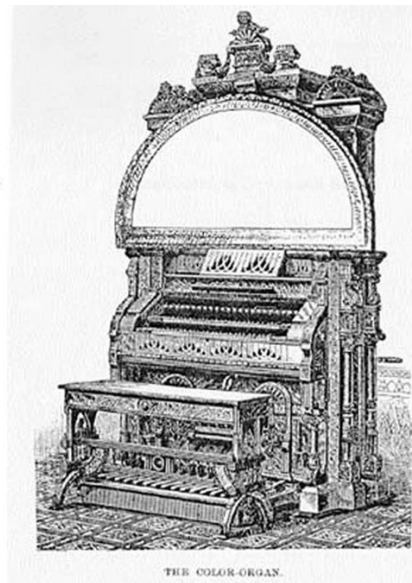


Fig. 04 Bainbridge Bishop's "Color Organ" (1877)

Alexander Scriabin developed a theory that related colors to sound. His work "Prometheus: The Poem of Fire" (1910) was composed with a part for "clavier à lumières", an organ color played with a conventional keyboard that projected the colors related to the music. Scriabin's code established a direct relationship between notes and colors, based on Newton's circle.

Other inventions worth mentioning: Thomas Wilfred's Clavilux (1920), the Italian Futurists Arnaldo Ginna and Bruno Corra "color organ" projection (1909), Vladimir Baranoff Rossin's Optophonic Piano (1916), Mary Hallock-Greenewalt's Sarabet (1918) and Arthur C. Vinageras "Chromopiano".



Fig. 05 Alexander Scriabin. "Prometheus: The Poem of Fire" (1910)

Scriabin's Key-Colour Scheme

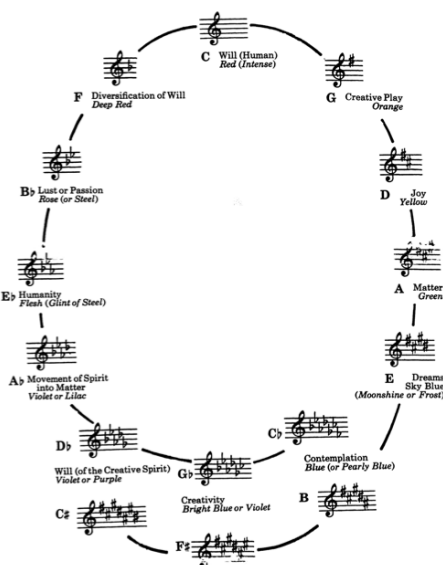


Fig. 06 Thomas Wilfred's "Clavilux"

Apart from this attempts to build a performative instrument with light and color for live acts, a different line of work focused on cinema as a new medium. Cinema appeared as a new kind of live show, although it's material was previously recorded. Artists felt attracted to the new invention, a medium capable of projecting light, mute first but then also with sound.

Special mention should be due to the work of Oskar Fischinger, Ellen Butte and Norman McLaren, who worked in the early 20th century on the relationship of image and sound in the revolutionary medium of film. This new technology allowed image and sound to be recorded on the same celluloid strip, with precise synchronization between both fields. These revolutionary creators worked on the relationship between sound and image in such innovative pieces as "The dance of colors", "Synchromy" and "Color rhapsody". Oskar Fischinger designed and built the "Lumigraph", a device that produced abstract color imagery. It was used in several concerts. He worked on the first abstract animation movies with an important impact on Hollywood film industry, like his contribution to Walt Disney's Fantasia.

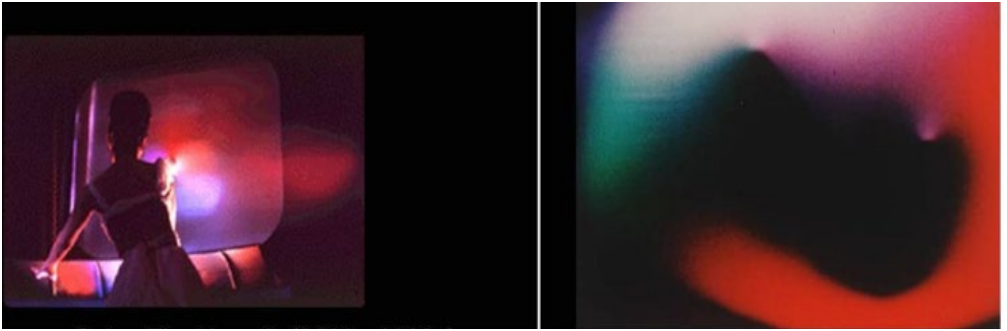


Fig. 07 Oskar Fischinger's "Lumigraph"

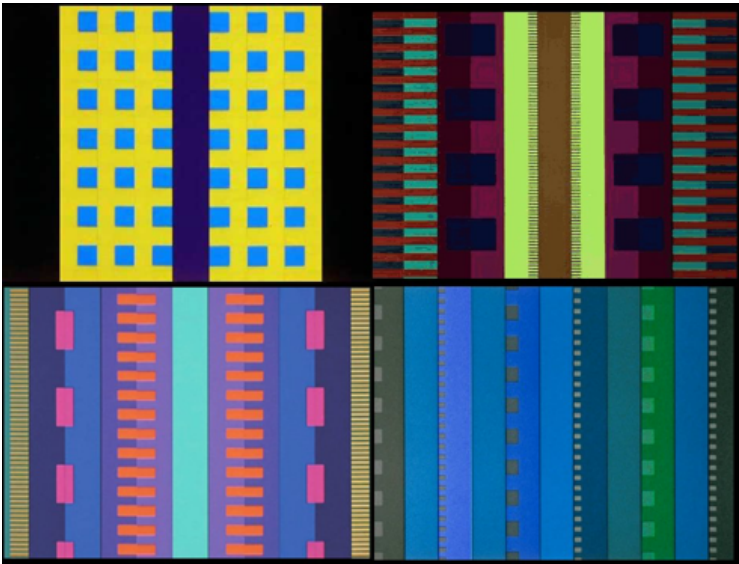


Fig. 08 Norman McLaren's "Synchrony"

Norman McLaren worked on new experimental techniques for animation, including scratching and painting the film stock itself. He also began drawing or scratching directly onto the optical soundtrack area of the film, and later he developed a system of cards with patterns on them which he photographed directly onto the soundtrack area. "Synchrony" and "Mosaic" are two striking examples of this way of making music. (2)

Many other experimental animators explored the field of abstract imagery, color, motion and their relationship to sound in film. The work of these experimental film makers allowed for explorations on synchronicity of media, but lacked interactivity, as all the content had to be pre-recorded on film. It allowed for studies on rhythm, color and shape relationships to musical content.

The liquid light shows of the psychedelic era focused on rich abstract imagery projected in real time on stage. The artists worked with different substances and materials, combining water, oil and alcohol mixtures with dyes and colorants. Heat, rotation or other physical movements contributed to the ever changing images created in realtime. Some projects involved a team of many members, with lamps, projectors, big planks and a really complex setups, as in the case of The Joshua Light Show.

Video recorders and the first video projectors incorporated the electronic image on stage projections, but real time processing was quite limited, mainly constricted to the operations possible on a video mixer and its primitive effects.



Fig. 09 Mary Ellen Bute



Fig. 10 Liquid light shows

Digital technology, slowly, brought us the capability to generate, play and project images that can be altered in real time with ease and increasing power. The video-jockey (VJ) can create rich live shows accompanying concerts or DJ sets, with many visual resources that drink directly in the early pioneers and their abstract imagery. Digital adds reactivity, real time processing and an unlimited source of content to be processed.



Fig. 11 Laurie Anderson

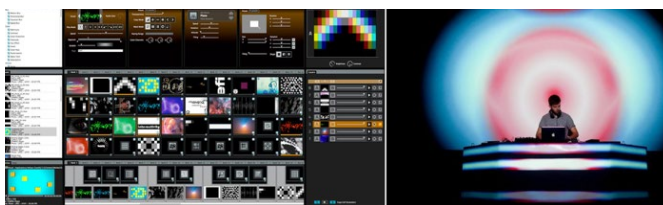


Fig. 12 VJ

The digital projector allows for the projection of content that can be modified in real time, according to the development of the action on stage. The artist/performer can interact with the system to play and alter the images in real time. Generative software is the perfect companion for this kind of sets, giving birth to the new autonomous practices of Audiovisual Performance.



Fig. 13 Mesa di voce

Programming environments designed for artists allow them to build complex machines, or systems custom designed for live performing. From a composer point of view, the challenge lies in the methods and rules needed for this double field composition. Algorithmic systems may soften the burden on the composer, sometimes taking too much control on the final work.



Fig. 14 Alva Noto

Notation – Visual scores

Visual scores have played a big role in the 20th century, establishing connections between the visual and the audible. The possibility of direct representation of sound and musical form represents a mythical goal for contemporary creations. Different tendencies have evolved around this problem, from direct coded systems to free strategies for open improvisation.

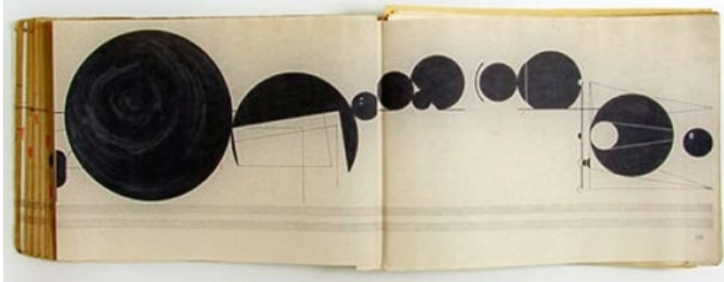


Fig. 15 Cornelius Cardew "Treatise".

Technical direct representations are possible, as image sonifications, but artists have been trying to establish other kinds of dual form languages that allows them to compose and perform works that combine both media.



Fig. 16 Kandinsky

How do you play a Kandinsky?

Kandinsky worked on the relationship between color, shape and sound. In his writings he established direct relationships between them, as “an acute angle is blue”, for instance. But any abstract drawing or painting can be used as a kind of visual score, and many 20th century composers worked on this field, as was compiled (and criticized) in John Cage’s book “Notations”.

The problem that arises when trying to play a painting as a kind of visual score is that of path following, establishing the order of events and the possible directions. Conventional score

systems establish a linear lecture, from left to right, as in occidental writing. A painting allows for free flow around it's shapes and structure, so there's no right way to play it, every reading is going to be subjective. It is true perceptive studies (Gombrich, Arnheim...) have found dominant behaviours when "reading" an image, and a well formed painting allows for fluid visual drifting along lines, contours and paths along the surface. Shapes appear as gliding elements that the eyes can follow, leading from one meaningful element to the other. This ordered lectures could establish a kind of dominant way of reading a picture, but even son these paths would never be identical, but variations on a procedure.

Free form visual scores can be used as generative material, intended for the emergence of new musical ideas and performative gestures, but they can't code a piece of music intended for future repetition.

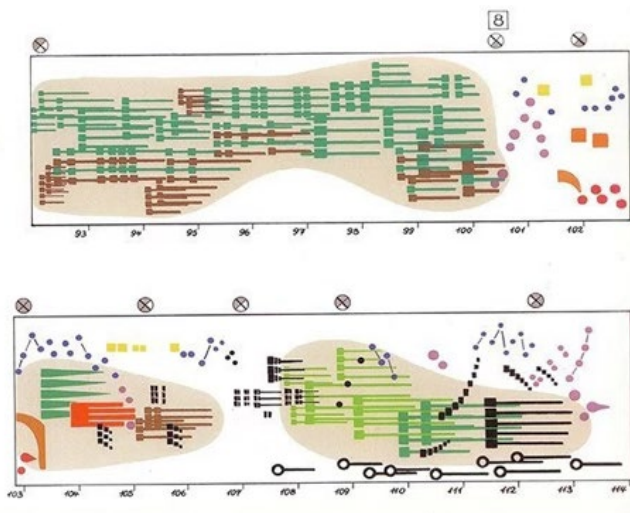


Fig. 17 Graphic score: Ligeti's "Artikulation".

Sync: Technology

Sync between audio and visual requires special software and communication protocols. Most artists use separate programs for each medium, so a network is needed for sending messages between both domains. Protocols can be established with personalized messages, establishing a basic form of communication between the audio elements and the visual system.

From one machine to another, MIDI is still a powerful and simple option. Midi notes can trigger events and midi control messages as as continuous parameters. Hardware MIDI controllers can be very useful as physical controllers sending data to both media.

Internal MIDI drivers create virtual MIDI ports, allowing for communication between separated programs. This allows for two different programs being used in tandem, the audio soft sending signals to the video soft, or the other way around. In this way we don't need a program capable of everything, we can opt for two independent programs, specialized in its field.

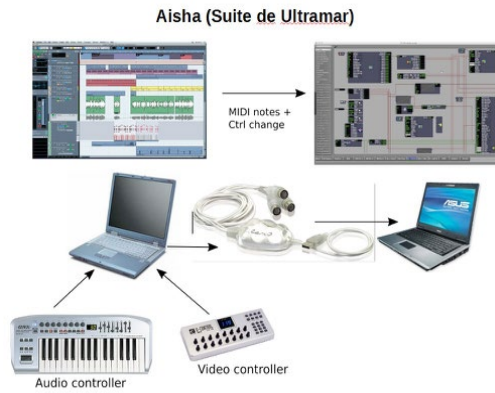


Fig. 18 MIDI set with two computers

The OSC protocol is particularly useful for the creation of combined audiovisual systems, as it allows for total freedom in the naming of signals and events. We don't have to use a "note" or a "controller" to change an image or sound, we can define our own set of actions and modifiers, with precise or poetic names for the information shared between sound and image (and viceversa).

The DMX protocol can expand these systems by sending messages to professional lightning rigs, creating coloured light environments that can be integrated with image projections and sound, getting closer to the idea of total art work, by creating complex environments where space and human experience are shaped by light and sound.



Fig. 19 La Monte Young & Marian Zazeela's "Dream House"

In the pursue of a personal protocol, we can use onomatopoeic words, descriptive terms, sensations, or simple classificatory systems... as in:

- tik,tok, klik sshh, bob, puk...
- smoth, intense, aggressive, dark..
- melancholic, joy, somber...
- jump, glide, flow, stop...
- a,b,c... a1,a2,a3...

We can build any subjective relationship between audio and visual fields, by contrast, similitude, connotation, etc. Some possible relationships have been proposed as in this article from Ableton's live team (3):

A direct visual representation of the music – via waveforms, timed responses, shapes or colors tied to particular sound

- immersive environments
- mesmerizing visual patterns
- highlight aspects of a particular space.
- Narrative/World Building
- imaginative speculation
- music is already built around a particular narrative
- the visuals create their own story
- parallel narratives
- spectacle is effective
- experimentation / try something new

From direct sonification to associative narrative, we can create a system that produces experiences and meaning with the contraposition of image and sound. Different strategies can be applied in order to play with meaning, narrative and immersive experience. Digital technology allows for the creation of complex audiovisual performative systems that explore this relationships.

My performative sets

In my work since 2000, I've been exploring this field, building systems and composing different sets for live performance. Some of this works will be analyzed and dissected, searching for it's motivations, technical solutions employed, problems and findings, and it's aesthetic output.

Working sometimes as a musician, sometimes as a visual artist, I decided to combine both activities around 1999. I started building my own systems, trying different combinations of hardware and software.

The ideal system should consider:

- Events (trigger, notes, ctrl...) produce meaningful reaction in both fields
- Real time handling modifies material on both domains
- Physical controllers acting on both fields
- Micro (single events) and Macro (form, structure) composition can be achieved and controlled
- Unitary thinking is difficult to get: the system must help

Confronted with the increased complexity of these systems, I adopted reductionism as strategy: textures as evolving backgrounds and geometric rhythms or organized discreet events on the foreground (minimalism/reduction of parameters).

I tested several programming platforms and also already made software, trying to find the best solution for each task. I focused on free open source alternatives when possible, as Processing and PureData. Let's analyze the main pieces.

Suite #0

Puredata was employed to build a machine that could handle macro-structure and single micro-events. A kind of sequencer with an emphasis on part design, with different signatures, tempi and durations for each part. Events were sent through OSC into Processing, which acted as a visualization of structure, events and progression of the piece. It was presented at Medialab Madrid + Radar in 2006.

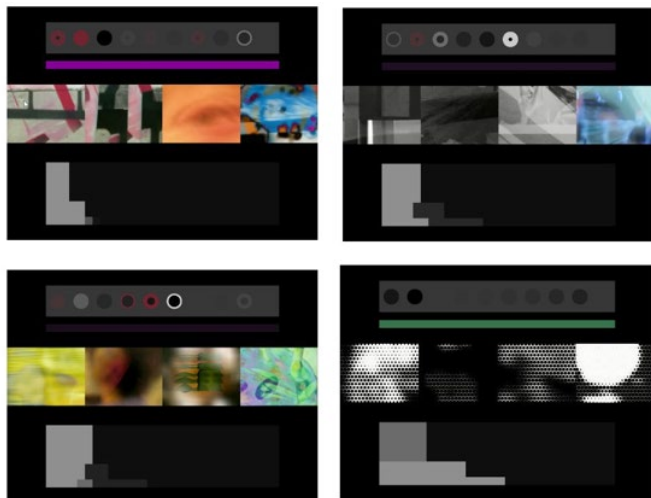


Fig. 20 Suite #0

Aisha (Suite de Ultramar)

A conventional DAW (Cubase) was used for the music composition, focusing on real time sound manipulation with different virtual effects. Midi events and controllers were sent to and from a different laptop running Isadora with the visuals, allowing for interplay between visual and sonic events and processes. Two different MIDI controllers offered a convenient set of knobs and sliders for the live performance. Discreet events occurred simultaneously, while image filters and audio effects established parallel transformative processes.

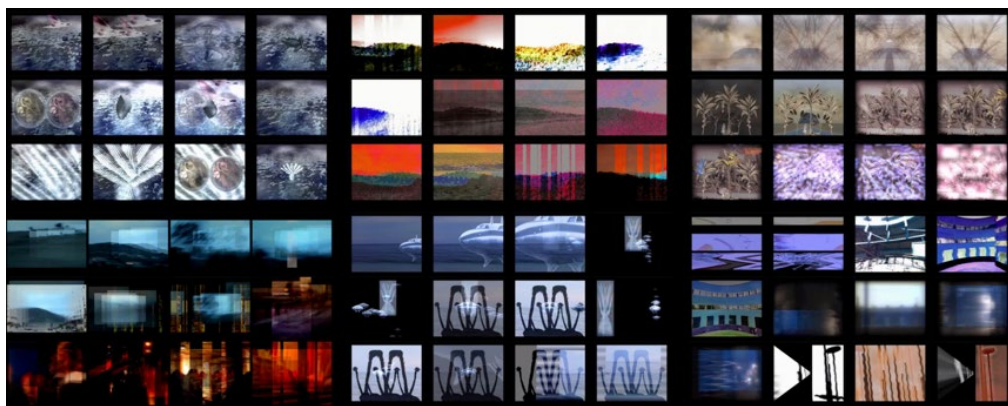


Fig. 21 Suite de Ultramar

Mapslids

I tried to achieve with PureData/GEM something similar to the visuals I was creating in Isadora. Audio was coming from Ableton Live (just invented) allowing for a more rich and diverse live interaction. MIDI notes, through a virtual MIDI cable, triggered events generating geometrical forms, opened and changed video files, and modulated parameters on filters and other visual

processes. I also achieved a system for opening and closing PureData patches by triggering a special MIDI note on a dedicated MIDI channel, allowing for total control of the set from Live. Dealing with two different programs simultaneously proved to be one of the hardest part of previous performances, and this provided an elegant solution.



Fig. 22 Mapslids

Robot dancers / mechanical ballet

Having worked previously with virtual reality (VRML, 1995) and 3D animation, and having composed some music for contemporary dance, where I created a system that connected sounds to light colors via DMX, I imagined an environment where I could control virtual dancers with my sound events, controlling a kind of “ballet mécanique”, something akin to Oskar Schlemmer’s Triadic Ballet, one of my inspirational obsessions.

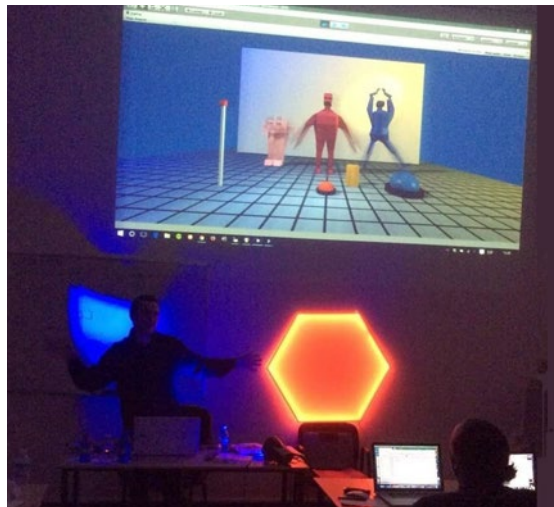


Fig. 23] Bot dancers

The new game engines allow for this kind of real time interaction in a virtual 3D world. I modeled and animated my bot-dancers in Blender, and developed a world in Unity for their dancing. Events would go out of the music software (Reaper) into PureData by MIDI, sending OSC messages into Unity and also DMX messages into stage lamps. This technical complexity allowed for total integration of sound, light, and even motion and space control, being quite close to the idea of total art form.

I even found I could also control virtual lights inside the virtual dancer's world, and also virtual image projection, closing the whole cycle of total integration. All the events could also be triggered or modulated with knobs, keys and sliders with the appropriate MIDI controllers.

The system was built as a prototype, not as a final art piece, due to the extreme complexity of the technology involved. It is working flawlessly now, so the next step would be the creation of all content necessary: music composition and sound design, 3D modeling and animation, stage design, lightning design...

An interesting expansion of the system could combine it with real dancers and a special stage set, designed with all the elements in mind.

Conclusion

Sound and visuals can be used for joined composition and performance, and this creative space it's been explored since decades, even centuries. Electronic and digital technology allow for the building of very complex systems, personalized to the sensibility and objectives of the artist. The pieces I've developed in the last 20 years have been exposed and analyzed as an example of the possible explorations in this exciting and fascinating field.

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Teatro Olimpico by Andrea Palladio

an iconic stage scenario; and the diffused lighting system by Mariano Fortuny – enhancing the aura of mystery in the Wagnerian universe

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My paper deals with the origins of stage design experienced through architecture – pointing out that the term scenography includes all of the elements that contribute to establishing an atmosphere and mood for a theatrical presentation: lighting, sound, set and costume design. Historically scenography has evolved from roots in the classical antiquity and notably connections to the architects of the Renaissance era - largely due to the theatrical activity in Eastern Europe in the twentieth century creating a historical interrelation between architecture and scenography. However, the separation of stage design from architecture is a modern notion deriving less specialization and cross-pollination of design disciplines.

My approach considers this relationship between scenography and architecture, firstly taking Andrea Palladio, one of the most famous architects of the sixteenth century, into a holistic exploration. Palladio designed the Teatro Olimpico in Vicenza and its infrequent permanent sets at the end of his illustrious career. It is still a unique example to learn from. Palladio said, “A room has to be for the eye, as music is for the ear”. I put up the question why the relationship between scenography and architecture by time became forged.

The annotation is interesting: scale drawings of a plan, section and elevations, and scale models; historically architecture has been expressed this way, but could the essential difference be that the stage is a fictional universe, a neutral space

for imagined places. Yet the modern theatre owes much to its historical and traditional connections with architecture - and lighting and sound design have been tossed into the mix because technology has made it possible to control and reproduce them, along with set and costume design.

My paper takes the term scenography further into debate. Focusing on this historical interrelation between architecture and scenography; I introduce Mariano Fortuny (y Madrazo) who was the rarest of theatre designers: he created both scenic, costume, and unique lighting designs in his Lab that he established in 1912 in the Palazzo Pesaro degli Orfei in Venice. Fortuny worked untiringly in this marvelous laboratory; shutting himself away from the world, he dedicated himself to diverse and ambitious projects. His innovations in developing electrical lighting instruments and electrical installation protocol revolutionized how theatres attacked the technical limitations of this newly developed technology. One cannot help being aroused by his contemporary innovations in textile design, dyeing techniques, and clothing designs.

Fortuny was greatly influenced by Richard Wagner in his theatrical settings, who, in turn, had a very intense relationship with the city of Venice. Fortuny went on to do much work in the theater, specifically related to lighting and set design.

My paper deals through these two designers of historical iconic theatre scenarios with scenic design as a holistic exploration of Opera Set Designs.

Keywords: Iconic Theatres, Light design, Architecture, Andrea Palladio, Mariano Fortuny

“Fortuny was fascinated by the idea of lighting the Wagnerian oeuvre, especially the Ring cycle, in new and experimental ways. He felt strongly that the great thundering God Wotan would never appear as Wagner had conceived him if he was not properly lit.” (Deschodt, 2000, p.125)

“The real dream of the Palladio’s Teatro Olimpico is that of always referring to something other than itself, while remaining constantly itself, with or without performances, as “monument” and as “theatre”; as “fake” theatre since it in the last analysis and in its own small a sublime caricature of the great ancient theatre of marble.” (Rigon, 2004, p.70)

Two worlds, separated by centuries, both affecting and entangling the stage as a space for imagined places. Can the question whether the origins of stage design can be experienced through architecture be answered by confronting two unique creators, two designers of iconic stage scenarios and techniques, separated by several centuries in time; Andrea Palladio and Mariano Fortuny?

It is my thesis that the term scenography includes all of the elements that contribute to establishing an atmosphere and mood for a theatrical presentation, involving lighting, sound, set and costume design. Taking the term scenography further into debate by focusing on the historical interrelation between architecture and scenography, I introduce the two famous creators and their works.

Mariano Fortuny (y Madrazo) who lived in Venice was the rarest of theatre designers: he created both scenic, costume, and lighting designs.¹ His innovations in developing electrical lighting instruments and electrical installation protocol revolutionised how theatres tackled the technical limitations of this newly developed technology.

Fortuny was called “the little Leonardo” and the “Magician of Venice”, a felicitous name for the artist with multiple talents and paradoxical nature.² It is difficult not to be thrilled by his innovations in textile design, dyeing techniques, and clothing designs. Marcel Proust described that the gowns were like the theatrical designs of Sert, Bakst and Benois who at that moment were recreating in the Russian ballet the most cherished periods of art with the aid of works of art impregnated with their spirit and yet original. *“These Fortuny gowns”,* writes Proust, *“faithfully antique but markedly original, brought before the eye like a stage setting, with an even greater suggestiveness than a setting, since the setting was left to the imagination, that Venice loaded with the gorgeous East from which they had been taken, of which they were, even more than a relic in the shrine of Saint Mark suggesting the sun and a group of turbaned heads, the fragmentary, mysterious and complementary colour.”* (Proust, 2006, p.748).

Among these designs was the Delphos gown that was a finely pleated silk dress first created in 1907. It was inspired by, and named after, a classical Greek statue, the Charioteer of Delphi. Fortuny was amidst the very first designers to propose a loose, body-skimming silhouette free of corsets, and many women were delighted and much enchanted by wearing such a dress (Carrier, 2009, p. 100).

The Delphos gowns were imported to Paris by the couturier Paul Poiret, and the fashion house *Babani* that sold them to actresses such as Eleonora Duse. The gowns are still desirable and the collectable pieces are sold at world record prices.

1 Mariano Fortuny was born in Granada in 1871. His father, Mariano Fortuny y Marsal, was a distinguished painter, and his mother, Cecilia de Madrazo, came from a family of artists, architects and critics (Byatt, 2016, p.6).

2 www.annamariiefisker.dk

Fortuny was greatly influenced by Richard Wagner in his theatrical settings, in Bayreuth, Fortuny's eyes were opened by Wagner to the possibilities and needs of the theatre. During the early 1890's, the costumes and scenery of the Tetralogy³ and of Wagner's other works were those that the composer had used during his lifetime. Fortuny was startled that the same scenery was being used in the Tetralogy as had been used for its first performance in the presence of Ludwig II of Bavaria in 1876. The contradiction between this naturalistic scenery and the spiritual or metaphysical music of Wagner was completely at odds with the spirit of Gesamtkunstwerk. Around 1893, only a year after his first visit to Bayreuth, Fortuny began his first experiments with light and its effects.



Figure 1. Project for light application. Model for the Bayreuth Theatre 1903 experiments with painted mirrors to add light reflection. Mariano Fortuny at Palazzo Fortuny Venice. Photo: Mark Pimlott.

During the later part of the nineteenth century, light had been transformed through the harnessing of electricity. Suddenly the mystic light of the cathedrals, the sensual light of the Venetian palazzi and the mysterious light of the gaslit streets became full of new possibilities (Osma, 1994, p.58). By 1900 electricity was taking over, and several companies were offering to install the new power wherever it was wanted: in factories, hotels, workshops and even in private dwellings. Nor was its potential overlooked by the artists of the day, as Fortuny himself exclaimed some years later: *'Do you know of any mystery more beautiful than electricity?'* (Tumiati, 1931). The English novelist A.S. Byatt accentuates that to think about Fortuny is to think about light. Light reflected from silk and velvet – and flesh – light on water and stone, airy light, dense light and almost infinitely coloured light (Byatt, 2016, p.56). As mentioned by Byatt, Fortuny invented and refined a system of reflected electric light for the stage – a dome - white at first and then with mixed and reflected colours, whereas Wagner's operas, in the days of gas lighting, had had endless painted backdrops (Byatt, 2016, p.63). With this invention, Fortuny was now able both to compose the setting on stage, conducting light as one conducts music, and to do away with the empty spaces between elements of the painted sets. He began with a white dome but moved soon on to a collapsible light one (Osma, 1994, p.166).

3 A tetralogy – from Greek, 'four' and 'discourse' – is a compound work that is made up of four distinct works. The name comes from the Attic theater, in which a tetralogy was a group of three tragedies followed by a satyr play, all by one author, to be played in one sitting at the Dionysia as part of a competition. Wagner's tetralogy, the ring of the Nibelung is among the famous ones (Rehm, 1994, p.16)

For some time, however, Fortuny's thoughts had been turning back to his old idea of a universal theatre that would revitalise dramatic art. He had already drawn up several plans for his friend Gabriele D'Annunzio, the Italian writer and poet, at the beginning of the century, and now started working on a large maquette of the project. The scale model reproduced Fortuny's vision in detail. It revealed an enormous amphitheatre, capable of being adapted to every kind of spectacle, which bore traces of Greek and Roman influence and recalled elements of Palladio's Olympic Theatre in Vicenza (Osma, 1994, p167). Alike the Olympic Theatre the back of the auditorium was bounded by a great loggia adorned with statues. An awning, like the velarium of ancient Roman theatres, retained sound and protected the spectators from bad weather, but was also designed to control the natural light, acting as an additional stage effect. The theatre included the Fortuny dome and indirect lighting system, 'thereby succeeding in transferring, in the field of lighting, that concept of an association between the stage (action) and the public, which in the Greek theatre was constituted by the orchestra (chorus)' (Osma, 1994, p.166). The dome enclosed the whole stage, but an opening at the centre let in natural light overhead that could be made work with the artificial light in the theatre, to produce harmonies and contrasts both on the stage and in the auditorium. It was to be, in Fortuny's words, 'a theatre in the sky, where people feel really out of this world' (Osma, 1994, p.167).

On 28.th September 1901, D'Annunzio departed for Vicenza, leaving Eleonora Duse with whom he both had an intensive collaboration as well as an affair, in Venice; Fortuny followed him the next day. They studied the Olympic Theatre and discussed the possibilities of adapting it for one of D'Annunzio's plays, but there were technical difficulties and the plan was never realized. The visit made a great impact on Fortuny, and he began seriously to consider the idea of creating a new type of theatrical building (Osma, 1994, p.74).

As the originality and modernity of Andrea Palladio's creative design did not escape either D'Annunzio nor Fortuny; so will it not escape the modern visitor argues Maria Elisa Avagnina, director of the Olympic Theatre in Vicenza (Avagnina, 2005, p.18). An argument one must agree with, feeling a kind of conceptive energy entering the theatre that seems unleashed by the meeting of an abstract model and real physical requirements. Soon after his visit to Vicenza, Fortuny returned to continue work on his dome, and by the beginning of 1902, he had produced his first large-scale model, which measured five meters in diameter. This early version already incorporated the two features that Fortuny considered essential; it could be folded so as to take up as little space as possible, and it was easily moveable (Osma, 1994, p.75).

During the 1920s Fortuny's contribution to the theatre gained widespread recognition. He had spent a great deal of time improving his dome, and it was now used in many theatres, notably in France, Germany and Russia. Italy, however, was the first to grasp its full potential, and his efforts were crowned by the installation of a large dome in the country's most famous opera house, La Scala of Milan. It was 22 metres in diameter and was composed of white, sized cotton of the kind used for Zeppelins, stretched over a metal framework that contained the various functional and support mechanisms. The dome was electrically controlled and could fold and unfold like a giant accordion in the space of 90 seconds and was inaugurated on 7 January 1922 with the production of Fortuny's favourite Wagnerian opera, *Parsifal*. The lights reflected against the white cupola and enveloped the whole stage, creating an atmosphere, which must surely have fulfilled the composer's dream of uniting painting, music and drama (Osma, 1994, p.166).

4 Vitruvius, was a Roman author, architect, civil engineer and military engineer during the 1st century BC, known for his multivolume work entitled *De architectura*. (Chisholm, ed., 1911).

In a way, Teatro Olimpico in Vicenza is also an illustrious place built on an ‘ancient’ but modern theatre involving Vitruvius’ lesson and Palladio’s invention.⁴ To get to the Teatro one must first enter the great courtyard of the Castello del Territorio that was erected at a strategic point here, during the Middle Ages, the area inside now free of constructions and laid out as a garden. Leaving Corso Palladio, the backbone of Vicenza, entering the area of the castle, here stands the Teatro Olimpico, appearing to huddle up against a section of the boundary walls of the former structure without any external signs of such a celebrated building. Andrea Palladio designed the Teatro Olimpico in Vicenza and its infrequent permanent sets at the end of his illustrious career. The project was the latest, and for Palladio the most extreme, application of the classical ideal. It marks solid and enduring arrival point in the long search for the ‘modern theatre space’. Palladio suggested building an ‘antique’ theatre modelled on classical traditions. He proposed the layout of a Roman theatre as conjectured by Vitruvius despite the narrow dimension of the site obtained (Avagnina, 2005, p.15). The first large room that you come to after the corridor is the one known as the hall of the Olympic Odeon, intended, as in ancient Greece, for musical recitals (Rigon, 2004, p.7) Constructed and completed by Scamozzi, a Vicenza born architect who inherited the unfinished projects of Palladio at his death in 1580, Scamozzi took over the process of constructing the Teatro Olimpico. The theatre is still used for the celebrated “sessions”, not just a work of art, but also a cultural phenomenon that still maintains its original functions: both as a centre for the activities of the Accademia Olimpica and then, importantly, a place for staging theatrical performances. In order to investigate and understand this place, the historian Fernando Rigon disputes, one must understand it in its dual and inseparable guise of both monument and theatre (Rigon, 2004, p.9)

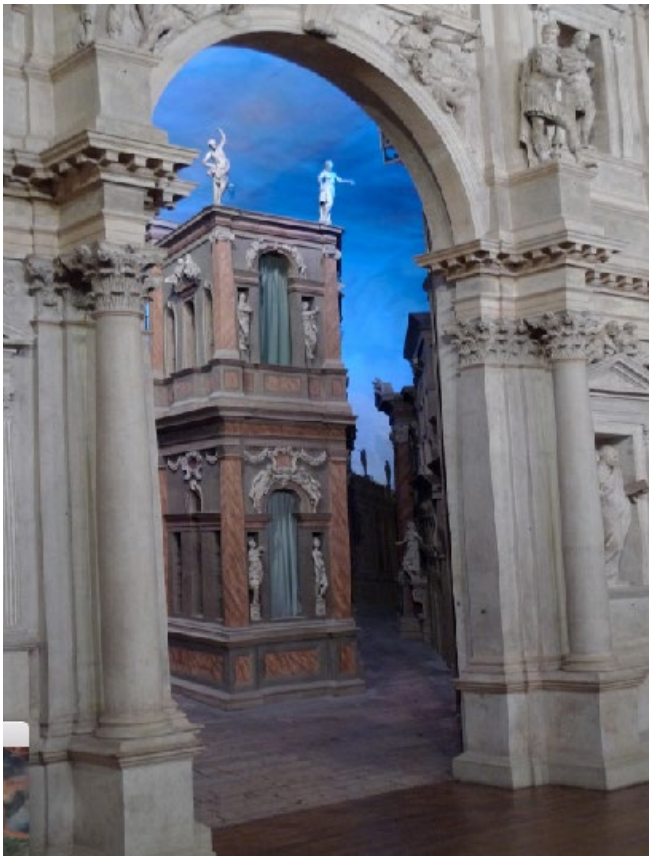


Figure 2. The Olimpico Theatre in Vicenza, conceived specifically for the performance of Sophocles' *Oedipus the King*, has survived for centuries. It ideally depicts the seen roads of Thebes, the location of the tragedy, but actually shows views of contemporary Vicenza: rows of 'fine blocks of flats and palazzi projected towards a distant horizon using the perspective artifice in a rising floor and transformed by masterly control of the lights. Photo: Anna Marie Fisker.

As this article demonstrates, scenography has historically evolved from roots of the classical antiquity and notably connections to the architects of the Renaissance era - largely due to the theatrical activity in Eastern Europe in the twentieth century creating a historical interrelation between architecture and scenography. Teatro Olimpico was the first permanent covered theatre of the Renaissance, the expression not a royal court, but of the private group with cultural aims; the Accademia Olimpica. The Accademia Olimpica had cultural and particularly scientific aims, with great interest in physics, astronomy and anatomy. These aspirations and intellectual commitments of the society are expressed in the motto *HOC OPUS HIC LABOR EST*, a passage from Virgil's *Aeneid*; a metaphor for the difficulty of reaching the light of truth and knowledge by way of darkness (Avagnina, 2005, p.7).

My paper has taken the term scenography further into debate. Focusing on this historical interrelation between architecture and scenography showing the theatre as a space and place of illusion. In Teatro Olimpico, this is added by the intangible but striking element of the light, controlled by Scamozzi's expert lighting direction. The lighting units from the original stage lighting system still exist, consisting of bulbs of glass, filled for the occasion with coloured oils, or sets of wicks in metal boxes. These were placed in hidden parts of the false architecture, a network of lighting points. The sets, made of painted wood with statues formed out of plaster, soaked rags, and stucco, create subtle illusions of perspective, with rows of temples, palaces and houses lined up along the roads. These do not so much refer to an ancient city as to an "ideal" city of the Renaissance - arranged so as to suggest views of the urban surroundings of Vicenza - and in this "Conforming to the mimetic and realistic tendency of contemporary scenographic practices" (Puppi, 1973, p.435- 39) (Barbieri, 1974) (Gioseffi, 1974). Concerning Fortuny, he was from an early age ripe for the world of Wagner. His first visit to Bayreuth around 1890 was a revelation, a thunderclap that echoed through the rest of his life. Once captured by the Wagnerian vision of art, Fortuny placed all his own creative, technical and scientific resources in the service of the "master", whose art he felt had been so poorly served by the unimaginative sets, costumes and especially lightning then in use (Deschodt, 2000, p.123).

I am convinced that the modern theatre owes much to its historical and traditional connections with architecture - and lighting and sound design have been developed as a logical progression of this because technology made it possible to control and reproduce them, along with set and costume design. In fact, scenography's encounter with architecture is continually being concurred, as if it is being deferred and eked out in time, filtered by a series of preliminary spaces that are elusive in some way. Teatro Olimpico is even today an iconic stage scenario, surviving almost 500 years, and the diffused lighting system by Mariano Fortuny enabled to enhance the aura of mystery in the Wagnerian universe and became the starting point for the development of modern stage lighting.

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SensaSound

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Applications based on the concept of interactive and generative sound have gained popularity in recent years. Such applications can be deployed to a garden, or indoor space, in an area where people can enjoy a sound experience, hearing sound programs prepared for reproduction in 3D. Moreover, visitors can also select the desired music program, and by using sensors of various types (such as motion, sound, or image for instance), sound aesthetics can be created and fit into the environment of the garden. The audience, besides having a contemplative role in the installation, can also interact with it, since their predicted, or random, movements are used to generate the interactive effects and the final sound composition. This sound composition follows the morphing algorithms for generative music.

A technologic interactive installation is proposed, aimed to create a music/sound atmosphere, based on a structure with different sensors, such as distance and force. This system controls an electro-

acoustic set, encompassing a number of speakers, including ultra-directional sound sources such as parametric loudspeaker arrays or sound beam devices.

Two types of sensors are being used: ultrasonic sensors, for distance measurements between it and the hand of the visitor, and force sensing resistors, sensing the force or pressure applied by the foot of the visitor.

The sound production is implemented in software, with the help of a MIDI API. The control of the Moving-Head-Intelligent-Lights equipment is done by using the DMX protocol, for commanding lighting systems.

An innovation of this project is focused in, for example, aiming the sound beam to a statue in an art museum, to get the attention of the visitor, as if the sound was coming from the statue itself. This creates playful and entertaining environments.

Keywords: Atmosphere design, Soundscapes, Directional sound, Interactive music, Sensors.

1. Introduction

The concept of interactive music means that all music can be changed by the action of external stimulus. This theme is related to dynamic or adaptive music, in which specific events lead to a change in the musical background.

This theme has always been present in videogames, in which its first use was in a game called *Frogger*, by Konami (1981), where music would abruptly change at a time when the player reached a safety spot in the game.

However, there has been a migration and an expansion of this theme, where the concept of 3D surround sound also had room to its development, along with the proliferation of virtual reality systems.

Special attention has been dedicated to some of the most interesting projects. Some of them are the *Interactive Garden*, by Moey Inc. [1], which consists on a visually and aurally appealing sculpture, driven by proximity and emotion.

There is also the interactive installation called *Firewall* [2], which reproduces different sounds and visual effects that change in intensity and shape as it is touched by visitors.

GRIDI [3] is another installation that translates the methodology of electronic music composition based in computer software, for an interactive physical installation. *GRIDI* was created by music producer Yuvi Gerstein with the simple aim of demonstrating the world of modern musical composition and showing that this field can be accessible and intuitive for everyone.

Musical garden domes are also a must in this research as they involve in a spectacular show representing an example of human creativeness.

An example of a musical garden dome is the *Garden Rhapsody* [4]. This is a show of light and sound, created by the *Gardens by the Bay*, whose general creative vision is led by the award-winning light designer Adrian Tan along with one of the most wanted music composer in Singapore, Bang Wenfu. The *Garden Rhapsody* has been in service since 2015.

Generative music is about making systems that make music. These systems are a set of different things working together as part of a mechanism. One of the first approaches was made in the field of recordings using speech tapes by Steve Reich [5]. From these tapes, two identical loops were made. A continuously changing soundscape was generated from these short loops.

2. Development

The proposed system had the objective of approaching the theme of playful sound spaces, interactive music, interactive gardens, etc.

A physical structure has been idealized, encompassing different kinds of sensors, which will respond to motion and to force applied by the user. Thus, the interaction with these sensors will shape the music being produced by the system, allowing for a unique sound experience, in which the sensorial characteristics of the human individual are essential for the user to enjoy their own compositions in an appropriate environment.

Two types of sensors are used in this setup: ultrasonic sensor, which is used as a distance measurer and a force sensing resistor, used as a transducer to measure the force applied on a given area.

Musical Instrument Digital Interface (MIDI) is used for sound production.

At a hardware level, this project uses an Arduino for processing the data coming from the sensors, and the core system implementation is carried out in a laptop, using the Python programming language in a Pyo [6] environment and a set of libraries concerning music generation.

In this last facet, after the system is tuned up, the future perspective is to migrate this system into a Raspberry Pi minicomputer, in order to change this project into something physically simple, aiding for its mobility.

The name SensaSound came from the two symbolic approaches of the project: sensations, owing to the desired sensorial aspect, and sound, because of the relation with music.

For the development of this idea, a wide research was necessary in various themes, such as interactive gardens, sheds, sound sculptures, interactive music, sensors for interactive music, and music with the Arduino.

The proposed system is divided up into three parts: sensing; treatment and filtering; and sound production.

2.1. Sensing

This part is about obtaining data through the interaction with sensors, in order to shape and control various music parameters, such as velocity, pitch and echo. The chosen sensors were the ultrasonic sensor and the force-sensing resistor. This first part is mainly composed by hardware, containing the sensors and the Arduino that will process the physical information provided by the sensors mentioned above.

Ultrasonic sensors

An ultrasonic sensor device can measure the distance to an object by using the reflection of sound waves. It measures distance by sending out an ultrasonic sound wave at a specific frequency and listening for that sound wave to bounce back. By measuring the elapsed time between the sound wave being sent and the sound wave return, it is possible to estimate the distance between the sensor and the target object.

The sensor selected for this use is the HC-SR04 [7]. The use of this sensor is achieved by directly wiring it to a microcontroller device, with no extra components needed. The supply voltage and ground terminals are usually provided by the microcontroller. The generation of the trigger pulse and the processing of the echo signal are also dealt with the microcontroller. The computational treatment will be described later in more detail.

Force-Sensing Resistor

The Force-Sensing Resistor (FSR) is a device that allows for the transduction of physical pressure, squeezing and weight. It is simple to use and low cost. The FSR is made of two semiconductor layers separated by a spacer. Indeed, the FSR is no more than a variable resistor. The more one presses, the more the active semiconductor elements get closer, causing a decrease in the resistance of the sensor. In order to use the FSR, unlike the ultrasonic sensor, there is the need to use additional circuitry.

Electric circuit

The microcontroller system that was selected to be used was the Arduino Mega. The wirings between all the components are shown in Figure 1.

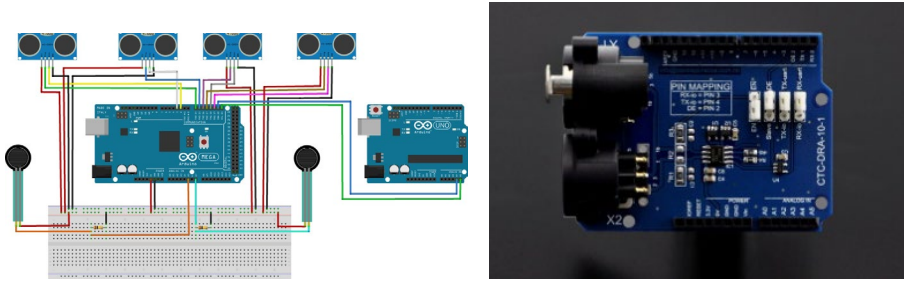


Figure 1. a) Global electric circuit encompassing the sensing section; b) DMX shield DFR0260 [8], going on top of the Arduino Uno.

As depicted in Figure 1, the final circuit encompasses the Arduino Mega, the Arduino Uno (with DMX shield), four HC-SR04 sensors, two FSR and two fixed resistors of 100 k Ω . In practice, all the elements external to the Arduino Mega were wired and soldered to a prototype printed circuit board (PCB) and fit in on top of it, like a shield board. Each of the ultrasonic sensors was placed inside a compartment with a known pre-defined distance when no interaction is present. The system must then be calibrated for this distance. In addition, the two FSR were bound to a flat platform that the user can step on, thus sensing the value of the applied force when doing so.

The echo signals, coming from the ultrasonic sensors, were processed by interrupt, so as not to have unnecessary processing by polling these pins for the arrival of the echo. This also enhances the real-time characteristics wanted for the system, by using an interrupt service routine (ISR) to run immediately, even if the Arduino is in the middle of running another piece of code.

The control of the moving head is carried out by a DMX shield placed on top of the Arduino Uno, which communicates with the Arduino Mega using pins A4 (SDA) and A5 (SCL), according to the I2C protocol.

This accounts for the sensing section. The rest of the system lies in a laptop, which also drives the output speakers. One part of the program running in the computer deals with the communication with the Arduino. The data generated by the Arduino will be sent and read by the computer, running the Python script. The first step is to install the Pyserial module, whose function is to link together the two initially distinct platforms [9]. The details about the processing performed in the computer are covered in the next subsections.

2.1 Signal conditioning and filtering

The distance data obtained by the sensors is filtered so as not to be sensitive to some intervening factors in the environment where the system is placed.

After reading this data, it is necessary to apply smoothing techniques to the resulting measured distances. These techniques are used in order to overcome the problem of possible spurious incoherent distance values, due to unwanted reflections or even some occasional fault in the sensor itself. Several types of filters were tested in order to check which provided the best results with little processing. The chosen filters were obtained using the Hanning window followed by median filtering. The results about this topic are addressed in Section 4.

2.2. Sound production

This part deals with the generation of sound, according to the data obtained by the sensors, or modification of a musical piece.

For the sound manipulation effect, different effects known in the production of music are used. In this case, a pre-made and marketed musical sample can be used. Pyo [6] module, based on Python, was chosen as the MIDI synthesizer. The first step is to import the Pyo Python module and boot the server. This audio server will open audio and midi interfaces and will be ready to send them the audio and MIDI produced by other Pyo objects.

The user can choose from a library what type of music will be played, interacting with a simple interface, which was designed using the PyGame library.

A class, named ManipSound was developed, receiving a music object as an argument. ManipSound is a class that is able to manipulate a sound source in order to change a determined parameter, creating a different sound for each control.

Different audio channels are allocated to different sensors controlling different audio effects, as music is playing. The graphical user interface is shown in Figure 2.

The selected audio effects are: 1) WGVerb - 8 delay lines FDN reverb, with feedback matrix based upon physical modeling scattering junction of 8 lossless waveguides of equal characteristic impedance; 2) Harmonizer - generates harmonizing voices synchronized with the audio input; 3) Chorus - the chorus effect occurs when individual sounds with roughly the same timbre and nearly (but never exactly) the same pitch, converge and are perceived as one. The speed and the volume of the sound can also be manipulated by the sensors.

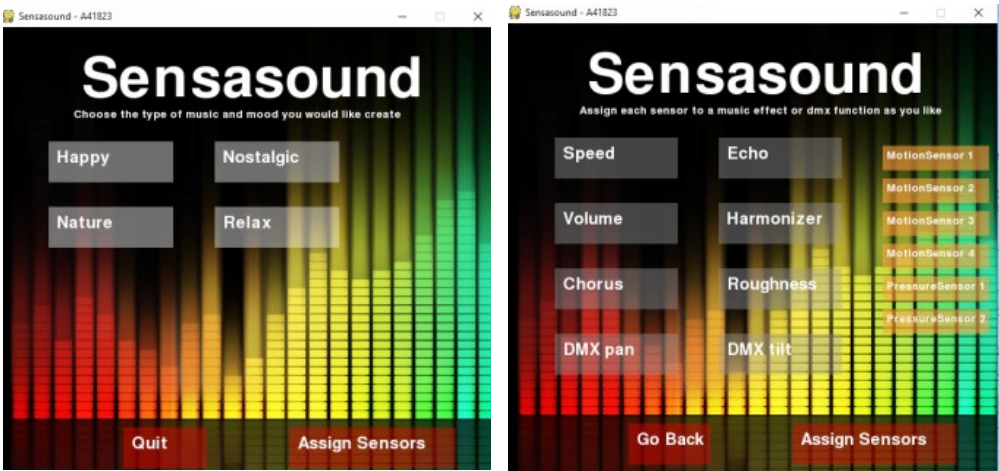


Figure 2. a) Graphical user interface: a) Choosing the type of music, b) Assigning a sensor to a given parameter.

Additionally, besides applying audio effects over the music, a Moving Head/DMX Lights device is connected to the system to control some movements of the user with a sound beam device attached. This connection is carried out using a DMX shield to link the Arduino directly with the device. Therefore, this system not only controls the audio effects in music, but the position of the directional speaker (sound beam) through the sensors the user is interacting with. Figure 3 depicts the global setup used.

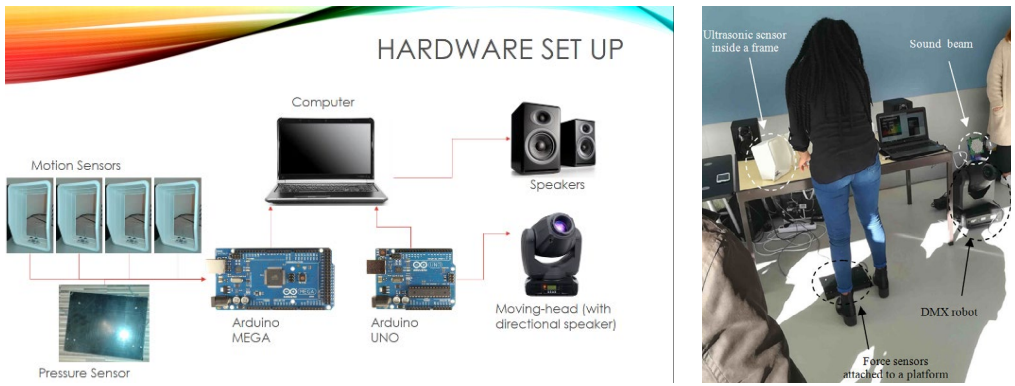


Figure 3. a) Setup of elements composing the proposed system; b) Live presentation of the system.

3. Software development

This section details the software that was developed in order for the system to work as desired. At the low level (or hardware level), namely when processing the data coming from the sensors, the program running in the Arduino must manage every sensor accordingly. On the other hand, to generate the music effects, another type of software is needed, at a higher level, by using Python and some utility libraries, such as Sonic-Pi [10].

3.1 Low level processing

Low level processing includes the software modules that address the sensors directly.

Ultrasonic sensors

Each of the ultrasonic sensors is processed using state machines. For each sensor there is a pair of state machines that manage the data obtained by the sensor. As depicted in Figure 4 a), this state machine is closer to the physical operation of the sensor, merely providing information whether there is an echo or not. Each of the states is run accordingly at a given transition edge of the echo signal. On the other hand, the state machine in Figure 4 b) manages distance computation, by listening to the other state machine. When there is an echo, there is information to process it and estimate the distance. These state machines communicate between them through the “Echo” variable. A distance outcome is obtained every 60 ms [7], here named TriggerGap. If no echo is received within this time, another distance measurement is requested.

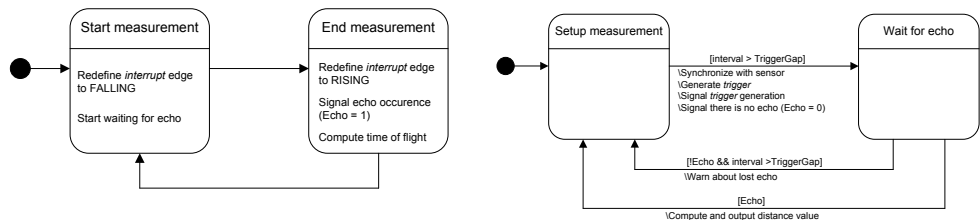


Figure 4. State machines that manage the operation of the ultrasonic sensors:
a) dealing with the sensor, b) providing the distance value, by using the round trip delay.

The processing needed to account for the operation of the FSR is only focused on acquiring the input voltage coming from the voltage divider and converting it to a representative number, i.e. there is a conversion from analog to digital. There is no need to transform the resulting number, as the space for representing the force over the sensor will be bounded within the range of the ADC of the Arduino.

3.2. High level processing

This section details the software that was developed in Python using higher level libraries in order to change music parameters, generate music through generative music algorithms and direct the DMX moving head.

For the communication of the DMX moving head, the Arduino DMX Serial library was used. This is a library for sending and receiving DMX codes using the Arduino. This library avoids timing issues on the low level protocol that typically exist when using software implementations by using the internal serial communication hardware. Therefore, it is very uncritical to add specific DMX effects on top of this communication library. DMX sending and DMX receiving are both supported by this library [11].

In the music scene, in order to create more appealing music using algorithms and changing different parameters it was tried a different option, the Sonic Pi. Sonic Pi is a live coding environment based on Ruby, originally designed to support both computing and music lessons in schools, developed by Sam Aaron in the University of Cambridge Computer Laboratory [10] in collaboration with the Raspberry Pi Foundation. Thanks to the use of the Supercollider synthesis engine and accurate timing model, it is also used for live coding and other forms of algorithmic music performance and production, including at Algoraves (an event where people dance to music generated from algorithms, often using live coding techniques, and short for “algorithmic rave”). Its research and development has been supported by Nesta, via the Sonic PI: Live & Coding project [10].

The part of generative music consisted of generating loops by using randomization with temporization.

First, using examples of the Sonic-Pi library, a piece is played consisting of three long loops, each of which plays one of two randomly selected pitches. Each note has different attack, release and sleep values, so they move in and out of phase with each other. This can play for quite a while without repeating itself.

Then, as the motion of the user is detected, there is an addition of a variety of music aspects, for example, the effect of ocean sound. This ocean sound is generated by using reverb effect, a choice between synthesizers of brown noise, clip noise or grey noise and random values for amplitude, attack (amount of time for sound to reach full amplitude), sustain, cutoff and pan (position of sound in stereo) characteristics. Another good way to create interesting music is to use pre-recorded sounds, traditionally called sample sounds which can be used in this context. Sonic Pi can do spectacular stuff with samples. Not only does it have a bank of more than 90 ready-to-use public domain samples, but it lets the user play and manipulate their own. Just as with synthesizers, these samples can have their parameters set, such as amplitude and panoramic. We can also apply time-stretching, and control them with envelope curves.

With this different approach on music generation and with the help of randomization, it is possible to create a soundscape that is very unique and always somewhat new, even if the motions of the user are actually the same.

4 Experimental results

The plots of measurements and filtering with motion sensors working simultaneously in real time are presented. It is noted that the “jumps” of the ill-calculated distances, caused by reflections or any other influence coming from an unfavorable environment are eliminated, as noted in Figure 5 as a result of various tests that were run with different types of filters to smooth the acquired signals, firstly in a controlled environment, with the generation of an artificial sine wave signal, and afterwards, in real-time conditions.

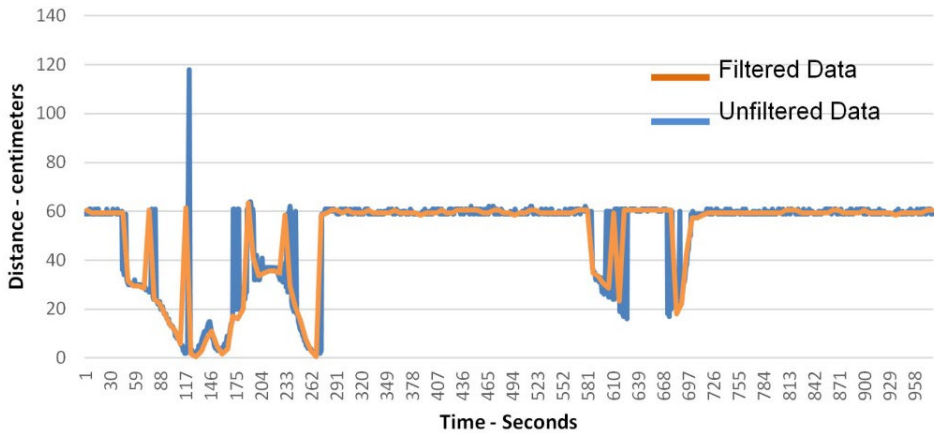


Figure 5. Difference between unfiltered and filtered data (filtered data is reduced by 10%).

An experiment was also made in order to understand how the ultrasonic sensors respond to the air flow in order to represent the wind, since this system must be robust in an uncovered area.

This test was performed in a laboratory room, where, with a wooden plate, vertical movements were exerted in order to produce flow of air. Thus, by simulating an uncovered environment (such as the garden or resort) where the system is exposed, its robustness has been satisfactory in this situation.

After the calibration of the hardware modules the software was configured in order to respond as specified. First, it was found an incompatibility between Python and DMX so the solution was to use the Arduino Uno with DMXSerial library for the communication with the moving device. Lastly, there was some difficulties with finding the best algorithm for the sonic-Pi module.

Public presentations were made based on the proof of concept of the system and the project showed enough potential for the future. Although the project has not yet reached the final result at the moment, the spectators had the opportunity to test the system, functioning as an experimental test where they showed a lot of interest about the idea and the peculiarity of joining different areas, as well as the user interaction with the system.

5. Conclusion

An interactive music installation was proposed, aimed to create a music/sound atmosphere, controlled by different sensors, such as distance and force. This system controls an electro-acoustic set, encompassing a number of speakers.

The system is able to create a multithreading approach with the Arduino Mega, using motion and pressure from sensors affected by a user, that will communicate with a Python Class. In this class, the data coming from the Arduino is filtered and is created a programming object that plays a predefined piece of music changing different technical features of the sound. Additionally, an Arduino Uno is used to control moving devices, such as a Moving-Head-Intelligent-Lights equipment via DMX protocol where a parametric loudspeaker array is attached.

Lastly, the module Sonic-Pi upgrades this application by introducing a new system with an unlimited range of creativity where the user can create his own sound and music by one simple movement. Several presentations using this context were already made where the public had the opportunity to experience an immersive sound atmosphere.

The interest in the themes addressed by the current and future perspectiveWs was acknowledged, which helped to emphasize the importance of the new technologies that have arisen.

The future work consists of including new algorithms. For example, genetic algorithms that consist of a search technique used in computer science to find approximate solutions to optimization and search problems. Other algorithms are the neural network algorithms (ANNs) where the first objective was to solve problems in the same way as the brain. Markov Chains are also an interesting approach to consider.

Acknowledgements

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Film dialogue and lyrics as catalysts for speech production

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Although dialogue and song lyrics in film and digital media often help the audience to understand the mental, emotional and physical experiences of the onscreen characters (*receptive language*), the speech production of the viewer (*expressive language*) can also be stimulated in various ways. This article discusses the film sound theory, neuropsychology and

practical significance of this less familiar use of soundtracks to catalyze speech and singing in the audience. Examples given include popular feature films, language training programs utilizing film and television scenes, and an interactive audiovisual speech program for children with autism that is being developed by the author.

INTRODUCTION

The purpose of this article is to explore various theoretical and practical approaches to the phenomenon of language learning, particularly expressive speech production that can be stimulated by audiovisual media.

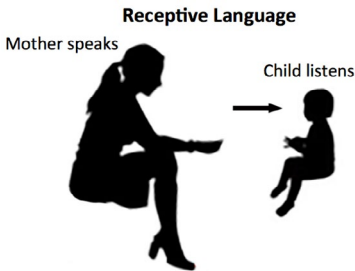


Figure 1. Receptive Language

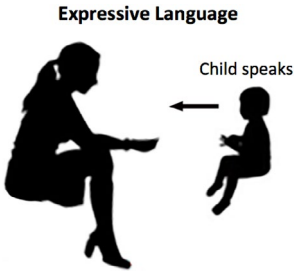


Figure 2. Expressive Language

For the sake of analogy, we may equate the medium that is producing the sounds to a speaking mother, and the audience to a baby who first listens to the mother, then eventually learns to speak like the mother. When a baby hears its mother speaking and begins to understand, this is the first stage of language development and is referred to as *receptive language* (Fig.1). After the baby begins to repeat the mother’s words, and eventually uses them in the proper context to communicate the baby’s own feelings and needs, then that speech is referred to as *expressive language* (Fig.2). Certain social and neurological conditions occur for the baby to evolve from using purely receptive language to including expressive language.

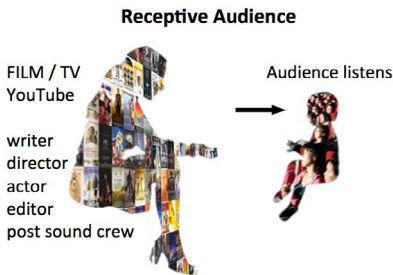


Figure 3. Receptive Audience

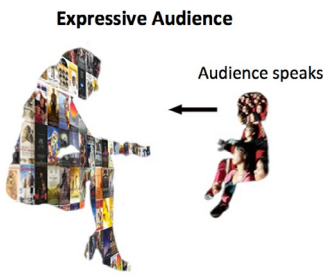


Figure 4. Expressive Audience

A film character’s dialogue, or speech production, is created by the team of writer, director, actor, picture editor and post sound crew, each contributing toward this central feature of the majority of mainstream soundtracks. The audience receives the sounds and in the act of understanding and remembering what has been spoken (or sung), employs receptive language (Fig.3).

There are certain circumstances when the audience will be stimulated to develop expressive language as well, depending on their social and neurological conditions (Fig.4). These conditions are at the core of the individual’s development of speech, as well as the communal, cultural phenomenon of a larger public learning speech from film soundtracks and other audiovisual media.

By examining the theory, examples and applications, we can more fully harness the power of the soundtrack and its impact not only on the mind of the audience, but also influence the audience’s vocal behavior during and after the film screening. Although this may happen spontaneously, as illustrated in some of the examples in this article, the intentional reasons

for creating this expressive language end-result range from branding an entertainment form through an iconic character's dialogue, to supporting the learning of a second language, to developing speech for individuals with neurological disabilities.

FAMOUS MOVIE LINES AND SONGS

The soundtracks of popular films have fertilized the spoken language of contemporary culture for many decades, just as Shakespeare's most recognized quotes have woven themselves for centuries from Old into modern English; Hamlet's 'To be or not to be...' has even earned itself the title of a feature film (*To Be or Not To Be*, Ernst Lubitsch, 1942).

World cinema is likely replete with examples of well-quoted dialogue in many languages, but for the sake of this article's focus and the author's direct experience, examples will be limited to those of well-known American movie quotes and lyrics. Here are some memorable snippets of dialogue:

Wizard of Oz (Victor Fleming, 1939) - 'Somewhere over the rainbow.' And, 'There's no place like home.' And, 'Toto, I've a feeling we're not in Kansas anymore.' (The author's personal most memorable line is, 'I'll get you, my pretty, and your little dog, too!' which terrified him as a youngster, but became a delight as he matured into adolescence.)

Gone with the Wind (Victor Fleming, 1939) - 'Frankly, my dear, I don't give a damn.' (The shock of this profanity seized the public to never forget the finality of that tumultuous love.)

Casablanca (Michael Curtiz, 1942) - 'Here's looking at you kid.' (According to the American Film Institute, this movie has the most number of famous quotes, though many seem to have drifted into less usage, like, 'Of all the gin joints in all the towns in all the world, she walks into mine.')

Singin' in the Rain (Stanley Donen, Gene Kelly, 1952) - 'I'm singin' in the rain.' (*Clockwork Orange*, Stanley Kubrick, 1971, shifted the context of that song with brutal irony.)

On the Waterfront (Elia Kazan, 1954) - 'I coulda been a contender.' (Marlon Brando's unique delivery helped emblazon this with a fully expressive dialect, as he did with *The Godfather* line, below.)

The Godfather (Francis Ford Coppola, 1972) - 'I'm gonna make him an offer he can't refuse.'

The Terminator (James Cameron, 1984) - 'I'll be back.' (And indeed he – or someone emotionally related – was, using similar lines in *Terminator 2: Judgement Day*, James Cameron, 1991, and *Terminator 3: Rise of the Machines*, Jonathan Mostow, 2003.)

When Harry Met Sally (Rob Reiner, 1989) - 'I'll have what she's having.' (The author has noted this line commonly used in situations where there is some unknown solid, liquid or gaseous substance being ingested that provokes extreme pleasure.)

Jerry McGuire (Cameron Crowe, 1996) - 'You had me at "hello."' And, 'Show me the money!' (Many people use these phrases – or variations – without necessarily associating them with the film, demonstrating how well integrated they have become into the vernacular.)

The Sixth Sense (M. Night Shyamalan, 1999) - 'I see dead people.' (Originally expressing a frightening experience, but now often used as parody in humorous or ironic situations.)

In 2005 the American Film Institute centennial celebration of American cinema polled 1,500 leaders from the creative community to choose their most memorable movie phrases. 'Great movie quotes become part of our cultural vocabulary,' wrote Jean Picker Firstenberg, President Emerita, AFI. The criteria for selection were that viewers 'use this language in their own lives and situations, and that it circulates through popular culture, becoming part of the national lexicon.'

FILM SOUND THEORY AND LANGUAGE PERCEPTION

What might be the triggers for this phenomenon of film dialogue and lyrics to be transformed into cultural vocabulary? An approach to answer this question comes from Michel Chion's *Audio-Vision, Sound On Screen* and his theory of the three listening modes: *causal*, *semantic* and *reduced*. The author uses the same terms in his book *Sound Design: The Expressive Power of Music, Voice and Sound Effects in Cinema*, and added a fourth listening mode called *referential* or *context*. (To facilitate introducing these concepts to film production students in the author's current academic presentations, he has revised Chion's terms of *causal*, *semantic* and *reduced* to more accessible terms of *source*, *meaning* and *shape*, respectively.) An important point that Chion makes is that these categories of listening overlap, so that "we hear at once what someone says and how they say it."

Causal / Source

We employ causal mode while listening to a sound in order to gather information about its cause or source. This occurs when recognizing a specific person's voice, like the whine of Brando's "I coulda been a contender", Schwarzenegger's Germanic "I'll be back" or Kelly's gleefully enthusiastic "I'm singin' in the rain," and becomes associated with the character's personality as an auditory icon. A vocal accent or prosodic uniqueness may help identify the speaker's class, culture or nationality (overlapping with both the reduced and referential listening modes).

Semantic / Meaning

When paying attention to the code or language to interpret information, we listen in the semantic mode. The audience remembers great lines that provoke vivid imagery ("I see dead people."), romance ("You had me at 'hello.'" "Frankly, my dear, I don't give a damn."), suspense ("I'm gonna make him an offer he won't refuse.") and wonderment ("Toto, I've a feeling we're not in Kansas anymore.")

Reduced / Shape

Listening that focuses on the traits of the sound itself, independent of its cause or meaning, is referred to as the reduced mode. Voices often carry specific frequencies and harmonic structure (also known as vocal 'formants') that become memorable for their sonic qualities, such as the high-pitched screeching witch in *Oz* ("I'll get you, my pretty, and your little dog, too!") or the low-pitched Terminator ("I'll be back.").

Referential / Context

Referential listening consists of being aware of or affected by the context of the sound that supports the emotional and dramatic meaning. This context can be on instinctual, cultural, historical or film/media specific levels, the latter being very much called into action with famous movie quotes. We hear the reduced quality of a voice and react instinctually with the referential emotion of joy (the lilting melody with "Singin' in the rain"), fear (the screeching witch, "I'll get you...") or dread (the monotone delivery of "I see dead people.") When the "I see dead people" line is used over and over, the initial emotional intention becomes vulnerable to parody, potentially creating a more comedic reaction.

In addition to applying the theory of the listening modes in the effort to answer this question of what triggers expressive language, there is a strong connection the audience makes with films that have earned box office success and 'legs' that reinforce multiple viewings (as demonstrated by the movie list above). These films often contain a gripping story, memorable characters and intense emotions, which serve as catalysts for a musical or spoken phrase to become iconic.

SINGING AND SPEAKING ALONG AT THE MOVIES

Certain films have catalyzed a kind of magical inspiration in the audience to join in spontaneously with the soundtrack. They may not have been the biggest musical hits on the radio, but the combination of image, character, plot and very catchy tunes led to the movie sing-along craze. Not only do the viewers go to repeated showings and know the lyrics, but often dress up as the characters and create a party atmosphere.



Figure 5. Sing-along Movies

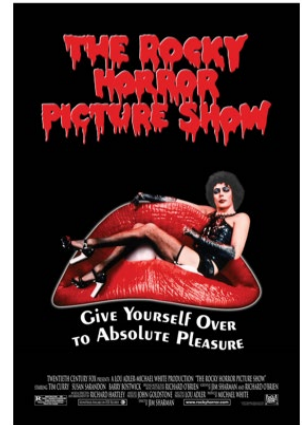


Figure 6. *The Rocky Horror Picture Show*

Some of the films that have caught on as sing-alongs include *Grease* (Randal Kleiser, 1978), *The Sound of Music* (Robert Wise, 1965), *Moulin Rouge!* (Baz Luhrmann, 2001), *Dirty Dancing* (Emile Ardolino, 1987) and the more recent blockbuster Disney's *Frozen* (Chris Buck, Jennifer Lee, 2013) (Fig. 5). These have become events with regular schedules, institutionalized by commercial companies such as Sing-along-a who organize through social media.

The act of singing along with movie song lyrics and joining in with the onscreen dialogue hit a high point with *Rocky Horror Picture Show* (Jim Sharman, 1975), the cult classic that continues screening regularly for over 40 years (Fig.6). The audience participation phenomenon was observed as early as the film's first run (when it bombed during limited engagements in seven of eight cities), and was later re-released as a midnight movie where the audience participation really began to flourish. Fans exhibit a compulsive, repeated cycle of seeing the film each weekend (some returning over 1000 times), memorizing each line and calling back, similar to responses in church during mass.

Sal Piro, author of "Creatures of the Night", relates his experiences with *RHPS*:

The first time I heard Louis Farese's voice speaking back to the screen, it was funny and I was delighted. Suddenly I was ten years old again, going with my mother to see Snow White and the Three Stooges. I remember that just as Snow White was about to bite into the poisonous apple, a voice from somewhere in the movie theater warned audibly, "You'll be soooooory!" The whole theater rocked with laughter. As the film continued, I wanted to shout out something clever too, but I didn't have the nerve...

But now, thanks to Louis and friends, it was all right to talk back to the screen. By the time I had watched RHPS twice, I knew by heart the places to yell lines and how to time them. By my third viewing, I was ready to try my hand at an original line. When Frank asked, "Whatever happened to Fay Wray?" I answered, "She went apeshit!" - exactly what the audience did when they heard me. This was the first of dozens of lines that I created. Some of them were forgotten, but plenty of them are still shouted out in theaters across the country today...

I not only invented lines; if I heard someone else's line and liked it, I kept it alive by integrating it with the rest of the litany. This is how the show "went public," people inventing lines and using the lines of others. An individual would yell a line; others would pick it up; then a whole group and eventually the entire audience would shout out the line together. Today, "old-timers" say that sometimes they miss the spontaneity of a single person creating a new line; they feel that the impact is lost when over a hundred people yell out lines, usually out of sync, at that. I don't agree. I feel everyone reacting together to the film is part of the charm - ROCKY fans as a community chanting and reacting to their film with love and affection.

MEMES AND NEUROKINEMATICS

When a verbal phrase successfully infiltrates into general conversational use, it can be termed as a *meme*, an element of a culture or system of behavior that could be passed from one individual to another by non-genetic means, especially through imitation. A meme can also be considered like a specific pathway through a previously unmarked open field being travelled upon so often, that it eventually upgrades to a signed road recognized by the majority of travels in that field.

Similar to the way a meme creates words that have meanings on a cultural level, each individual learns language within their own brain functions. By hearing the words repeatedly in similar context, the listener builds neuronal connections by associating those sounds to appropriate actions (verbs), objects (nouns), descriptions (adjectives, adverbs), etc. and learns receptive language.

What are the conditions within the film watching experience that support the creation of language memes? The research studies of Dr. Uri Hasson, who coined the term "neurokinematics", support the connection between receptive language-learning in a group of people and the listening mode theory. He found that storytelling elements of speech within a specific single film story actually unify people's brainwaves, being dependent on what listening mode was presented.

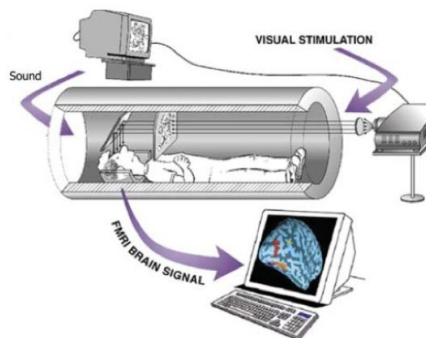


Figure 7. Neurokinematics (from Hasson et al, 2008)

To do this (Fig.7), he used three variations on the same soundtrack: a) played in reverse; b) scrambling the words out of order; c) played as original. The results showed that a) less brainwave synchrony occurred between listeners when the film speech was played in reverse, using exactly the same verbal sounds but completely unintelligible (reduced listening only); b) somewhat more synchronous brainwaves occurred with the same individual words being heard, but scrambled into incomprehensible phrases (reduced plus partial semantic listening); c) the most synchrony occurred when the soundtrack was played as its original recording (reduced plus full semantic listening). This biophysical evidence reinforces the listening mode theory as a model of conditions for creating a meme when using the full set of listening modes. In particular, the completely functioning semantic listening mode produces the most synchrony in all the listeners.

As noted later in this article, the principles of learning, mirror neurons and neuroplasticity can also help explain these essential conditions for the meme to be formed.

INSTRUCTIONAL DESIGN AND LISTENING MODES

Recommendations from the film industry have been formulated to help instructional designers apply sound to help enhance learning. MJ Bishop, an expert in educational technology and director of the University System of Maryland’s Center for Academic Innovation, writing with the author, proposes to expand the use of sound in learning materials beyond the common application of narrating the screen text or adding occasional bells and whistles to gain attention.

	Acquisition (content support)	Processing (context support)	Storage/Retrieval (construct support)
Select: make clear delineation of salient features (figure/ground)	1. Direct attention.	2. Isolate information.	3. Tie into previous knowledge.
Analyze: organize presentation (grouping/hierarchy)	4. Focus attention.	5. Organize information.	6. Build on existing knowledge.
Synthesize: make the "big picture" clear (Gestalt)	7. Hold attention.	8. Elaborate on information.	9. Integrate with existing knowledge.

Figure 8. Educational Model of Learning and Film Listening Modes (from Bishop et al, 2011)

In the educational model of learning, the three stages of *acquisition*, *processing* and *retrieval*, correspond to the terminology of *receptive* (acquisition and processing) and *expressive* (retrieval) language referred to in this article (Fig.8).

Furthermore, Bishop and the author have described a correspondence between the three learning stages and the four listening modes. Acquisition occurs when sound is used to gain attention, in particular with novel, bizarre or humorous auditory stimuli that make those sounds stand out from other stimuli. For acquisition, the reduced/shape mode of listening can be employed, for example, to stand out with a louder or higher pitched sound from the baseline sound qualities.

As the sound is processed, the listening mode of causal/source helps the learner associate with previous stimuli and sources, using similar neural pathways to bind with long term memory.

And finally with retrieval, those associations of sound are recalled through the learner’s previous knowledge, calling upon the semantic/meaning mode of listening to help integrate the new material and transfer to new learning contexts.

The educational model of learning can help give perspective on how film can be a vehicle for each phase of the language learning process. Instructional designers, filmmakers, foreign language teachers and speech language pathologists all work with these same neurolinguistics rules, each with a somewhat different goal.

FILM AS A LANGUAGE TEACHING TOOL

The power of eliciting expressive language-learning through film can be harnessed with specific intention as a foreign language teaching tool. For all the reasons cited above, employing the entire spectrum of listening modes can support this most effectively. Further considerations are made by the industry for foreign language learning.

Language teachers (citing examples below who are mostly teaching English to non-English speakers) incorporate popular film and TV scenes in their curriculum for several reasons. The story, characters and production values offer motivation and engagement, while presenting authentic and varied styles of language that students can emulate. If students are not living in an English-speaking environment, then film is a means to expose them to colloquial expressions and a more authentic flow of speech than would be heard from a non-native English teacher. Facial expressions and body gestures in dramatic scenes can give clues to the meaning of the words that would be lacking from a non-visualized context, offering a model to the neophyte speaker.

English Central, an English language-learning website, provides a selection of thousands of short subject videos in a great variety of subjects to appeal to each student's personal interest and helps generate greater commitment to the skill-building process. The program offers students an assessment tool and an adaptive vocabulary learning system to practice the lines, record themselves, and get feedback on their pronunciation.

Another language website, *English Attack*, uses both linear narrative and interactive games that immerse the student in a world of authentic English. Practicing with these daily entertaining exercises keeps motivation high. With a large number of lessons, they employ movies, TV series, music videos and TV news programs to support their pedagogic material.

TV series, in comparison to feature films, can offer some advantages for learning language. They are shorter in duration and let the student come back to the characters over and over, helping predict what might happen next. Many TV shows reflect real life, which means that the characters in those series use more practical real language and grammar.

The need to learn specific language areas can be supported with specific genres of films. For example, business English can be picked up from movies such as *Wall Street* (Oliver Stone, 1987), *The Social Network* (David Fincher, 2010), *Office Space* (Mike Judge, 1999) and *The Big Short* (Adam McKay, 2015). These films can be watched with and without subtitles to help become accustomed to a range of dialects and accents, improve listening and comprehension skills, build vocabulary, and learn more colloquial words and phrases that are used in the everyday business environments.

The Image Conference, held every year in a different country, focuses on this issue 'to explore the possibilities which film, video, images and video games offer to both language teachers and language learners. The rationale behind The Image Conference is that today we are saturated with visual stimulation and that the visual image has taken over. In the twenty-first century, the ability to interpret, analyse and create images is an integral part of literacy. The aim of The Image Conference is to put images at the centre of the language learning agenda and offer guidance on using images critically and creatively in language teaching in the age of the Internet.' This union of leading experts in audiovisual media and language-learning synergize with their insights and know-how for increasing the effectiveness and innovative use of image and sound.

DISNEY-SPEAK

Repetition of viewing well-told filmic stories, especially Disney animated movies (often musical), has some remarkable benefits for those with impaired language-learning. The book *Life, Animated* (Ron Suskind, 2014) and documentary film of the same title (Roger Ross Williams, 2016), details the story of Owen, a boy with autism who lost speech at age 3. In an unexpected way, he connected through multiple viewings of animated Disney movies and was able to communicate with family members through the scripted dialogue and songs of the heroes, villains and sidekicks (Fig.9).



Figure 9. Life, Animated book and film, and Disney's The Jungle Book with Mowgli and Shere Khan characters

Ron Suskind, Owen's father and author of the book, recounts how his son first began responding to repeated screenings of the fully depicted Disney characters and to their dialogue.

Owen heard words as intonation and cadence, their meanings inscrutable... It seems he was slowly learning Japanese – or, rather, spoken English – by using the exaggerated facial expressions of the animated characters, the situations they were in, the way they interacted, to help define all those mysterious sounds. (pg. 57-8)

Emotional engagement with movie characters clearly supported Owen's language development. In *The Jungle Book*, a dialogue sequence between Mowgli, the young protagonist, and Shere Khan, the tiger, teaches the audience how to deal with fear. Ron (as Shere Khan) initiated this screen dialogue when Owen (as Mowgli) was being challenged with something he was avoiding or running from.

Shere Khan (Ron) asks Mowgli (Owen), "Could it be possible that you don't know who I am?" That's the opening line. Whatever he's doing, Owen will snap around... as Mowgli: "I know you, all right. You're Shere Khan." It's flawless, but there's more: Owen's posture, as he steps forward, shoulders back, is just like Mowgli's in the movie, like a boy trying to summon courage.

"Precisely," I retort in Sanders' formal accent, checking my nails, which is what Shere Khan does at that moment: "Then you should know that everyone runs from Shere Khan."

"You don't scare me. I won't run from anyone."

"Ahhh. You have spirit for one so small."

Of course, that last line is the destination, the inspiring kicker to the exchange. Hearing it, Owen smiles. I smile back, knowingly, conspiratorially, and then he'll often do something he's fearful of. That's the most amazing part. It works. (pg. 59)

The notion that Disney movies stimulated Owen's brain to develop his language abilities is considered by his father Ron as a natural flow and a testament to the power of engaging story and relevancy to our own lives.

The use of his affinity for Disney from his earliest days, and in recent years ever more so, is something of a proof of neuroplasticity. His brain was using Disney to get around the blockages of autism, to find a way. It was using Disney to discover, itself; just as he was using Disney to discover himself... (pg. 241)

It's not about the wisdom of Disney. It's about family – sometimes wise, often not – and about the power of story in shaping our lives. Disney provided raw material – publicly available and ubiquitous – that Owen, with our help, built into a language and a tool kit. I'm sure, with enough creativity and energy, this can be done with any number of interests and disciplines. (pg. 248)

Owen himself offers gratitude for how film served his expressive language acquisition.

“Without those movies there would never have been me,” he said, and “I would have never talked a lot.” (pg. 335)

Ron Suskind has taken the next step to help other children with autism by creating *Sidekicks*, an app that presents an interactive animated character, or “Sidekick,” that lives on the child’s phone/tablet and loves what they love. The parent speaks through the Sidekick, as they screen clips from the child’s favorite animated films, helping to build social, emotional and language skills.

Another example of learning to speak from a film soundtrack is cited in *Neurotribes*, by Steve Silberman. Leo, a boy with autism, and his father Craig created a ritual around watching *My Neighbor Totoro* (Hayao Miyazaki, 1988, Japanese original, English version distributed by Disney).

“If you have to get hooked on something, at least this film is pretty good,” Craig chuckles good-naturedly as his son is transfixed by the scenes they’ve watched together thousands of times. To stay engaged, Craig tries to notice one previously unseen detail each night that slipped past him before.

But the film has also turned out to be a valuable tool for aiding his son’s language development. When Leo was younger, if he was introduced to someone new, he would cry out, “It’s Mei!” like the little girl announcing her arrival in the film. Then he started making comments that aren’t in the film, like saying “Chopping broccoli” during a cooking scene. Now when his mother walks into the kitchen, he’ll announce that it’s time for chopping broccoli. What began as a mere echo evolved into a scripted interaction, and then the script became Leo’s way of engaging the world. (pg. 52-53)

OPERA HYPOTHESIS, MIRROR NEURONS AND DSLM

Based on neuroscience research, what makes film, and in particular musical films, such a powerful medium for learning spoken language? This ability to learn to speak through song, employing a brain function called neuroplasticity, has been proposed by Dr. Aniruddh Patel, author of the book *Music, Language and the Brain* (2008). His **OPERA Hypothesis** (Patel, 2011) cites research suggesting that musical training enhances the neural encoding of speech when all these conditions are met: **Overlap**, **Precision**, **Emotion**, **Repetition**, and **Attention**.

Overlap – There is anatomical overlap within the brain networks that process an acoustic feature used in both music and speech (e.g., pitch, spectral shape).

Precision – Music training demands greater precision in certain aspects of auditory processing than does ordinary speech perception.

Emotion – Engagement with music elicits strong positive emotion and enhances the focus of the learner. This extrapolates directly to the audience’s emotional engagement with most popular films and memorable characters, especially those singing catchy songs.

Repetition – Musical training often requires many hours of repeating the same composition. Repetitive film viewing is also an element in developing famous movie quotes, language-learning from films or movie sing-alongs. The cases cited of children with autism learning to speak by screening Disney movies over and over, provide another example of the power of repetition to support expressive language development.

Attention – Musical activities that engage this neural network are associated with focused attention, similarly to the audience’s focus when immersed in watching a good movie.

While the OPERA Hypothesis suggests certain stimulus conditions that support neuroplasticity, *mirror neurons* have been postulated as having a physiologically-based brain structure that supports learning by imitation. Although considerable controversy continues as to the localization of mirror neurons in human beings (they were first discovered and mapped in monkeys in the 1990's), this theoretical model can offer further explanation for the connection between film watching and speech learning.



Figure 10. Mirror Neurons

Mirror neurons are said to be activated in one person's brain in a similar manner to that of another person who is being observed by the first person, potentially providing a mechanism for action-understanding, imitation-learning, and the simulation of other people's behavior (Fig.10). But beyond the mirroring of another's behavior and actions, it seems this also pertains to intentions and emotions behind those actions, as with a smile and the associated feeling of happiness. This experience happens immediately and effortlessly (Iacoboni et al, 2005).

According to the mirror neuron theory, the viewer who watches an engaging film will feel what the character is doing and feeling on screen because their brain activity is actually mirroring the character's brain activity. Studies using fMRI (functional magnetic resonance imaging) show that neuronal activity for several viewers of the same film scenes is similar, supporting this hypothesis (Badt, 2013).

It has been suggested that the mirror neuron system can be utilized for fostering the development of communication and social skills for populations with expressive language deficits in nonverbal children with autism, in particular when engaged with others in music making (Wan et al, 2010).

The principles of the OPERA Hypothesis, mirror neurons and listening modes have been put into practice by Dr. Hayoung Lim, PhD Music Therapy, who developed ***Developmental Speech Language Training through Music (DSLM)***. This training methodology employs image, music and dialogue to teach expressive language to children with autism.



Figure 11. Dr. Hayoung Lim administering DSLM to young child with speech delay

Dr. Lim added to DSLM the important notion of pattern recognition, also known as Gestalt perceptual principles, for composing the most effective songs for learning. These patterns are present in the melody, rhythm and harmony, making it easy for the children to anticipate and remember the tunes. The tunes mirror the spoken word natural cadence, known as prosody, as for example: 'What do you like to eat.' – 'Daah da-da daah daah daah.' When the musical elements are faded in the DSLM training, the spoken words retain the same rhythm as the song rhythm. These auditory qualities contribute to stimulating the reduced/shape listening mode for effective language learning.

Along with the presentation of the target words in both song and speech, the therapist shows the child a card with a graphic image representing each word, helping prompt their memory and understanding of the meaning of the word. The semantic/meaning listening mode becomes activated with the association of word and image.

The lyrics of each song are based on a *social story*, that adheres to a specific format and guidelines to objectively describe a person, skill, event, concept, or social situation. For a child with autism, these would address current target behavior goals, such as following directions or using a quiet voice (Brownell, 2002). Through the social story, the referential/context listening mode links the child's auditory attention to their personal life stories, enhancing their learning process.

In the clinical trials all of the songs were recorded on to videotape and presented to the children participants two times consecutively through a television monitor, with the singer on-screen showing the target word cards and accompanied by guitar. The results of the trials for children with severely disabled language development showed a significant improvement in their vocabulary acquisition when using DSLM, over a control group that received similar speech training but without music (Lim, 2007).

SING AND SPEAK 4 KIDS

The author has taught university-level film and game sound design classes and consulted professionals for two decades, based on his book *Sound Design: The Expressive Power of Music, Voice and Sound Effects in Cinema* (2001). The learning approach relies on training the listening (receptive) skills of the students and clients, so that they may become capable with their creative (expressive) abilities in producing effective soundtracks for film.

As filmmaking has become available to all ages through the ubiquitous use of cell phone video cameras and YouTube distribution, the author has broadened his teaching platform to include children and teens who are very open to learning, especially through game play. With this in mind, the author, who also has a degree in neuroscience, has been focusing on providing interactive audio and music products to enhance brain health and education.

Upon reading of the work of Dr. Hayoung Lim and DSLM, the author recognized that a collaboration could result in a much needed service to the target group of pre-school children with delayed expressive language development, some with autism spectrum disorder, who are at risk of failing to enter kindergarten with their same-aged peers. Even with speech delays, these children often can sing easily, because their brains are wired to receive and express the musical patterns of song.

The resulting interactive audiovisual program, called *Sing and Speak 4 Kids*, applies DSLM techniques as well as the conditions required for neuroplasticity described in the OPERA Hypothesis. Short video songs with specific target vocabulary words are presented by an onscreen singer/speaker, who invites the child to sing along. These songs are designed for activating the child's attention with specific listening modes, as described above with DSLM.

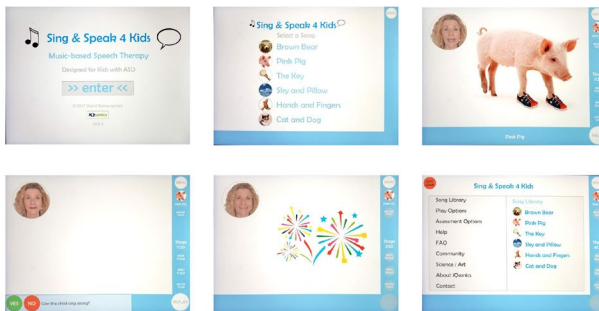


Figure 11. Screenshots of *Sing and Speak 4 Kids*

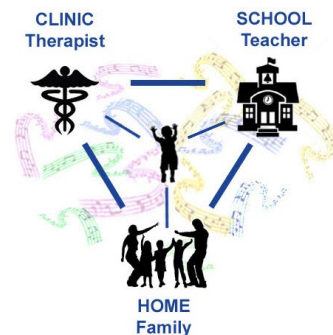


Figure 12. Team trainers collaborate to support children with Sing and Speak 4 Kids

Once the child is singing, the program gradually “fades” the musical elements in stages into spoken language. The child first mimics the singer/speaker, then as the singer/speaker drops out the target word, the child remembers the word to fill in, taking initiative to sing/speak on their own. The final step confirms the child has learned the meaning of the word, with the singer/speaker asking a comprehension question for the child to answer.

The visual information in the program is equally purposeful. Photos of the target words accompany the sung or spoken words, and short whimsical animation sequences and pleasant musical tones reward the child when they perform correctly.

While playing the program, the child is accompanied by a team of parents, teachers and therapists who use an online monitoring system, so the whole community participates in this process that encourages social engagement, adding to the referential/context listening mode. Through the use of these intentionally designed film soundtracks and images, children with speech difficulties are supported in development of their expressive language.

CONCLUSION

By design, repurposing or attaining iconic status, audiovisual soundtracks are shown in these examples to contribute to the development of expressive language in the audience. Several models of film sound theory, communication and neuroscience help clarify the underlying mechanisms that create conditions for learning speech production. With an invitation to put theory into practice, the author encourages further exploration and application of the material presented herein for research, teaching, artistic and therapeutic purposes. Academics and educators can investigate further links between the fields of film sound, music, learning, speech-language and neuroscience, supporting the design of effective communication tools. Filmmakers, sound designers, music/song composers, and game developers may adapt this analysis for increasing engagement with their audience. Therapists can augment their understanding and practical tool set that can offer their clients greater fluency in expressive language. Language teachers can access the power of film to support their students’ acquisition of both receptive and expressive second language.

AUTHOR’S BIO

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Design as a tool for Education in Dyslexia: the Importance of Musical Feedback

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Technology has created a great deal of new possibilities for education and educational tools, that are open for exploration and that have already started to shape new ways of learning for the younger generations. In cases where students face specific obstacles such as the ones brought by dyslexia, the new media can be the answer to motivate and help students engage with school and hopefully overcome their difficulties.

This project aims to explore the use of alternative methods to teach young students how to correctly spell, considering that spelling is one of the most common difficulties in dyslexic children and that there are very little tools that have been created to help with this problem, especially within the Portuguese language.

By combining animation, illustration and music the solution takes shape as a digital game for children ages six to nine years old, where the user is asked to complete the words considered “tricky” or similar to each other. The user is then presented with an animated illustration that creates a visual memory aid to help remember how the word is correctly written as a future reference. This concept originates from the fact that multisensorial stimuli have better results

than the traditional ones in students with learning difficulties. This way, sound becomes a very crucial part of the game and one of the most complex elements to design. Because of this, a collaboration with music students from the university of Aveiro was established which resulted in the composition and recording of the interaction feedbacks, music and voices. As a consequence, the creation process aimed to answer the following questions: How can we design sound to create a positive and motivating atmosphere, making sure that the learning process is a pleasant and exciting experience? Considering the different levels of difficulty that are present in the game, how can we identify them using music? How can we bring animations to life and transform them into memorable events using sound? By answering these questions, the sound work for the game was developed, according to the necessities of the user and the educational context, thus becoming an active part of the solution and not just a decorative element. Concluding, therefore, that sound represents a new ally in designing digital educational tools and in including all kinds of students that may need alternative ways of learning.

Playing on the smart phone, the Ipad, with a Playstation or even a Nintendo are activities that have now become very common during childhood. Even if there is a great discussion on the possible negative effects of this kind of devices being introduced at very young ages, there are also various arguments in favor of the benefits they can bring, demonstrating that technology can seriously amplify the possibilities of playing and learning. In spite of it all, it is safe to say that these new “toys” have become an inevitable part of today’s children development and, as consequence it would be unthinkable not to consider them when talking about education. We can also say that these new technologies are responsible for the opening up of opportunities in the way we learn, educate and communicate. In the case of Dyslexia there is the necessity of using this type of devices in order to teach students with this specific pathology, especially in learning the Portuguese language. Considering this new reality, the game “Disletra” emerges as a tool for teaching the correct spelling in Portuguese, presenting the possibility of practicing and learning through visual memory, using illustration and animation as the main vehicles to achieve these goals. This way, the sound feedback becomes a fundamental part of this project, as an instrument to create the ideal educational environment to stimulate the child’s motivation.

It is quite important to understand that just in a few generations, a dramatic increase in the access of visual content has taken place. Today, in developed countries, children see more images than the majority of adults have seen in their whole lives (Knight, 2004,p.1-p.2). This difference is a fundamental factor to consider in the way we design for childhood, because it has an extreme impact on the children’s visual literacy, an important aspect of the human development in this initial period of their lives. In reality, great part of our education focusses on learning and communicating, and the current technology we have available is certainly altering the way we do it, as Gunther Kress states:

*“At the present moment we are once again at a point where the relation of speech and writing, and the questions around ‘language’, are being remade.”*Kress, 2013, p.26

According to Kress, images are gradually overcoming writing, as a form of representing communication, thanks to technology. Thus, a general preference for the screen over the traditional book is now occurring (Kress,2013). This paradigm change is, in reality, quite positive for children that suffer with special needs in learning such as Dyslexia. These young students strongly benefit from incorporating the different senses and *stimuli* in learning over the traditional methods:

“Os métodos de ensino multissensoriais ajudam as crianças a aprender utilizando mais do que um sentido, enfatizando os aspetos sinestésicos da aprendizagem e integrando o ouvir e o ver com o dizer e o escrever.” Teles, 2004, p.727

This way we can single out illustration as an indispensable contribute to education and educational tool for this target user because this kind of visual representation increases visual literacy. This idea is reinforced by Alan Mal, that considers illustration the subject that most dedicates itself to explaining and elucidating information, within the visual arts. Which as a consequence, turns it into a great institutional tool, because information it is consumed and assimilated more easily in a visual format. (Male, 2007,p.91).

In “Disletra” illustration is joined by animation which, being a technique that utilizes dynamism as a way of expression, needs to be accompanied by sound. Sound by itself is simultaneously another vehicle of communication with the user of the game, completing the experience and aiding the memorization process. Therefore, one of the crucial aspects of this project is precisely the sound design.

However, adding to the benefits of knowledge retention, music offers, in this context, motivation. It is a clue constantly present informing the player about their success and their failure, and that is also responsible for the creation of a specific environment that welcomes the user into the universe presented by the game.

Considering these goals, a sound track was developed for “Disletra”, in collaboration with music students of the university of Aveiro, taking part in the subject of Musical Composition, oriented by Professor, Isabel Soveral. This collaboration was developed throughout a semester during which many creative meetings occurred in order to discuss the right tone for the project as well as the goals to be achieved by the project, and leaving also time for some experimentation with instruments and different melodies to be used in the game. From the first moment, it was explained to the musicians that there was a strong need for the creation of an initial music theme that would welcome the child into the game, as well as different music for three different game levels that would represent the progressing difficulty of the challenges presented in “Disletra”.



Fig 1. “disletra” Game title

Another factor that was taken into consideration was the motivation as the primary use of the music in this educational context. Motivation, as it was referred, is the fuel that accompanies the child throughout the game. According to Pierre Jovelot, Guillaume Denis and the “Self Determination Theory” (STD), developed by Ryan e Deci¹, motivation exists in three distinct levels: intrinsic motivation, extrinsic motivation and amotivation. Intrinsic motivation makes us act freely because there is the desire or interest in completing an action. Extrinsic motivation makes us act by influence of other factors such as reward or fear of consequence. (Denis & Jovelot, 2005). During the game both types of motivation are in play, however, in the case of sound feed-back, the goal would be to increase the intrinsic motivation of the user, generating interest in the child towards each challenge. But how can you translate this goal into music? What is a positive sound? How can we inflict the will to progress through music? These are some of the questions that were discussed with the music team during the project.

Besides motivating, music needs to reflect the graphic image that had already been designed for “Disletra”. The challenges presented in the game were illustrated in order to create a friendly and a bit silly environment, that would approach the child with playfulness, contained in the animations, using it as a conducting line for the game narrative. Consequentially, the big challenge was how

to translate the visual universe into a sound universe, which ended up becoming a rich creative process of communicating between two distinct senses. Seeing and hearing.

The musicians had access to the graphic design material which was used as a starting point for the team to start creating. Later in the collaboration, based on the first drafts of the music pieces presented by the students, a negotiation process took place, contemplating the existing diverse musical textures. The term “texture” was frequently used throughout the discussion in order to find a common point between the two sensorial planes. One sound is capable of transmitting to the listener memories of another place, time or even materials and tangible feelings.

The same happens with some musical instruments. Sometimes words only are not enough, and body language or improvised vocal sounds become very useful in trying to transmit the image into what it should sound like to a musician. Because of this, the collaboration was carried on by a feeling of synaesthesia.



Pic 2.. Example of the challenges presented during the game. Contrast between two similar words

Synaesthesia is frequently described as a unique and abnormal phenomenon, and often times seen as a singular genetic predisposition, that only a few possess. However, if we observe the art world there are various examples of this sensation and, in my opinion, it is something experienced often by those who work in the creative field. This way, the opinion of B.M Galejev is suitable, because the author describes synesthesia as a common ability of inter-sensorial association that manifests itself through imagination and uses metaphors which have inherent meaning capable of transitioning to another sensorial plain (Galeyev, 2007, p.28). Galejev also states that, following this reasoning, music is naturally synesthetic:

“That is because the ephemeral, abstract nature of music simply calls for embodiment, and this process is accomplished through the associative (in this case synesthetic) psychic mechanism”

Galeyev, 2007

In this case, the associations described by the author corresponded to the most efficient vehicle in order to create a bridge between design and music. For instance, the violins first sounded too rough in the initial proposals of the music team, as if they were sand paper or dry hay. There was also the strong need for1 more “humidity” in the music, that was later identified as a lack of an instrument like a marimba, then introduced in the project after discussion.

Once the musical identity was established, the team focused on the sound feed-back for the challenges in the game, letting the user know when a mistake is made or when the challenge has been successfully completed. In this case, the sound design ended up being something simple, composed by one instrument in order to differentiate this type of communication from the rest of the music featured throughout the levels which feature more complex music where evolution can be heard from level to level, by

1 Within SDT, the humans’ social development is driven by the satisfaction of innate psychological needs for competence, autonomy, and relatedness.(Jouvelot,2005) creating anticipation and letting the child know they have reached more difficult challenges.

Conclusion

In Conclusion, the process of creation between design and music is challenging because it deals with two different types of fields that have in this particular project, been approximated by synaesthesia. The game “Disletra” depends a lot on its ability to successfully motivate and engage the child, something that would not be possible without any sound feedback, thus becoming evident that music is not only a decorative accessory in digital design projects, but an active part of the solution.

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Visual representation in musical education: technology and sound-image

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Since the first graphic representations of music, apparently vague but also suitable when it is used verbally and memorised, from Guido d'Arezzo – and his contribution for staff notation and the relationship between pitches – till 20th century graphic notation – like John Cage and Cornelius Cardew –, music has always had something visual that we can relate, as well as to watch or to teach.

This is a part of my – work in progress – master design project. Thus, this paper shows the importance of technology in developing new ways of teaching and understanding musical concepts in a ludic context of musical education. The main goal is to build something that can help non-musicians to understand how musical concepts such as pitch, rhythm, expression, form and timbre work by using methods of drawing as a tool. Besides that, it will help to understand how they recognise an image – like a painting or an illustration – as a graphic notation, so then they can relate to the sound. To get all this information, the teaching method based on workshops for young kids will help them to experience different

sounds by drawing and using manual and digital ways. Therefore, it will force them to explore, to learn, to play and to improvise in a ludic way.

To succeed, two workshops are implemented: one for Casa da Música, leaded by Dra. Helena Caspurro – lecture of University of Aveiro and jazz musician. It is based on composing music in the classroom by relating draws and sound to the augmented reality and programming; and the other is an experimental workshop where people/kids have to draw something on the computer in two different ways: firstly, they must try to relate the draw they did to musical concepts without listening to anything; thereafter, they have to do the same thing, but listening at the same time they do it.

In conclusion, using the technology as a tool to build educational programmes will help people to understand the relationship between sound and image in a ludic, natural and interactive way. Thus, they can explore on their own and build imagery scenarios and programming.

Keywords Graphic notation; Musical education; Interaction Design; Visual representation; Workshop.

Introduction

One of the topics of my research is Technology and Sound-Image on Visual Representation In Musical Education. Throughout this study, subjects such as sound + image, ludicity in education mediated by technology, graphic representation and sound interpretation are addressed.

The present paper shows a research displays design knowledge as a multidisciplinary tool. Furthermore, focuses on how simple and easy-to-use technology can improve visually a sound-image representation in an educational environment. At first, it is important to dig into visual representations of music or, in other words, to research about musical notation as an important and graphic tool to write, read and understand music. As musical notation has been around so far, it is more relevant to focus it from 20th century till nowadays. At the same time, it is possible to visualize the technological development and how it helped the ludicity in musical education and the connection between graphic representation and sound interpretation. On the other hand, this paper will show two exercises made, their results and how important those experiments were.

Context

Every day we are constantly surrounded by information. Most of that information is understood as symbolic images by giving them a meaning, related with our knowledge and experience. Therefore, those images are a visual representation of what we see, listen or imagine. Sound, on the other hand, has an important function in amplifying the sensations and the interpretation of those images or to create and help to imagine new images and contexts. Name it synesthesia, the relations made when a sound has been heard and made it see a colour/image and vice-versa.

At the top of this relationship between sound + image, music has an important role for this investigation: it is the starting point for a research on how music (thus sound) is represented graphically and visually. Musical notation has this deep connection between what it is being played and what it is being represented and understood visually. As Walters (et. All, 1997) once said:

“Score-writing is a powerful form of visual communication that reaches across the barriers of language, space and time.” Walters, Cardew, & Philips, 1997

This quote is important to understand the role of musical notation and how it helped not only to understand the movements of the sound and the music, but also to reach to more people and become easier to read, understand and, in the following case, to play it.

For this paper proposal, the focus is on the notation is only from 20th century until now. This era is known for the most interesting ideas that came along in arts. A lot of artists, philosophers and part of the society started to think in new ways of expressing themselves, as they felt that everything was deeply saturated and overused. At the same time, everybody started to notice a new technological and scientific revolution and therefore, it helped to open new horizons and thinking methods (Kaneda & Sen, 2014). So did the artists. They started to rethink their musical compositions and look at different ways of expressing themselves. Consequently, musical notation started to change, as musicians and composers felt that traditional scores were not enough to write what they wanted (Psimikakis-Chalkokondylis & Newland, 2010, p. 9). At the same time, new electronic instruments appeared, which they were used in musical compositions. These factors, hand in hand by socioeconomics factors, helped to redesign musical notations and their music became more graphical to represent. Moreover, painters and musicians began to work together thereby those graphic notations became more “artistic”. In other words, graphic notation was more than a mere musical notation: they are actual paintings and works-of-art.

“The performer may choose to realize for example, as a circle, some sort of circular sound, movement or gesture” Nyman & Eno, 1999, p.10

As odd as it sounds, music composers started to care more about the sound movement and intention itself than to write the notes precisely. As quoted by Nyman and Eno stated, the way you sound is more important than the way you play. It is similar to the music written in 11th century – as they used notation to remember the movement of the sound, because the actual notes were taught by their masters or composures – and a more symbolic and graphical method to represent music.

As beforehand written, composers and visual artists (like painters) worked together – or very close. Important composers such as Cornelius Cardew, Brian Eno, John Cage and Earle Brown had their own way to write, to understand and to express visually their music. For example, Cardew's Treatise has this partial abstraction of notation – “partial” because he still uses a score-line in the bottom to represent a staff notation – and almost as an infographic representation of sound; Brian Eno had a Mondrian-like geometric representation of his musical structures; and John Cage and Earle Brown with their complete conceptualisation of sound structure and notation. Even if they used parts of classic notations, the usage of electronic instruments and ideas forced them work as movie directors for their own music. Mostly, they could write exactly everything they wanted to hear or simply let the musician interpret on their own way. Painters like Joan Miró, Piet Mondrian and Paul Klee did the same on the other way around: instead of composing notation for music that works as paintings, they made paintings that worked as musical notations. So, we have musicians to “translate” paintings like Miró's Woman in Front of the Sun (1950) into music.

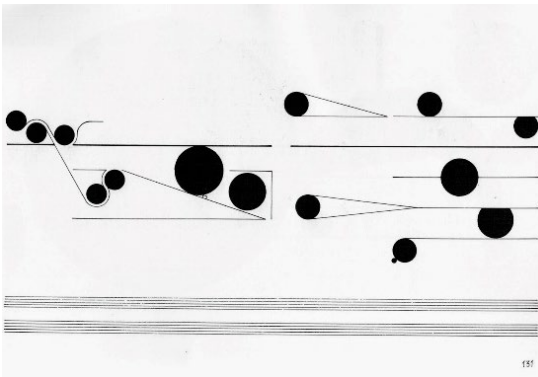


Figure 1. Cornelius Cardew (1963-67), Treatise

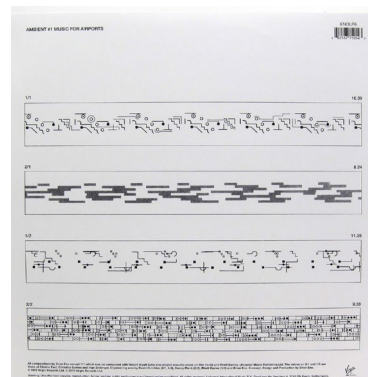


Figure 2. Brian Eno (1978), Music for Airports

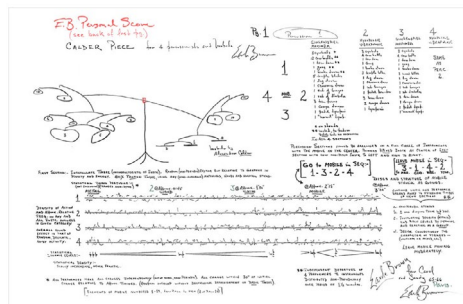


Figure 3. Earle Brown (1966), Calder Piece

Side by side with those developments in musical notation, a significant number of contemporary artists and engineers started to develop and to design tools which could be use not only for making music, but also to communicate it and to teach it in different ways. The educational part has a profound importance because it is one of the bases for those developments. Most of the created things are used as educational tools and inspiring the artists or engineers to develop tools in that way. One of the most important sound engineers and artists is Iannis Xenakis. Inspired by the Bell Labs and their Graphic 1 (Tufts & Sacred, 2010, pp. 167–168), Xenakis created his UPIC (Unité Polyagogique Informatique CEMAMu) in 1977, a touch-screen graphic table, bigger and better than Graphic 1. Both tables were designed to create sound simply by drawing – and also using different colours and textures – on their screens with a light pen whilst listening. The accuracy of UPIC made him compose several music and records by “drawing” his own music – like *Mycènes Alpha* (1978). Xenakis and the Bell Labs helped musical composition and experimentation to reach to new public. Not only new composers, but especially new people, like children, would be able to try new instruments and technologies, learn by improvising and, at the same time, understand visual music easier.

“I am hoping that it would sort of dissolve this VIP status that musicology has that it’s only for the chosen few, if you are super clever, and you’ve studied for billions of years, you understand scales.” Guðmundsdóttir, 2011

Even if these thoughts are from the last century, they are still accurate nowadays. Another project is Biophilia Educational Project by Icelandic artist Björk Guðmundsdóttir, in 2011. This project reveals that it is still important to rethink about how we experience music and how it is possible to teach and to learn in a ludic way. Björk with her project sought to explore as well as new ways to create music for herself and for her new record – *Biophilia*. To challenge herself to compose and then to use her methods to build an app where people – musicians but in particular non-musicians – could learn music in different ways. Instead of learning under a classical and very rigid systems, she made it looks easier and funnier. Her educational project were then tested in several schools with different kids in different countries.

All of these projects are deeply interesting in a pedagogical point of view. Even in 70’s, they were important in this area for the future of education and what has been devolving for it. The ludicity in these projects made them both interactive and playfull (Lopes, 2005). It made possible to learn and to have fun at same time, and that is important when you are talking about someone who is not a professional – or do not even thought about that – but they wanted to try something new and to have a better experience. Even though it is not a good idea to think that something that is ludic is less educational or it has to be taken seriously (Lopes, 2004). Ludicity and ludic technology and methods should be taking as important as the information which is been teaching. The following workshop stands for this idea.



Fig.4. Iannis Xenakis (1977), UPIC

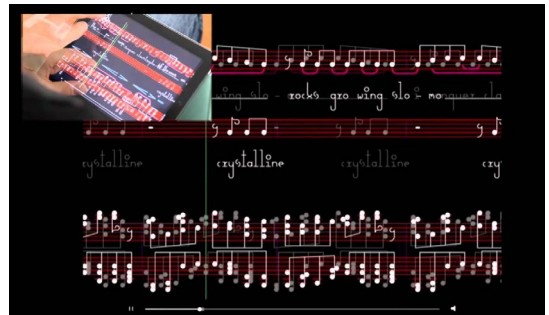


Fig 5. Björk Guðmundsdóttir (2011), Screens from Biophilia Educational Project App

1st Workshop “*Compór na Sala de Aula*”

During the investigation, I was invited by Prof. Dra. Helena Caspurro to join her team and to develop an exercise for her upcoming workshop. It is based on pedagogic and ludic exercises to explore sound, music, interpretation and composition. This workshop took place at Casa da Música, in Porto, and for a group of several primary teachers whose would learn new tools – and how to create their own – to teach their young students to interact and to explore music and sound. This workshop had a duration of 1 day, with the collaboration of two students of Dra. Caspurro: Inês Teixeira and Pedro Galego. It is relevant to mention that everyone in that team were musicians and music students except me. I had only studied music.



Figure 6 & 7. Marcelo Baptista (2016), Stills from the Workshop

As reported, the main goal of this workshop was to develop tools for a musical relation in primary school for kids. This was the starting point, then I tried to develop something that I could fit in a sonic-visual technological process of understanding and learning music in a ludic environment. In other words, transforming draws in physical communication supports mediated by a digital technology. After a couple of ideas developed and experimentations made, in this collaboration I came out with the idea of developing a simple ID Card-like based on a visual interpretation of a personal sound performance or music.



Figure 8. Joan Miró (1950), Woman Behind the Sun

Apart of my exercise, there were a couple of others exercises where people could express themselves through sound movements and body expressions. One of them was an exploration of a traditional Portuguese sing-a-long melody in loop. This exercise was intended to interpret on their own way and to make new melodies of this song. The other exercise was more exploratory and abstract.

The focus of this one was to “translate” into sound a painting by Joan Miró. The idea was to understand the movement of lines, the intensity of colours and which ambient it should give to the performance, as well the position of the elements which gave them some idea of a time line and time expression.

Heading back to my propose, Bilhete de Impressão Musical (“Musical Impression Card”) is a personal card for each one participants. Every card had the project identification, each ID number and a personal visual code to be recognised in an augmented reality phone app named HP Reveal (used Aurasma). In the middle there was enough white space to create a graphic representation of their personal sound performance. It worked as a personal signature.

This exercise is structured in 3 different steps:

- 1st. Children had to self-portrait them in a one-minute body expression and musical way, while I was recording them. This performance followed a series of exercises for body relaxation to make them feel comfortable. Later on, this record will be used a-posteriori on an augmented reality program. In a classroom, these practices would help teachers to create a good relationship with their students and make them feel free to perform;
- 2nd. Later in the exercise, the performer shall draw in 30 seconds a graphic representation of their interpretation. This representation would help them to develop intellectual understanding of music and what it makes them feel it. This exercise develops children’s drawing capacity, as well as their creative thinking. The quick time gave them a boost to think faster and more precise, so teachers (and eventually children) would draw the first thing that came across their minds;
- 3rd. The final step was to relate everything they have done before, each musically and graphically, using the augmented reality option. With their phones’ cameras on top of the code, the app would recognise it and reproduce the performance. At the same time, they will still have the opportunity to see the card and what they draw. In a simple step they had the visual-sound performance and their graphic representation. There was a background work: each video had to be related to each visual code into the app in order they could use it. This specific step would be interesting to explore in the classroom with children. They would have a chance to interact with this kind of technology, which is quite easy to use. Furthermore, they will have an idea about what is programming and how to do a video.

To summarise, this workshop helped me to understand how important a designer thinking and methods are to explore and to experiment different ways to teach something in a ludic and interactive way. Also, I hope it will help Design to see different possibilities in its own area, to explore ways of turning a simple draw into something different from a distant environment. It is important as well to think about exercises that would help the user to draw freely and expressively, instead of giving them too many rules to explore.

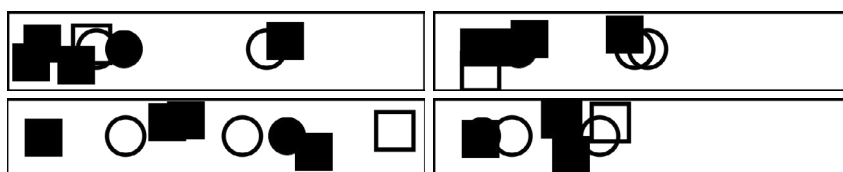


Figure 9. Marcelo Baptista (2016), Examples of AR codes

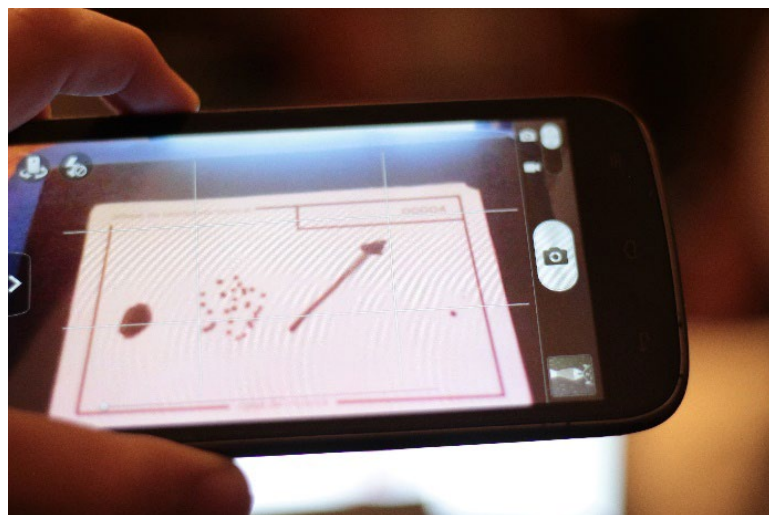


Figure 10. Marcelo Baptista (2016), Reading camera screen

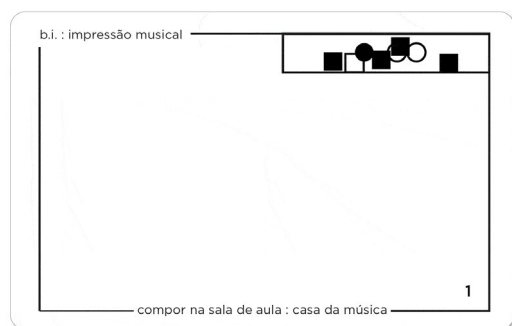
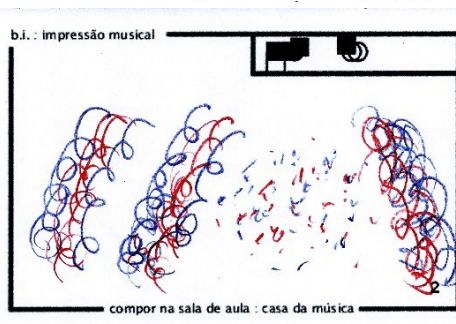
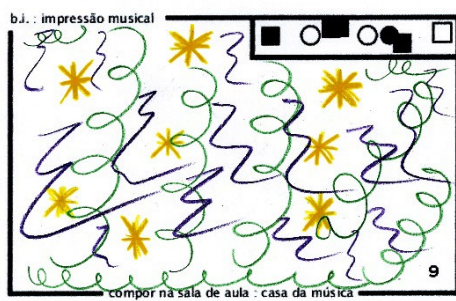


Figure 11-15. Marcelo Baptista (2016), ID-card model & examples of draws made on workshop



2nd Workshop “Noema/Noesis”

The second workshop was a simple exercise which started as an academic propose to develop an idea that could represent our dissertation theme based on Noesis and Noema theory.

Noesis and Noema are a Husserl’s phenomenology which means two different ways of perception of an action. It is helpful to understand if people do perceive what it is supposed to. Noesis means the actual meaning of a particular action or object and Noema is our interpretation and perception of an action (Rassi & Shahabi, 2015). For example, if I hear a sound, I imagine something visual to relate to. However, this does not necessarily mean that it is the real meaning of that sound. I could draw something on a screen and then someone try to relate that with something musical, and that perception would be different from the actual meaning of that draw.

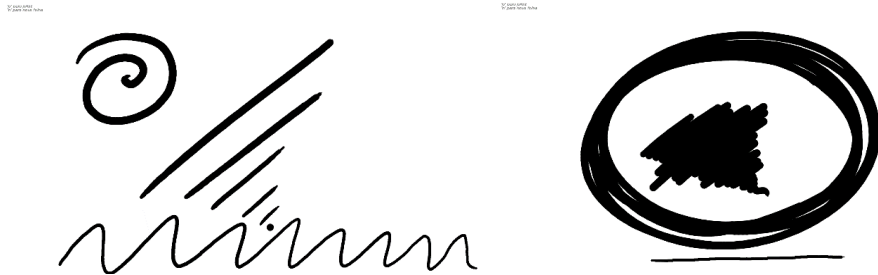


Figure 16 & 17. Marcelo Baptista (2016), Workshop graphics examples



Figure 18 & 19. Marcelo Baptista (2017), Stills from the second workshop

The goal for this exercise was to build an interactive artefact where people could relate visuals and sounds in a very straight forward and simple way. I built a little programme on Processing software where people could draw in a graphic table something of their desire. On the screen, it will appear what they were drawing in a simple black and white illustration. The colours were not used in this exercise so I could make it simple and it indeed matches with my main dissertation project. While someone is drawing, a sound is playing and matching with their draw movements. For example, if I draw a line growing up, I would hear an ascending sound.

Thus, I invited a couple of students to test this little exercise. Firstly, students had to draw something simple on the graphic table, without hearing to anything. Then I would ask them how the draw “would sound if you had to translate it into sound movement?”. This question helped them to think about how they could relate image and sound in their minds. This is a noema interpretation. Later, I asked the same people to draw again, but now they would hear a sound at the same time. This helped them to suddenly understand that which movements they were doing and how it could be “translated” in a sound movement.

This kind of exercise are a simple way to relate sound and image. It could be possibly abstract in a way, but it is a first step for something more interesting and important, like to teach people something about music, relating it with images and graphical movements.

Finally, I “reused” this practise on my final master project. The workshop was developed to test a prototype of a musical machine based on electric paint technology. This wood box recognises people’s touch on the paint of their illustration and then reproduce a sound. It is almost the same exercise but produced in an analogical environment, which is also important for children (the target) to interact with. In this workshop I teach notions of musical concepts, like notation, pitch, rhythm, timbre, form and dynamic. The digital program that I developed was used during the spare time while the participants’ illustrations were drying. Even if it is done on a computer, users still have an analogue interaction with draw. It is also a more precising tool than the musical machine.

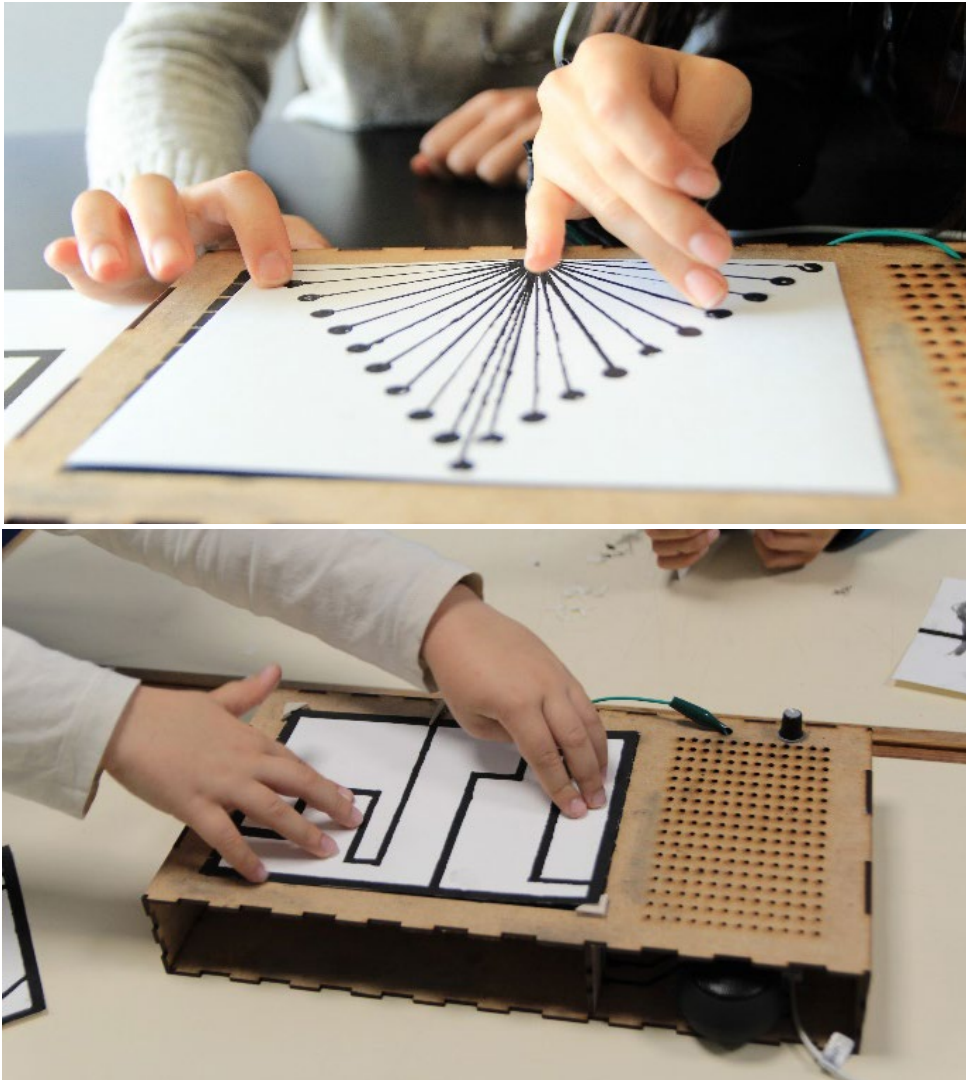


Figure 20 & 21. Marcelo Baptista (2017), Stills from the workshop

Conclusion

This part of my investigation helped me to understand the usefulness of a multidisciplinary work in design. Not only in my area, but also in all these different areas I've worked on, which are far from design, could be related and understood under a designer point of view and to build bridges between them. It is important to build tools to improve a better and understandable vision of music and sound through a visual and interactive environment. Those visuals should be more abstract and free of pre-concepts, as it is way more ludic and playful to learn new things. Above that, it makes users and investigators to get in touch with new technologies which could improve new teaching areas, like semiotics and programming, and develop new interest for the users.

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The Consciousness of Sound

Carlos Alberto Augusto

Composer and sound designer

Tragedy, Aristotle wrote in the *Poetics*, exists even without performance or actors. It is therefore implicit in the written text that casts it to posterity. Is it alive then? Or does it become alive as it is performed? How? What does it mean exactly to breath life into a text? Can a theatrical text have a soul? Or is tragedy something else

altogether? Can a theatrical performance have consciousness? Can art in general have a soul? Tononi's *Integrated Information Theory* is a tool, developed in the course of the studies of the brain, that might help shed some light on these questions.

Keywords: Sound, Theatre, Integrated Information Theory, Consciousness, Orality, Literacy, Cinema

We are constantly subject to stimuli, originating inside and outside of ourselves, that generate experiences. These in turn have a dual consequence: they help us understand our own inner reality and the reality that surrounds us. Sometimes we are aware of these stimuli but they often elude or even trick us.

Diane Ackerman (1995), the poet and writer, describes an experience of smelling the eucalyptus during her childhood in California. Years later in NYC, upon sensing the same smell, she describes it as having the power to evoke this childhood memory.

Yi-Fu Tuan (1993), the geographer describes another type of association. To Rimbaud, he writes, the letter “A” reminded him of the color black. To Nabokov the same letter elicited two reactions. The “A” in English, suggested the tone of aged wood, whereas in French it suggested polished ebony.

An old whaler from the Graciosa Island (Azores, Portugal) told me that before radio communications started being used, the method for signalling the approaching of a whale to the whalers in the island followed these steps: a watchman stationed in a sentry box situated on the top of the island’s highest mountain, would fire rockets in a coded sequence. This sequence of sounds indicated not only the presence of the animal, but its location and trajectory. Upon listening to the sounds each whaler would run towards the nearest boat, which would in turn lead them into the desired location.

The first two examples indicate intimate experiences, of which we become aware because the people involved in them described their nature and their reactions. So many experiences like these stay forever inside the deepest corners of our minds because they are not described through language or expressed in any other form. They can be difficult or even impossible to describe. In the case of the whalers, the fact that these men were coming from different locations, heading collectively towards the same goal, means that they all reacted in the same way to the experience of listening to the codified sequence of sounds.

In these examples, the descriptions of the experiences and the reactions that ensued mean that everyone was conscious of the stimuli that acted upon them. In the first two examples we can only become aware of these reactions because the people that were subject to them were willing to describe their experience. In the case of the whalers their reaction testifies that there was a collective consciousness of the sounds and the experience was shared by them all.

The subject of consciousness has been discussed by artists, scientists and philosophers. We all know what consciousness means. But how can we share the experience that this consciousness entails with others? Francis Crick (1994), the scientist who along with James Watson gave us the structure of DNA, stressed the physical nature of consciousness and noted that it is an “active process”.

A process therefore, a dynamic one.

The study of consciousness is important not only because it is a particularly special human trait, but also because there is often no external indication that this process is taking place. Language is one of the ways we become aware of these inner experiences of others. This was the case of Ackerman’s experience with the sense of smell or the examples of synesthesia in Rimbaud or Nabokov described by Tuan.

But things might be different if we witness complex behaviours and have no help from language or any other external element that can throw some light on this complexity. It is clearly the case of new born children or patients who have suffered an accident that prevents them from describing their condition. It is also the case of a normal person during sleep. And what about animals? Evidence shows that they can be subject to the same stimuli as we are and show a similar behaviour. What about computers? These machines perform tasks that only humans

were hitherto capable of performing: They can interact, guess, recognise voices and faces, write music or poems. Is it legitimate to say that they have a consciousness, since they are capable of performing human-like activities? Can we rule out the possibility that all these beings and machines have at least some sort of consciousness? How can we obtain proof of that?

“It seems alive” is an expression we often use in relation to animals, objects or machines because a stimulus and a response to it shows intriguing similarities with the human behaviour under similar conditions. Certain theories like Leibniz’s panpsychism suggest that consciousness may be a common thread throughout the universe. Some scientists even claim that given its apparent ubiquity, consciousness should be considered a fifth state of matter.

Is it be possible to describe more accurately the character to of consciousness? Is it be possible to measure it like we measure electric current or pressure? In the framework of these questions Giulio Tononi has proposed an Integrated Information Theory (IIT).

Very briefly, in the words of Tononi, “The IIT claims that, just as the quantity of consciousness generated by a complex of elements is determined by the amount of integrated information it generates above and beyond its parts, the quality of consciousness is determined by the set of all the informational relationships its mechanisms generate. That is, how integrated information is generated within a complex determines not only the amount of consciousness it has, but also what kind of consciousness.”

“Consciousness is experience,” Tononi emphasises and IIT, he further notes, “aims to provide a principled account of both the quantity and the quality of an individual experience, and a calculus to evaluate whether or not a particular system of mechanisms is conscious and of what.”

IIT is based on a set of axioms (which refer to consciousness and the experience it generates,) and postulates (which refer to the physical systems, upon which consciousness is based.)

Conscience exists, IIT recognises, on its own as a unique phenomenon. At any given moment each experience is unique, i.e., different from any other possible experience.

Consciousness, IIT points out, cannot be reduced to its components, it is singular in its content and in the spatio-temporal dimension it occupies. The structure that supports consciousness is built upon mechanisms. Each mechanism exists in a state that is not dependent upon the observer, and is capable of generating cause-effect type of responses, by itself and independently of any external causes.

A system is structured so that its mechanisms, in changing their state, generate responses, based upon the information they receive. This allows them to evaluate previous and possible future states. Those evaluations are different from the ones that go on in different systems, even if they are based upon the same mechanisms.

A system of mechanisms, in a certain state, determines a specific structure, different from any other possible structure. The system is unified, i.e., it cannot be reduced to any sub-system that is not independent and it cannot be reduced to any sub-system that is interdependent on it. This interdependency can be measured as the value of integrated information.

This is but a very brief summary of the theory. I suggest reading the materials listed below and the numerous others available on the subject.

The challenging quest

IIT emerged in the context of neuroscience,. It was rooted on the studies of the brain and addresses that area. Despite the origins of this theory and the field it aimed to be applied, the

amplitude of its goals and the merits of its conclusions — to be sure, still under assessment — the model suggested by IIT seems appropriate to the study of other areas, and seems like an unexpectedly useful tool to help answer other questions and analyse other phenomena, bold as they might seem to be. Art in general and theatre in particular, may sound as improbable candidates to place under such scrutiny.

“Theatre is a universe of deliberately manipulated dimensions” (Augusto, 1990). All arts are rich, diverse environments, even if that is not always readily acknowledgeable. Applying IIT to uncover some of theatre’s hidden dimensions seemed like a challenging quest.

“(Consciousness) is all we are and all we have: lose consciousness and, as far as you are concerned, your own self and the entire world dissolve into nothingness” (Tononi, 2008.) Art’s probable ultimate goal is to create consciousness. Not a metaphor of consciousness, but actual consciousness and therefore experience. If it does not create consciousness art is probably also dissolving into nothingness.

From the standpoint of IIT, the creation of experience through art can be accomplished following a double sequential process.

Firstly, by creating mechanisms (equivalent to the *Neuronal Correlates of Consciousness*) and sub-systems that produce the integrating process. Secondly, by exhibiting the object of art, in which case the interaction with the audience generates the final integrating process. By exhibiting the object of art the artist transform the spectator into the ultimate integrator.

In the first case we have the creation of the illusion, in the second case we have real experience.

Tragedy exists without actors and acting in the text, as Aristotle wrote. But it does generate a sub-system with a low level of consciousness. When it is presented to the public, maximum integration and the highest level of integration can be obtained.

All this is contained firstly in the text which creates its own “Neuronal Correlates”, its mechanisms, organised in systems and sub-systems, represented by the characters, their traits, their states, each containing a repertoire of possible states, creating connections, referencing past states and suggesting possible future states. All this sets up a topology that is capable of generating a unique experience.

Tragedy is present, in fact, without actors and performance, already in the written text, as Aristotle put it. However, as he further notes, it is an enactment of a deed, not merely a reciting of a text. In pursuing this goal tragedy creates a sub-system, to use a notion of IIT, that has a low value of consciousness which reaches its full value when the text is enacted in front of an audience, hopefully generating experience.

Writing provides the framework within which this happens. Writing creates the “Neuronal Correlates of Consciousness”, that tragedy needs to achieve full experience, preparing its mechanisms, its characters, their states, their links, unfolding its repertoire of possible states and their current and future possible combinations. It thus produces the necessary conditions to generate a unique experience.

These are the elements that are presented to the public.

If these mechanisms work, if they provide the necessary information about the systems and sub-systems and these successfully generate integration processes, all the way through the final integration process that is performed by the public, the system is capable of achieving a high degree of consciousness, ergo experience. Real experience that does not derive from a *a priori* real life situation.

Writing further creates conditions to generate the unique character of this experience, distinguishable from other similar experiences or from experiences that result from lower value consciousness states, or, as Bennet (1990) puts it, “the codes/systems of expectation which provide the necessary markers for what is (or is not) included in a production.”

The audience registers the unfolding of all possible states, the changes that occur in each mechanism and sub-system, as a super system allowing it to perform the final integration process, which generates unique experience. This is based on a written text. Each mechanisms and sub-systems unfolds, without the interference of any extraneous elements, and is capable of generating a process of integration that has a high value of consciousness, and is thus capable of providing the strongest possible experience to the audience.

I am not trying to provide a mechanistic explanation for the work of art, but rather to find relevant aspects that might help interpret more objectively the *quality* of art and explain subjective or poorly explained concepts such as the aristotelian “catharsis” or Benjamin’s “aura”. Under this model, we can postulate that what helps define the success or failure of a work of art is its capacity to generate maximum integration under the constraints that the work of art itself defines.

In the case of the theatre, it is through sound that the entire process evolves. Sound, much like the electric current that runs through our nervous system, feeds and ties every mechanism, and it is through sound that the final integration process takes place. Greek theatre — an art form based on a text or script — is a sound ritual. What seems legitimate to conclude when we analyse the history of Greek theatre, is that given the importance of rhetoric in Greek society (arguably the original “mass media”) and under the influence of other factors such as religious chants, an art form emerged that inherited its formalism and economy firmly based on different elements of acoustic communication.

This new art form demanded a space specially designed to project words and music, allowing the public’s reaction to reach the performing area without any constraints, thus creating a physical infrastructure that allowed the free flow of these acoustic communication elements.

Walcott (1976) stresses this point when he writes that “stage, orchestra and auditorium formed a single unit and so too did actors, chorus and spectators, all of whom were sharing in a common act of devotion.”

In a theatre such as Dionysus the distance between the *orkestra* and the front rows would be about 20 meters and about 100 meters for the more distant rows. The largest Greek theatres could house between 14,000 and 50,000 spectators. In Athens, half of the city’s population would attend each performance. If we compare spaces, taking into account dimensions and capacity, the closest we have now is a small football stadium. An actor 1.80m tall would not seem taller than 9cm to the spectators of the front rows and 2cm for the more distant ones. At these distances, masks were used to compensate the difficulty of using any subtle visual expressions. Any props, settings and costumes (using these concepts in their modern interpretation) would be of very limited usefulness. “Subtlety was left to the human voice, which was, both for the actor and playwright, the principal means of expression. (...) Although not much could be seen in Greek theatre, everything could be heard” (Arnott, 1989.)

For the playwright, in turn, subtlety was achieved through writing for sound and silence. Várzeas (2001) writes about the “silences” in Sophocles. She describes the ways silence is carved, and how one anticipates the ways sound in turn emerges. In his use of silence, in the ways silence “represents and controls duration, the behaviour of the character that uses it, the reactions of the other characters, all that as a means through which he wants the *spectator to receive and*

understand his scene,” one clearly the pivotal role that sound played in the original theatrical performance.

As Arnott further notes, subtleties can only be understood within a context that is difficult for us to understand today. Only a public generally endowed with great listening skills, that enabled them to listen to a play in such circumstances — capacities that modern audiences do not possess — can we understand how Greek theatre evolved and the special traits the audiences must have had to attend these performances and their role in them.

Audiences were not passive. They participated actively, becoming deeply involved, questioning and commenting what went on on stage. “Greek theatre, then, clearly illustrates a direct relationship to the society it addresses and, at every level, includes the audience as active participant.” (Bennett, 1990).

This formula was used throughout the classic period (Greek and Roman) until this period fell into decay and it finally ceased to be used. Scattered elements of this formula were used during the medieval period, mixed with other elements of the popular and religious tradition. This also came to an end until an attempt to recover it was made during the Renaissance period, as it is well known.

“The ancient Greek drama (...) was the first western verbal art form to be fully controlled by writing. (...) Paradoxically, although the drama was presented orally, it had been composed before presentation as a written text. (...) But until print appeared and eventually had its fuller effects, the voice’s allegiance to episode always remained firm. (...) Print (...) mechanically as well as psychologically locked words into space and thereby established a firmer sense of closure than writing itself could.” Ong, 1982

While the word was locked and closure became firmer, the performance area moved into new smaller covered spaces, safe from the unpredictability of the weather, the audience was progressively pulled away from the area of performance and silenced, separated by lights and by a proscenium, made to look through a framed stage box, focused on the vanishing point of the trompe-l’oeil painted setting, distracted by an increasing number of visual elements, added to sustain its decreasing participation in the process of integration. All this produced a disturbances that have never been properly corrected.

The progressive shift from an oral and acoustically centred world into a literary and visually dominated one opened the way to the introduction of extraneous visual elements, “which tended to distract attention from the dialog, which caused [Ben] Johnson to give up writing masques, not wishing, as he said, to compete with the carpenter or the scene-painter” (Hartnoll, 1987.) The introduction of new visual elements, separated from the text, contributed to disrupt or even destroy the process of integration, decreasing the value of consciousness and threatening the quality of the experience. According to IIT, if there is no integration, there is no experience.

A dumb discourse

“Alonso - I cannot too much muse, such shapes, such gesture, and such sound, expressing, — although they want the use of tongue, — a kind of excellent dumb discourse.”

The Tempest, W. Shakespeare

Theatre based on a written text was created in Greece over 2500 years ago. Sound is the element that runs through and links its most basic building blocks, and creating the framework within which all interactions took place: the performing area, the technique of the performers and the capacities of audiences all fit coherently within a common space that has an acoustic nature.

Sound permeates the smaller crevices of Greek theatrical space. The written text relies on the sounds of the spoken word and the music to trigger the mechanisms that produce experience. The original formula that characterised this art form persisted throughout the Classical period, it declined as this historic period withered and it was recovered during the Renaissance. However when the formula was re-enacted, the original conditions that gave it that coherence had already changed. The performing space was different, as seen. No longer designed to be acoustically responsive and act as a special resonance chamber, but to accommodate different, more immediate needs. The further introduction of lighting, scenery and lighting, which, like the space, were all elements destined to fulfil a role outside the text, completed the change.

The coherence in which a play functions is determined by the text, in its several elements and in its structure. This coherence, which represents a sort of genome of this art, was recovered after the decline of the classical civilisations, during the Renaissance. But during this period western culture also went through profound changes. One such change, of particular importance since it had profound consequences, was a shift from an acoustically-centred world view (we perceived the outside reality mostly through listening) into a visually-centred one (the eye became the dominant sense.) A transition from an oral into a printed culture may have acted as one of the reasons for this shift. The “world heard” was omnidirectional, fathomed through sound. It was a world of resonances and echoes, a centripetal world, a world of inclusion. The “world seen” has different qualities, produces different signs, reflects upon the environment itself in a different segmented way. It is a centrifugal world, it divides, it promotes separation. Writing for the theatre reflected the “world heard.” The “world seen” demanded other qualities that writing for the stage never incorporated properly. Producing texts designed for the “world heard” through the tools and demands of the “world seen” produced an object which lacked coherence, that could never be convincingly grasped. Writing for the theatre never coped with this worldview filtered by the eyes, except perhaps during the ill-fated period of the *commedia dell’arte*,

The introduction of visual elements in theatre production, on top and sometimes against the spoken text, added no value to the its economy.

Is it possible to use the original Greek model and successfully incorporate additional mechanisms not present in the original sound rooted concept? This model was created, developed and functioned successfully under circumstances deeply different from the ones we have today. Should we change or adapt the model? Other arts, cinema, video and dance, for example, developed languages that incorporate both audio and visual mechanisms in their sub-systems. These mechanisms are reflected and weaved into the very fabric of the text. They are not “décor” or “effects”. Theatre is a conservative form of art, in the sense that it has a precise and not very flexible concept, and it never coped properly with change.

The case of integration

Every form of art seems to obey to the same principle: to create sub-systems of internal mechanisms, based on attributes of that particular art form. From these stems a preliminary process of integration. In that sense it already possesses some degree of consciousness and produces some degree of experience. These early processes are then presented to an audience, individually or collectively. The audience constitutes the element that performs the final stage of integration, generates the highest possible value of consciousness and elicits the final experience. Any disturbance in this chain will ruin that experience. This is valid if we are watching a movie or a dance performance, looking at a painting in an exhibition or reading a book. In any of these cases the “text” contains all the elements necessary for the integration.

Disturbances, as mentioned earlier, that might accidentally jeopardise the experience generally come from elements external to a particular form of art or from an improperly designed object.

Theatre is a case of a long established art form that deliberately introduced disturbances in its own internal processes of integration which lead to generating a low consciousness value content. The increasing dependency on visual information paved the way to the introduction of technology that attracted the direction of the eye in an art that was built upon the rule of the ear and hearing, in which the text plays a confusing role.

Modern technologies, particularly digital technology — light tracking along with video and sound projection technologies — could help regain and enrich the original Greek formula, provided these elements are incorporated in the writing process and that playwrights, themselves, become literate in the use of these technologies. This is the challenge that modern theatrical production faces.

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Abstract Rhythm Model

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The Abstract Rhythm Model results from a research whose main objective was to identify and understand the relations between music and painting, regarding their material means and their compositional processes. In this paper I briefly present a schematic conceptual representation of these relations, as well as a technique capable of operationalizing this scheme.

I discuss the possibility of deconstructing the material means of musical and pictorial creation, striving to identify correspondences and divergences between them, in order to reach what might be called (following Adorno) “an immanent principle in a pure sense.”

Drawing on a *two-dimensional* perspective of the material means, I suggest that the process I named *colapsagem*, an interaction of one of the dimensions on / against / with the other dimension (for each of the material means) can

accurately portrait the deconstruction process, allowing us to come close to “essentialy” common / transversal elements of the creative / compositional endeavour, both in music and in painting.

These elements (shape and duration) occupy a central role in the explanation of the Abstract Rhythm Model.

The Abstract Rhythm Model can be used as a multi-artistic compositional model, a single model for emerging parallel composition processes, in different artistic expressions, having a common initial *phase*. To illustrate some of the model’s *features* I present some examples of what I called universal score. I will use some extracts from *qup*, which is a piece I composed for alto saxophone with resonator tube and drums, and a piece that was also object of exploration and pictorial performance / interpretation by an invited artist.

Keywords: music, painting, compositional process

Introduction

The research I'm about to present was mostly pursued while I was doing my Masters in Composition and Music Theory, at the School of Music and Performing Arts, Porto (Portugal) (Hamido, 2013). I will shortly present the experiential and exploratory trajectory from which resulted some works, as well as multiple emerging reflections that motivated me to study the relation between music and painting and that led me to the Abstract Rhythm Model (ARM) creation.

I will then present ARM's framework and techniques, as well as an example for its implementation. I will finally draw some conclusions and future directions for this research.

1. Previous work and influences

"(...) How I wish, father Bartolomeu, that my music would one day be able to expose, oppose and conclude as do sermon and speech (...)"

in *Memorial do Convento* (Saramago, 2000, p. 114)

This is an excerpt of a book that I read while I was still a teenager. It portrays a dialogue between a musician, Domenico Scarlatti, and the priest Bartolomeu de Gusmão, in which the former speaks about his dream, to make music convey meanings that can be deciphered by all, as it happens with oral speech.

Scarlatti's dream triggered a set of reflections, questions and readings that marked some experimental work that I have developed since then. The plurality and miscegenation of my long lasting artistic interests also fostered these reflections, as well as my gradual improvement in mastering some technological tools.

In *Musical Syntax* I decided to take the risk and the effort to achieve the means for transcoding sound into text in real-time. I mobilized a set of digital tools that allowed to capture and process the sound of my saxophone in real-time, with written characters appearing in a blank wordpad document which, in turn, was being projected on a screen¹. The correspondence of each note to each character obeyed a set of rules implying a non- arbitrary relationship between signifiers (articulated sounds and letters) and meanings (in a poem by Fernando Pessoa). I named this project *musical syntax* because it involves a combinatorial logic of sound and visuals, generating understandable meanings.



Figure 1 - example of correspondence between notes and characters for Musical Syntax

SaxPaint was an improvised music and painting performance, a sort of a game-based activity, in which I and the artist/painter, with whom I collaborated, followed each other, obeying a set of simple, previously agreed rules. We alternated the “conductor role” of the performance, in the first two phases, and then we improvised freely in the third phase. This was an experience of correspondence between music and painting, involving a more markedly performative aspect.

¹ To see a short clip of Musical Syntax: <https://goo.gl/C4BQpx>



Figure 2 - lines, phase 1 of *SaxPaint* performance

In *Musical Syntax v2* I used an IBM electric typewriter (Selectric II) as the output for the musical messages being transcoded. The resulting fictional text was dependent on the sound, and this interplay became all the more interesting as I was also playing with the sounds of the typewriter itself.

One last previous work, *VidiV*, was a piece for vibraphone and video projection, in which several correspondence rules between the sound and the elements on the video projection were established. In this work I conceived another transcoding system making use of digital media: with real-time video generation, pre-recorded video and through composed music².

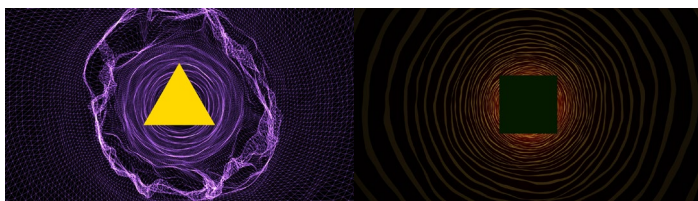


Figure 3 - stills from *VidiV*, part III

These several transcoding systems were intended to be a starting point for co-construction processes involving artists and musicians. But there seemed to be this persistently dependence underlying all resulting products: In *Musical Syntax* music was dependent on writing, since the score was a text; music dependent on painting/visual elements and vice versa, in the case of *SaxPaint* and *VidiV*; and writing dependent on music in *Musical Syntax v2*. This dependence and sometimes even process rigidity, created uncertainty as to the nature and relevance of the material media (musical, visual and written) because the outcomes in one of them were dependent on outcomes on the other. Also, it seemed that in *SaxPaint* and *VidiV* the division of performance and score into different parts with a different set of rules, and the constant exchange of roles, opened the range of possibilities and ensured simultaneously, or rather alternately, the individual interest and independence for each material.

It seemed that the dependencies/constraints created by the transcoding systems themselves (rules for correspondence) somehow prevented each of the expressive media from reaching their full potential.

So, although still attributing relevance to this working method sustained in the articulation of various means of expression, “integrated creativity” as Joan Truckenbrod (1992) defends, at this point I realized that I should try to preserve the independence of languages. Although I gained conscience that at some point a system based on some set of correspondences would still be necessary, I also realized that striving to understand the nature of the relation between music

² To see a short clip of *VidiV*: <https://goo.gl/TcNZBZ>

and painting, and their compositional processes, would imply going through a deep differentiation and comparison of their respective material means. For the purpose of my work I decided to focus on sound as the fundamental material mean of music, and image as the fundamental material mean of painting.

Two questions arose:

- What correspondences can be found between music and painting?
- How can the compositional processes of music and painting be related?

Although these are theoretical questions, they actually emerged from practical problems and from *praxis* - the reflective dimension of my own practice. Trying to answer them, I wanted to gain some insights into the “fundamental” relations between music and painting from which I might extract “true” correspondences, useful for co-creation processes.

1.2 Brief literature review

Several authors have explored various correspondence scenarios between music and painting as well as notations and reciprocal translation systems. In most of them, we observe the option to deploy and evolve one medium depending on the other, without preserving the independence of the languages.

We find in Collopy (2001b) an exhaustive overview of the types of correspondences already explored, including evidence that this issue has been occupying the reflection of man for centuries. Most frameworks for correspondence, however, pose numerous problems, first by their speculative character which ensures no effective correspondence (“real match”) between music and painting. Fred Collopy even characterizes correspondence between colors and sounds as random. Furthermore, whereas the physical phenomenon of color tells us nothing about the existence of color scales, the division of the continuum of sound frequencies in musical scales directly relates to the physical phenomenon of sound, i.e., the nature or organizational essence of music (Vergo, 2012).

Still, many authors present arguments against the doctrine of correspondences. I would like to refer particularly to the writings of Goethe who, in his theory of color, states that color and sound cannot be directly compared because although both are derived from a common “superior formula”, each is a derivation, assuming individualized surface forms and directions:

“Color and sound do not admit of being directly compared together in any way, but both are referable to a higher formula, both are derivable, although each for itself, from this higher law. They are like two rivers which have their source in one and the same mountain, but subsequently pursue their way under totally different conditions in two totally different regions, so that throughout the whole course of both no two points can be compared.” Goethe, 1840, pp. 298-299

In the course of my survey on the state of the art, I came to realize that systems that seek to match music and painting parameters may produce interesting results but cannot be taken as universally driven or absolute.

Regarding the parameters of material means of music and painting, only analogies can be drawn, and no actual (“true”) correspondence can be defended in relation to these parameters.

This renewed openness towards the design of analogies and the projection of a “superior formula”, redirected, or rather, tapered the area of my research in a more conceptual, perhaps more philosophical sense. In this context, among all the works reviewed, *On the Spiritual in Art* (Kandinsky 1912, trans. 1946) is the one that assumes the greatest impact and presents a

most valuable contribution to my own work. It aroused in me and nurtured a new conception of thinking, making and appreciating art.

In this remarkable work Kandinsky says: “Deeply concentric, each art is separated from the other but on the other hand, they are combined in their innermost tendencies.” (Kandinsky, 1946, p. 36). He is referring to the “Principle of Inner Necessity”, the central element of his thesis, whereby all objects, whether words or visual elements, transport an inner vibration. He further argues, in *On the Question of Form*, that pure abstraction is equivalent to realism because they both refer to the expression of these “inner resonances” through material means; therefore, the real and the abstract are inwardly equivalent, and the artist can use either one to express himself, which eliminates the so called problem of the form (Kandinsky, 2008, p. 23).

Kandinsky’s written correspondence with the composer Arnold Schoenberg, with whom he shared many views, also added much to the conceptualization of Compositional processes both in music and in painting, as well as to the fundamental relations between them.

Similar to Kandinsky’s approach, Adorno proposes a category of convergence between music and painting, only attainable when each of the arts pursues its own “immanent principle” “in a pure sense” (Adorno & Gillespie, 1995). This idea of a “pure sense” is directly related to several other authors’ concepts, among others, the “total work of art” by Wagner and Patricia Railing’s “pure painting” and “pure rhythm [conceived as] fusion of time and space in abstract art” (2005).

These concepts that explore fundamental tendencies and principles (which underpin the very idea of what is “essential” in art) have significantly fueled my reflections and brought insight into the questions I posed concerning the relationship between music and painting. They made me think that perhaps there is something interior to the art making process, and maybe we need to deconstruct Art to try to see what’s inside, to expose its essential nature and understand the inherent / immanent relations among its various derivations.

“Every act of creation is first of all an act of destruction (Pablo Picasso)
Yes, but always with a constructive intention. (Guerino Mazzola, Joomi Park, Florian Thalmann)
Mazzola, Park, & Thalmann, 2011, p. v

2. A model for Composition: Abstract Rhythm Model (ARM).

2.1. The Framework: < | >

After a thorough review on the possible approaches to the relations between music and painting I came to understand that, despite the enormous diversity and virtually unlimited amount of possibilities, all of them seemed to fit the following representation < | >

<		>
Opening Point	Parellelism & Anology	Convergence & Resolution
Create	Combine	Simplify
God	Man	Machine

Table 1 - <|> framework

It aims to be a representative scheme of the types/stages of relationship between music and painting.

This first stage happens before there is actual music or actual painting, it represents a place where they converge and after which they can become actual music or actual painting. The point from which creation begins, much like Goethe's mountain where the artistic expressions start to take form.

In this second stage, music and painting are already formed, so they co-exist, and in this stage we can try to draw an analogy but there is no single parameter from one that can be related to only one parameter of the other. There can be multiple analogies - it's free, it's coexisting.

In this third stage we would create multimedia pieces like Musical Syntax, where one can only have his piece if a set of rules or algorithms/chain of linked parameters are met. Then one would have a convergence of the two media, although not exactly of music and painting, but more of an interpretation of music and painting.

With my research I focus my attention on the first type of relationship. My goal is to better define the path that goes from the common point, the "original" convergence state of music and painting, to their material realization. With this purpose, I'll start from the deconstruction of the material means to try to reach the common point, the starting, "original" point of creation. The locus of a likely real convergence between compositional processes of music and painting is situated before their material means even exist. They still are not music or painting and so they are not separated yet, so they can actually be the same compositional idea. This is what I intend to argue.

2.2. The strategy: Deconstruction

In order to be able to analyze the convergence between music and painting, I have to identify a sound and a visual object that do not exist yet, as material objects. Just like Kandinsky's, Schoenberg's and Picasso's approaches suggest, it is essential to deconstruct the material of each medium.

The study of sound physics tells us that sound results from air pressure variations (or other material medium) over time. This pressure change is relative to the atmospheric pressure and has a positive and negative direction as the particles move through the material forward and backward. In addition, the temporal quantity occupied by a sound corresponds to its duration. Thus, the deconstruction of sound can be designed in terms of pressure and time values. Every pressure change needs a duration to exist, and no duration without pressure change results in sound. Consequently, one could say that these are the "essential" elements in music.

Kandinsky's work advanced the process of deconstruction of painting - color and shape. The shape alone, can trigger a deconstruction of painting. A painting with height and without width, would be similar to a painting without height and with a given width - a non-painting. The product (meaning multiplication) of these two dimensions (height and width) gives us the area - the area occupied by the form. Thus, shape exists in space through the area it occupies. Color, in turn, can behave similarly to pressure change; it is in relation to the background color that other colors will contrast and give life to forms. In short, any color needs a shape to exist, and no shape exists without contrasting color. These elements would thus be essential to painting.

Music		↔		Painting	
Pressure	Pressure values			Color	Color values
Time	Duration			Space	Shape

Table 2 - Deconstruction of material means: dimensions and its elements

On the one hand, these schemes can be very useful for identifying some parallels between music and painting. On the other hand, they serve well the purpose of deconstruction of both music and painting into dimensions that can be considered essential to its existence / creation, as the exclusion of any of those dimensions makes them into non-music or non-painting. This is the basic idea supporting the techniques presented in the following section.

2.3. The Techniques: *Colapsagem*, *Extrusion* and *Stamp*

The idea of collapse, already mentioned above while conceptualizing the essential dimensions of each medium, serves at this point to transform any material into a non-material. Colapsagem is my word for the technique in which a dimension of one material is collapsed in another dimension of this same material.

In the case of music comprised of a sound with a pressure change as shown in the figure below (Figure 4 [a]), the colapsagem of all pressure values, of the duration of the sound, in a single instant in time, would mean the collapse of time in this song (Figure 4 [b]). In practical terms this instant will have a pressure value resulting from the average of the other absolute values, thus ensuring that it is normalized. Only a “click” will be heard. This “click” contains the start and the end, indistinguishable, only deducible just like the non-painting with a null-area, mentioned in the previous section. However, there is a before and an after framing this non-music, the same way it would be possible to construct a frame for a canvas, for example, 0x40cm

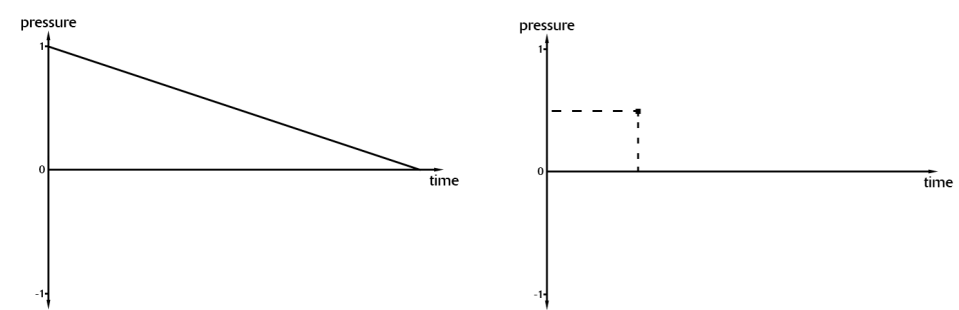


Figure 4 - Example of Colapsagem in music (a & b)

Accordingly, the result of colapsagem on a painting’s colors (Figure 5 [a]) in a single point in space (Figure 5 [b]) would mean the collapse of space in this painting. The beginning and the end of occupied space would be coincident, in which case the area of shapes would be null. As for the resulting color, the same process of the previous example can be used - the average of collapsed colors.

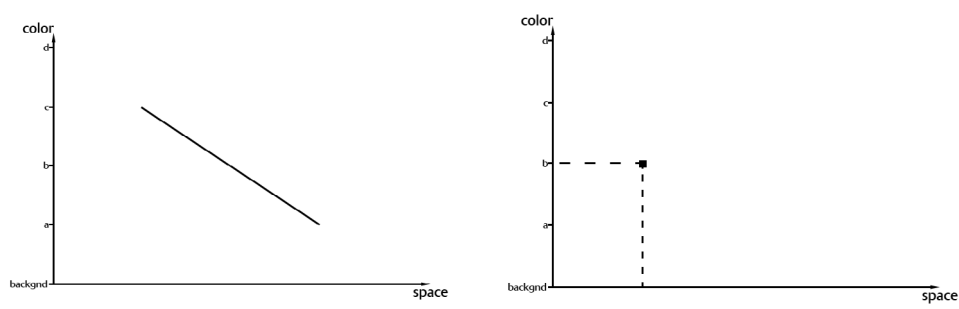


Figure 5 - Example of Colapsagem in painting (a & b)

In both cases, the point of Colapsagem is like a subatomic particle of artistic medium. You can, therefore, take it as a new starting point for composition. The most immediate solution can arise directly from the previously described process of Colapsagem: instead of doing the Colapsagem of the values of one dimension into a single value of the other dimension, we can apply this process to a range of values in the other dimension.

This is actually the same as making an extrusion of the single value collapsed. For the purpose of this article I'll not go deeper into exemplifying this process.

Alternatively, colapsagem could be made in another dimension, i.e., instead of collapsing the values on the vertical axis, collapse them on the horizontal axis, as exemplified below. In the case of a sequence with three sounds (Figure 8 [a]), the colapsagem of each sound duration into a single pressure value would result in what I have called stamping (see Figure 8 [b]). This Stamp keeps the information on the individual durations of sounds but it collapses the range of pressure values they may have.

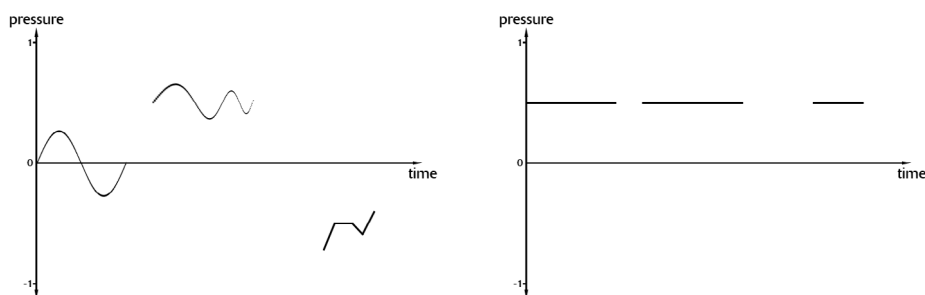


Figure 6 - Example of stamp in music (a & b)

In the case of painting, the idea of stamping becomes even more evident because the shapes remain, but the color is now monochromatic.

A final reflection on the nature of deconstructions and elaborated schemes shows two things:

- a) The horizontal axes, which correspond to time and space, are in fact infinite and all the compositions developed according to them are relative and therefore transferable to any time or location, posterior or anterior;
- b) The vertical axis corresponding to relative pressure levels and normalized color tones are taken as finite (although one might conceive an endless pressure increase and color saturation on non- standardized axes) and all compositions created in line with them, yield different results when they are transposed

2.4 The model: Abstract Rhythm Model.

Having thus arrived at an idea of prevailing conceptual stability on the horizontal axis - time and space - I devised a single model for the composition of music and painting; this model should articulate the two presented schemes (see table 2) and be based solely on the relative elements - forms and durations. This model can only indicate the existence or non-existence of content.

And since it is a one-dimensional model that needs to be read in a linear manner, such as a score for a single percussion instrument, I decided to call it Abstract Rhythm Model. “Rhythm” is thus used herein as referring to the existence of shapes and durations, and is characterized “Abstract” because it does not in itself discriminate a specific rhythm but rather the mold to build a rhythm to be interpreted.

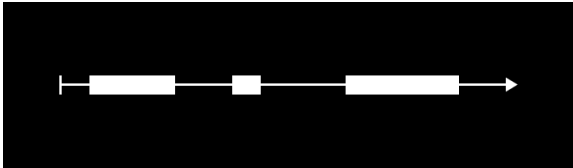


Figure 7 - Example for ARM

As we can sense by observing the example in the picture above, this is a silent model, it only speaks to us “inwardly”. At the same time, white on black creates an analogy with Kandinsky’s white and black, which are described as “silence with hope” and “silence without hope,” (1946, p. 68). In this case, hope is bounded, constructed, and points out the moments in which, out of the silence may emerge vivid color and sounds.

The figure below illustrates a short composition using the Abstract Rhythm Model for constructing the referred “rhythmic molds”. On the same figure I also plotted what could be the sound and pictorial interpretation of this sample short score. It now becomes clear that it is possible that the material embodiments of this model (rhythmic pattern) result in music or paintings with equal or smaller durations/shapes than the durations/shapes of the respective rhythmic blocks.

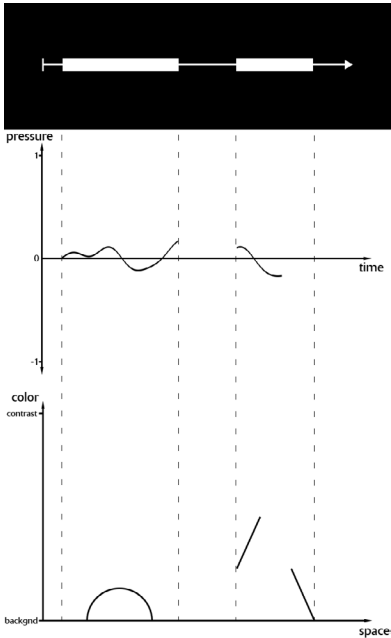


Figure 8 - Example of composition using ARM

Thus, this model preserves the independence of the languages because it implies that pressure variations and colors are constructed independently and in accordance with characteristic principles of the medium material in question. This model also calls for the use of a modulatory action: keeping the same rhythm, the distribution of corresponding values (pressure and color) will be modulated.

2.5. Composition: qup

Based on the proposals presented above I developed a compositional work – qup, a piece for alto saxophone with a resonator tube and drums³. A painting was also produced by Joana Gomes based on this same work, a pictorial embodiment of the same piece (see Figure 9).

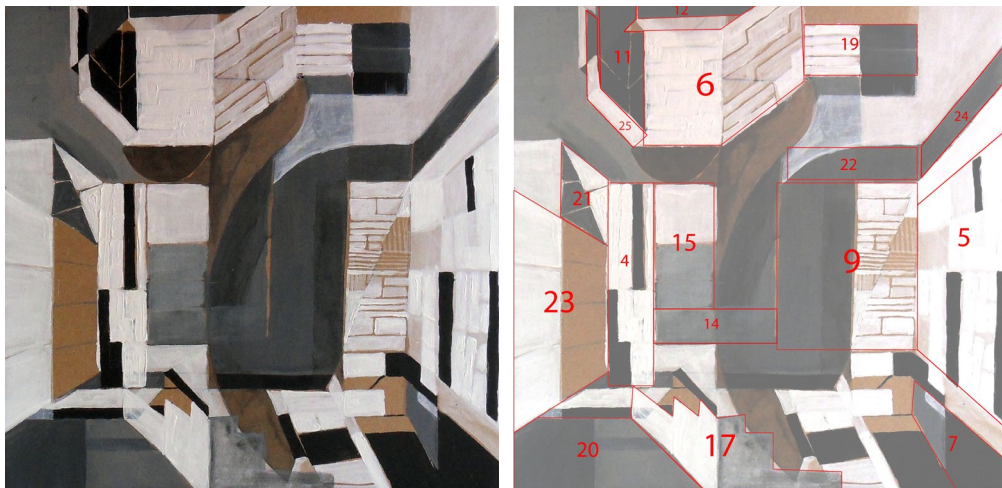


Figure 9 - qup by Joana Gomes (painting with sections on the right)

qup is structured in sections that can be repeated until the performers feel like it. These sections were precisely notated in a graphical-score fashion which I have called universal score (Figure 10). This score served both musicians and visual artist. As indicated by the legend on the last page of this score, the silences are defined, as well as the proposed rhythms and the written (or specified) rhythms. And even though these forms are indicated here with specific colors, the same rule of freedom about the colors to be used for all forms also applies in the case of painting. What matters are the proportions - for pictorial forms or musical durations – hence the claim that this is a universal score.



Figure 10 - excerpt from qup universal score

3 To see full score and video excerpts of qup: <https://goo.gl/CdSnid>

3. Conclusions and future directions

Even though no true correspondences can be traced between music and painting, my <|> framework, which traverses all approaches reviewed, points to a stage where not yet existing art can be related. It may also be used to compare other artistic fields. The deconstruction process of music and painting, gives us a new perspective on their material means of expression. Abstract Rhythm Model brings a new perspective that allows us to relate different artistic compositional means mediated by the same compositional model.

Eventually an ARM-based Theory of Composition can be developed in the future (?). More importantly, this research sets the tone for multi-artistic collaborations within a less hierarchical/constrained context.

Even though in this paper I focused less on the technological implementations and implications for the <|> framework and ARM compositional model, those were elsewhere subject of a longer discussion and also pose inspiring challenges for future developments.

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From static to dynamic: representing images through music

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Image representation and music are two concepts that, although they are different forms of human perception, vision and hearing, both present themselves as transmitters of messages, which arouse different emotions and reactions in individuals. Although the two concepts can live individually, the human being is able to perceive and apprehend both at the same time and as such, had a will to unite them, developing techniques that provide the transmission of contents, as well as pleasurable experiences and delight. This project aims to test the relationship between moving images and a music associated with it. This is an old relationship, which in the first forms of representation of moving images also had associated music for attracting the attention of the viewer, but also for a better understanding of the animation exhibited. The project was developed based on the issue of the representation of moving images, and besides some exercises of deconstruction of the dynamic image, for physical supports, it was also considered important to investigate and approach the relationship between the representation of the image and a musical production related to it. Following this, a fictitious festival of opening titles was developed called “Entreaberto”; considering that this is the environment that brings together

all the conditions to demonstrate and relate these two concepts. The project aims to tackle the detachment that exists between graphic production attached to the artefacts that coexist with a film with other in a static form. For this event, in addition to the communication composed by the physical objects that incite the movement, the festival’s own opening title was developed in partnership with the students of Music of the University of Aveiro, with the purpose of creating a unique theme song.

This exercise is distinguished by its multidisciplinary nature, rejecting the idea of “ordering” the song, but including the role of music in the planning and representation of dynamic images. This partnership allowed us to understand how musicians, non-designers, interpret the proposed storyline in a non-visual way. The intention was to understand how music interprets and represents the image intangibly. Music has a powerful, though often unnoticed, effect and sometimes may even be overpowered by the image. In this way, it can be said that sound strengthens the image and the image strengthens the sound, in a relationship of balance and harmony to which it is due to the synergies generated, in this case between designers and musicians.

Keywords: Communication design, music, motion, interation, experience¹

1. Introduction

This research was born out of deep interest in the representation of the image and motion image and also the stimuli linked by them. Sound, when used simultaneously with these registers, is perhaps the strongest element that complements the moving image. However, often left on the background.

As such, it was intended to explore and understand its relation with the representation of images.

In order to better understand this research, the process started by addressing some contents that could serve to better understand this symbiosis between sound and image. Although this study may be of an amplified and generalist nature, it was decided to focus mainly on the sound allocated to the open title production, where the theme songs are. This kind of image representation was chosen because of its inherent characteristics. Open titles, unlike other means of visual narrative in motion, has as its particularity the initial presentation of any content that comes in this sequence, defining the tone for it and functioning as a responsible vehicle to provoke in the viewer a higher level of interest and attention to what will follow.

For this purpose, a theoretical approach was applied to the representation of the moving images within the open titles, the sound, and the linking elements of these two areas that served to support the practical verification of the same through a project with the students of the bachelor of Music course integrated in their introduction to composition lesson at University of Aveiro.

Objectively, this research focuses on the understanding of the relationship between sound and image in motion, and it aims to understand what's the impact on the spectator when the two associate. That is, although image and movement may exist and fulfill its function individually, it was intended in this study to understand the impact of this association and to reflect as a single final product, providing a more complete and profitable experience. It is thus, intended to explore the senses, in this case vision and hearing, and to perceive how their combination arouses different stimuli and sensations. It is also the purpose of this study to understand how artifacts produced to be transmitted visually are interpreted by those composing music or sound compositions. Consequently, by involving these composers or musicians, in the process by which one intends to convey a message through a specific and practical case creating a open title for a (fictitious) festival of film open titles and in order to provide more synergies between these two areas.

1.1. Motion picture representation and music

The human being constantly receives stimuli through his senses that provoke in him, distinct sensations, creating and shaping his experiences. For this study, only vision and hearing mattered, which correspond to the visual stimuli given by the representation and communication of images and music.

Since music is a temporal concept, it was determined that it would be equally important that the study made in the field of image representation was also of this nature, as such, it was decided to focus on the study of the moving image, more specifically the open titles for cinema. Open titles combine the triad of elements that constitute the interest of this investigation namely **image – text – sound** - these three elements are generally composed in tune to create contents that arouse the interest of others (Zantides, 2012). Open titles can be compared with the cover of a book, as both have the purpose of a first layer, crediting the authors, the team and the cast, or even just titling the work, and at the same time fulfill the function of sharpening and instigating curiosity in the viewer (Braha, Byrne, 2011). As such they are elements of great importance to the success of the film by building anticipation, sometimes revealing some of the main characters and the challenges they will face from then on, or preparing the audience for the



Figure 1. Music students in the presentation concert.

movie environment, from which issues arise that more will be answered later. These, therefore, make a prediction of what the film will be, without revealing it entirely.

There is a great responsibility in the conception of this type of content for the presentation of the film, where open titles must capture the essence of the film, to give continuity to a coherent narrative. These are graphical productions that usually may be found either at the beginning of the film, after the first scene, or in the end as closing credits (2011).

1.2 Relationship of moving pictures and music

It was only with the introduction of sound in the 1920s and the color film in the 1930s that the open titles began to take shape, developing to what we know today, gaining recognition and importance in the studies both by cinephiles and in the design field (2011). As such, sound and consequently the introduction of music in the cinema, later also applied in the open titles changed completely changed the perspective of these means making them a more complete and pleasant sensory experience (Inceer, 2007).

There are two categories for the sound used in this environment, the diegetic and non-diegetic (Winters, 2010). Diegetic sound refers to the actual narrative, so it refers to all the sounds in the film that occur in the reality of the film. While non-diegetic refers to the opposite, including all sounds from the outside world or that are added in a layer other than the real narrative (Winters, 2010). This research focuses only on non-diegetic sound as it includes music, soundtracks, and special sound effects that are not really taking place on the scene. The introduction of music in this channel creates a kind of audiovisual illusion generated by added value, a concept that according to Michel Chion (1994) allows the introduction of non-diegetic sound, so that it enriches the image in order to create the impression that the experience of a scene can provoke in the spectator and how it absorbs the information and expression that comes from it (1994). This situation makes the added value incorrectly give the impression that it is unnecessary for sound to only duplicate a meaning when in fact it carries this meaning alone, or disruptions between music and image (1994).

Although the sound is not often noticed, its absence is immediately felt creating awkwardness and lack of guidance. It is therefore always expected that a song accompanies the visual narrative, even if it is not happening in the real scene. Although it also performs an aesthetic function, it transposes this barrier, helping to guide the public's emotional response, premeditating events, or otherwise creating an unexpected effect on the public (Winters, 2010).

1.3. Production parts

When it is necessary to create an open title, it is anticipated that the most useful form for a designer entrusted with the task will be in the beginning of the shooting of a film, so he has a more creative understanding of the narrative and tone of the film before this be finished (Braha; Byrne, 2011). This process can also facilitate the request of scenes that have been cut or even appeal to the director of photography in order to obtain a set of images of the same universe of the film, but that are not present in it (2011). Thus, as the success of the open title can depend

on the involvement of the designer at the beginning of the film, being the fundamental sound component in the integration of both the open title and the film. However, this is not a normal process. Often, the designer tends to approximate the visual content to the prepared sound for the open title. According to Rock Ross, as a producer of open title films, he believes that it is important to know the unfolding of the film in order to study mood, colors and rhythm so that these sensations can be accentuated with music (2011). Pacing, that is, rhythm is perhaps the most important element when crossing image and sound. The rhythm of the music must therefore accompany the rhythm of the moving image, and ultimately intends to unify and reflect the tone intended for the film in question (2011). Another method described by the same author, says that if the director of the film already has a song in mind and defines and reflects the tone of the film, the designer can produce the visual content in order to complement and praise the song in juxtaposition (2011).

Music / sound thus become indispensable to the composition of an open title. According to Stacy Nymo some animations may suffer from some complexity just because they have no accompanying soundtrack leaving the viewer without guidance and clarification of the content presented. Music precisely helps the composition to gain personality and rhythm and of course to the decoding of this complexity (2011).

1.5. The open title and the music: examples

According to Melis Inceer (2007) the story of the open title can be divided into two eras: the pre-Saul Bass era and the post-Saul Bass era (2007). This division is due to the assumed turning point in the production of this type of content, protagonized by the open title produced for the film "The man with the golden arm" (1995) by Saul Bass of Otto Preminger. Composed of an animation with cutouts, contrasting the black and white lines reflecting the mind of a musician who fights against heroin addiction. Jazz as the choice for the open title soundtrack creates a resemblance to the narrative of the film, as well as a good synchronization with the rhythm of the animation, promoting a powerful concept that sustains itself (2007). As Saul Bass played an important role in the production of visual content for open titles, composer Bernard Herrmann also played a key role in the production of musical themes for films and open titles, working mainly with filmmaker Alfred Hitchcock. Among them is the film "Psycho" (1960) composing a theme by using a string orchestra that accompanies the movements of the white lines, alternately horizontal and vertical, contrasting with the gray background. These movements are synchronized with the music, and although innocent they provoke a certain nervousness, brutality and lack of control, which portray the psychological state of the character (Brahá; Byrne, 2011). "I felt that I was able to complement the black-and-white photography of the film with a black-and-white sound. I believe this is the only time in films that a purely orchestra string has been used." (2011). It is common to find a strong musical presence in Hitchcock's films by which he discovered the existential distance and emotional gap between the audience and the film, despite the violence and impact of the visual scenes, these were not enough to create a visceral involvement (Brown, 1980). It would be necessary to include music, with some particularity, that communicated all the irrational feelings that only the moving image was not able to do (1980).

Although open titles serve to credit the company, team and cast of the film, their purpose is much more about the anticipation and definition of the tone of the film, and as such, sometimes the contents can be arranged according to the narrative of the film. A very clear example is the open title "Fahrenheit 451" (1966) that depicts a futuristic dystopia where all books are burned leaving the world with nothing written to read. As such, the open title presents itself with a series of static images superimposed by a musical theme, also composed by Herrmann and by a masculine voice that recites the credits throughout the images, immediately referring to

the central question of the film (Braha, Byrne, 2011). In this way some strangeness is created by shifting the attention focus that was initially centered on the visual part to the sound part, also changing the way the audience perceives and internalizes the movie question. “Uccellacci e Uccellini” (1966) is another example where music and sound are the focus of the open title, presenting simple cards with static images, accompanied with music and credits with typography. However, one hears an opera singer who adds some adjectives as if he were a narrator who was about to start telling the story.

The music from the saga of “007 James Bond” films has become as important as the visual content of the open title, always bringing something new. However, they retain the story and identity of the film through a “signature melody”. The set that forms this open title, visual and sound content, have become the hallmark of these films. When you hear the song, it is immediately recognized that you are about to see a James Bond movie. Another example, can be given with the starring and striking soundtrack of the Star Wars film saga.

Composed by John Williams, the soundtrack that accompanies the typography that tells the beginning of the story. This is purposely anachronistic, resembling a late nineteenth-century orchestra, leaving aside any futuristic music and sounds that would have been expected, since everything else was so different from reality. The director intended that music become familiar and simultaneously explore the emotional field (Nickalls, 2010). This field is probably what evokes powerful public responses through music, since they relate intimately to the individual, with music being only a causal agent (Jushl, Patrik N., Kahlil G. 2013)

2. *Entreaberto*: exercising music and image

This project starts from a previous reflection of the communication that results from the relation of the dynamic image and the static image and its adaptation to a physical support.

The project arises with the purpose of bridging the takeoff that exists between the graphic production affects the artefacts that coexist with a film and understand how one can communicate dynamic images in static supports.

Starting from the example of cinema open titles, a fictional festival called “Entreaberto” was created. The search for innovative and creative ways of communicating the dynamic image was the motto for the practical development of this research, through experimentation of different techniques and visual tricks. Although the project aimed only at the materialization of physical media that reflect this environment, a proposal to create the open title of the festival appeared in the course of the development of the festival, in partnership with students of the bachelor of the Music course of the University of Aveiro for the lesson of musical composition. First, the exercise was presented to the students who were able to choose between 3 different projects presented by the Master’s Degree in Design students. It is assumed that the choice could have been determined by the level of interest and personal involvement in the project, which proved to be a positive point for the conception of this work. When the group was formed, there was still no defined idea for the open title, neither there was no storyboard to illustrate any kind of imagery. It was only known the project of the festival and the research developed until then, which put the designer and musicians on the same footing, that is at the beginning of the project. The assumption would be that the musicians could compose an original theme for the open title, but since all parties were on the same level, it was never intended that the theme was just an order but a joint work throughout the process. Some concepts and phases were delineated by which the open title should be governed as dynamism and movement. It should also reflect 3 phases to symbolically represent a brief history of the open title.



Figure 2. Part of of title open made for Entreaberto

It was intended that all visual stimuli be coherent and accompanied by sound stimuli. The musical composition itself was made as the images were created, allowing them to contribute with ideas, adjusting them with the music in order to create a perfect harmony with sound and image. The animation created for the open title could never exist without the music or at least it would not have the desired impact and understanding. A practical example comes as early as the beginning of the open title begins with the lines to rise, and these are accompanied by a crescendo sound that guides the viewer in the direction of the movement giving it an intention. Just as in the third part where there are glitch breaks as well as the tone of the music also changes so that this change is accentuated, also helping to fill the empty space between the transitions.

3. Conclusion

This partnership allowed to understand how musicians, non-designers, interpret the proposed plot in a non- visual way. It was intended to try to understand how the music interprets and represents the image in an intangible way. The result was very interesting, because it was able to see the musicians thinking of a sound as a shape for the image, or even a complement to the scenery. The theme produced was so very well integrated on the visual composition because of the conjunct work of both designer and musicians. Music has a powerful effect, though often unnoticed, and sometimes can even be dominated by the image, but it is likely to conclude that if music and image are given the same importance, the results may turn out richer.



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Beyond dualities – The performing body and the virtual *corpus* (a poetic catalogue) & trilogy I

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Although conceived in very disparate ways through times, different virtuosity ideals show that there is an ontological and almost stable conception of the performing body as a mediator between dualities (outside/inside; form/matter). The anthropological machine incises the performing body, shaping it according to the ideals in vogue of the *making human* subject, through different times. The performing body is then erased and shaped as a kind of channel for another reality, a realm from the outside, that can be an ideal of sublime in the Romantic, or the objective ‘musical work’ in the structuralist approaches of the 20th century. The new field of Performance Studies brings new ideas that try to contradict the strict dualities, bringing new concepts of ‘musical work’ and acknowledging Performance as a place for creation of meaning, instead of assigning it the usual role of reproduction of meaning. However, these new formulations, which try to go against the claimed ‘objectivity’ of the *werktraue* ideals, oppose them within the same logics of duality, calling for the

subjectivity of the performer – the intentional, the emotional, the personal narrative, the *all too human* (Nietzsche) subject.

The formalist and structuralist conceptions left (and still leave) energetic forces, impulses and processuality behind, focusing on a rigid and immutable structure that should be imposed upon the performing body, whereas subjectivity approaches of Performance studies, focusing on the will and intention, tend to bypass the pre-human, post-human, the non signifying and non-organized body.

As composer/performer my research has been focusing on finding directions for opening new ways of thinking musical creation and musical performance beyond usual semiotics and beyond the organized and emotional narrative. My paper will reflect upon the possibility of a virtual dimension of the body, a dimension that could open new insights for thinking musical creation and performance.

Keywords: virtual level of the body; corpus; music-making body; intensity; musical performance

Trying to think beyond dualities

The centrality of the role of the 'body' can be regarded as a general tendency in the new music scene since the postwar. The standpoint we arrived is no longer one that thinks or approaches music as the art of ineffable¹, but one that starts to assume the body as having an extremely important role in the musical process and that acknowledges musical gesture as the multi-modal event where musical meaning is created. But it is my opinion and claim that the dimension of this role can still go much further and open for *other* conceptions of musical creation. The body is no stable ground on which one can create anew. The body is in each moment, continuously (re)creating itself, disintegrating, modulating, discovering itself, undermining itself, surprising itself. There is no way we can predict accurately this process: we cannot, however hard we try, answer Spinoza's ultimate question 'what can a body do?'.

In the process of music-making, Western Art Music (WAM) has put all its effort in giving a clear 'answer' to this question, establishing performance and virtuosity paradigms and ideals through times. But establishing clear ideals for the performing body means giving a clear answer to a question which cannot be clearly answered. It implies simplifying complexity, reducing/erasing dimensions or important layers of an issue. WAM has therefore not been able to clearly encompass *other* dimensions of the body and consequently, *other* conceptions of musical creation.

The problem is probably that the discussion has been made most exclusively from the point of view of the explicit knowledge towards the organized and signifying body and towards its intentional, narrative realm. The questions in discussion are mostly related to what we can control, and how we can control, how we can control better, finding bridges or building new ones, linking, integrating, pulling together. These are of course essential tools and perspectives for rendering possible any acts of creation and innovation: otherwise we would surely get lost in entropy... But what probably is still missing is a deep discussion on the dimensions of the body that we cannot control, or that are beyond the notions and dichotomies of control/ out of control: dimensions we cannot even express in words because there is no vocabulary for them and which nevertheless, play an extremely important role in the musical process.

My claim continues: the body has been thought and approached mainly through the installed paradigm of dichotomy composer/performer since the beginning of XXth Century, a paradigm which surely opened most outstanding doors for musical creation and performance. Nevertheless, the opening of certain doors led (probably, as always) to the closing of others: it imposed a strict dichotomy between musical idea/musical practice, outside/inside and the roles of composer and performer got more and more distant from one another getting either associated to the role of *creation* of meaning (the former) or *reproduction* of meaning (the latter). In the musical vanguards of the postwar the performing body began to assume a more relevant role: instead of being regarded as an invisible channel for the music, it was explored as a 'noisy' mediator, brought to foreground as musical subject and, more recently, as musical thematisation in composition. But still, it has been mostly approached through the lens of this dichotomy paradigm and its frequent top-down relation. From these recent approaches, a completely new situation emerged, as Craenen (2014) puts it: the "*virtuosity of the performer is revealed from the outside, as it were, rather than manifesting itself as an elusive authority of the music-making body. Instrumental virtuosity becomes a compositional concept or a strategy with which the composing body forces access to the performing body*" (p.130). The performing body brought as musical subject and

1 This statement can be valid for the context of Music Academy. However, the philosophical discourse (and mainstream opinion) about music is still very often entangled with an ontology of music that is based on this immaterial and ineffable essence and/or natural order trans Fordham University Press. Ids being Rand a, growing, ramifying. esting way a tic:ility of "spended reality: the reality of a. See note 2.

musical thematisation to composition, along with other aesthetic motivations, were important 'revolutions' in the emancipation of the role of the body in musical creation and performance of Western Art Music since the postwar. It is however my strong conviction that *other* revolutions of the music-making body(ies) are still to be made: they will certainly ask for completely new conceptions both of the body and of music, certainly forging new ways for musical creation. For this we will probably have to think away from dichotomies and notions of inside and outside: not anymore thinking the body from the 'inside' as the inner and subjective quest of the Romantic, nor thinking it from the 'outside' as the mostly 'objective and structuralist' 20th Century paradigm. New Performance studies brought very important new insights regarding the concepts of musical work and creation of meaning and try to go against the claimed 'objectivity' of the *werktreue* ideals, but oppose them within the same logics of duality, calling for the subjectivity of the performer – the intentional, the emotional, the personal narrative. It is probably all about the old quiz of the box: for going further is not enough to think out of the box, but it is required to abolish the box itself.

Towards the virtual

corpus (a poetic catalogue): an exercise for taking this discussion further

The seeking for this discussion and for finding *other* ways for musical creation have been the drive for the work on a trilogy of solos for piano and sound disruptions in which I am both composer and performer and which is the subject of my ongoing PHD research in Aveiro University. This trilogy has been developed since 2009 and is thought as a first part of a major (and possibly lifetime project) named *corpus* (a poetic catalogue). It is a project that aims to rethink/reformulate, reinstate/recreate in each situation the bodies in musical performance or just generally, the bodies in artistic creation. It is a catalogue of mainly musical pieces/performances, which are however transversal and multi-dimensional in its configuration. The name *corpus* brings the concept of body to foreground and, simultaneously - making reference to Jean Luc Nancy's formulation of *Corpus* – reinforces the impossibility to encompass the body in a single theoretical or artistic formulation, proposing the idea of endless catalogue of multiple, diverse and fragmentary insights. *Corpus* is therefore also approached as meaning this large collection/catalogue of works, as an idea of collection or catalogue with an organic perspective.

Mostly characterized by its mentioned transversality, multi-dimensionality and its drive towards exploring threshold zones of the performing and instrumental body(ies), the trilogy has been developed in collaboration with visual artist/cinematographer/film director Daniel Costa Neves. It is composed by the pieces/performances *through this looking glass* (2010/11) for prepared piano, toy piano, electronics, recorded tape, mobile & props; *In Praise of Disorder* (2013) for semi-prepared piano, installation of bells and sirens, toy piano, noise boxes & recorded tape; *Listening: the open* (2016/ ?) for piano, resonant metal plates installation & recorded tape. All pieces of trilogy have been premiered at Maria Matos Theatre in Lisbon.

The main focus for musical creation was going more and more towards threshold 'zones' of musical practice and contrarily to the sonotropic² perspective, the ungraspable quality of these threshold zones was not regarded as a consequence of music being conceived as an art of ineffable, but precisely the contrary: the fact that music was regarded as an activity of the body was taken itself as responsible for its unutterable quality at various levels. Musical creation was in this context therefore not regarded as a state of loosing body, of suspension of the body (sonotropism).

2 The general tendency of Western philosophy to proceed "as if music held a metaphysical valence in excess of the usual mediators of language, culture, and history" (Scherzinger, 2012, p. 350), was recently conceptualized as "sonotropism" (Scherzinger 2012) and is being more carefully analyzed by a number of studies, which have as research subject the 'place' acknowledged to music in Western philosophy (and consequently in Western culture).

It was approached as a complex multi-modal event, but enhancing the fact that the body, in the context of this event, was not taken as a given, not taken for granted, not regarded as a stable ground on which music could be created anew. The body is itself disruption of meaning, it implies being in constant (re)formulation, being a continuous making-body.

Towards a virtual level of the body

Research led me towards recent clusters of thought that try to forge new conceptions for the body and also for musical creation. They include perspectives from philosophy, musical/artistic research and science, have an independent development and no apparent connection between them: each of them does not make clear reference to one another. But at the end we have interesting intersection and tangent points and two surprising main aspects in common: the opening for a *virtual* level of the body and of music and the approach to music as a topological experience of making body. Music is making body as much as the body is making music. In order to have a slight glimpse on what this virtual level could stand for through different conceptions or formulations, I will bring together two clusters of thought by 1) Jean-Luc Nancy, Peter Szendy (with important references to Nietzsche, Barthes) 2) Paulo de Assis, Lucia D'Errico, (bringing Brian Massumi, Gilbert Simondon, a big emphasis on Barthes and Gilles Deleuze).

As a general idea that could be found implicit in these clusters is the assumption that we can only long for *focusing approximately towards* this level and not, at any rate, for *clearly focusing on* this level because the ungraspable is by definition impossible to focus on: it does not stay in place, it cannot be expected in a specific linear time point or space and when it happens to emerge, it does so in a glance, in a microtime frame but opening for new and non-linear conceptions of time and space.

Nancy refers the body, through his idea of areality (*aréalité*)³, as an extended and non mediated concept, as a body to which a level of a suspended, 'areal' reality belongs: the body is referred as having a lack of reality which is real. In this suspended reality, a *mute or autistic sense* of the body seems to 'operate', failing however to make sense. It might be a sense for sensing this same discontinuity of sense/meaning, a sense which could be disruption of meaning *itself*. It is approached as having a seismic character or behaviour and Nancy therefore formulates the body as the *archi-tectonics* of sense.

Szendy (2016), inspired by Nancy's concept of *corpus*, formulates the concept of *phantom limbs* in the context of musical performing body as "*improbable bodies without figure or destination. (...) threads or traces of still unorganized organs – neither living nor dead – that are membering, dismembering, hurrying, crowding, growing, ramifying*" (p.21). Along with this concept, the process of creation of these phantom limbs in musical performance is described as *effictio*, bringing together the terms *effictio*, *fiction* and *efficacy*. *Effictio*, an old rhetorical term, which meant a general description of a body, is used in this context along with the idea of 1) fiction, since for one side the phantom limbs are fictional limbs and 2) efficacy, since the process of this fiction is described as being extremely efficient – the lack of reality of these limbs is regarded as a real dimension of the body. Szendy, through Nancy's notion of *areality*, opens explicitly a discussion for thinking a virtual dimension for the musical performing body.

3 "Areality is an antique word, signifying the nature or specificity of an aire ("area"). By chance, this word also serves to suggest a lack of reality, or rather a slight, faint, suspended reality (...). But this faint reality makes the whole areal real, where the so called archi-tectonics of bodies is played out and articulated (...). The real, as areal, merely reunites the infinity of maximal existence (...) with the finite absolute of an areal horizon." This "reunion" is not a mediation: and what body means, what body means and provides for thought, is only this, that there's no mediation here. The finite and the infinite do not pass into one another, they do not dialecticize each other, or sublimates the place to a point, or concentrate areality into a substratum. Body has this sense, but this sense must, in turn, be subtracted from signifying dialectic: body cannot mean body's real sense beyond body's reality horizon. "Body" must therefore make sense right at extension (including the extension of the word body...)." (Nancy, 2008, p.77)

Bringing together concepts as Massumi's *affect*, Simondon's *transduction* or Deleuze's *body without organs*, Paulo de Assis and Lucia d'Errico opened a discussion for a seemingly virtual level of the body and for the importance of energetic processes that play before or beyond the subjective narrative claimed by musical performance studies. This most interesting discussion is being held and taking different shapes in the projects *MusicExperiment21* and *MusicExperimentX* at Orpheus Insitute. Assis (2017,1) brings Barthes' concept of *somatheme* to foreground and affirms that "*the 'possibility of delirium' and the centrality of 'desire production'*" (p.25) of the somathemes open up a new space within the music-making body. Claiming that "*such openness to pulsional energies would carry a 'revolutionary' potential, allowing for a completely different reading of music history, composition, and performance*", Assis goes further and asserts that "*Barthes's somatheme could act as the central concept for this revolution*" (p.25-26). The somathemes are *image* descriptions by Barthes related to tempo signatures of Schumann's *Kreisleriana op.16*. Assis (2017, 1) reinforces the fact that these *images* should be interpreted in the sense of Freud's *imago*, an "unconscious object-representation", which "can be an image, but also an emotion, a feeling, a behaviour" (p.25) They are described in different perspectives mostly as 'pulsating' figures – both musical figures and figures of the body, acting between layers of *geno-song* and *pheno-song*⁴. They make the beats and the blows that are sensed by Barthes (1985) as the essential musical core of Schumann's *Kreisleriana*: "*I actually hear no note, no theme, no contour, no grammar, no meaning, nothing which would permit me to reconstruct an intelligible structure of the work. No, what I hear are blows: I hear what beats in the body, what beats the body, or better: I hear this body that beats*" (p. 299).

Barthes' conception of this level of the body and of the music, as a level that cannot by no means be found in the the written score is brought together by this research cluster (D'Errico, 2018) with an ungraspable dimension of the body conceived as *intensity* or *affect* by Brian Massumi (2002). This latter is described as not following a logic of sense, but as following a logic of sensation instead. According to Massumi, the fact that it does not follow a logic of sense does not mean that it does not relate to the signifying or semiotic dimension. It seems in fact to establish a relation, but one of a different kind: it does not follow a traditional correspondence or logic of the excluded middle, but instead, and according to the same author, it enables a different connectivity through a logic of resonance/interference. This ungraspable level is theorized as unqualified, as not being action, because it cannot be directed towards an intention or goal. It is not regarded as passivity either because it is nevertheless regarded as vibration: as vibratory motion and resonance. This dimension seems either to feed back, dampen or interfere with the signifying realm.

According to Massumi again, this dimension of the body is something which cannot be associated with a raw domain of the body, a kind of 'naturalized' or pre-evolutional state in a logic of dualism of culture vs. nature. It feeds back every kind of functions in the brain, higher functions included. It is a level that defies concepts of inside and outside: it seems to operate outside the mind, but within the realm of the body.

4 Based on Julia Kristeva's semanalysis and concepts of *genotext* and *phenotext*, Barthes asks for a second semiology in music and acknowledges two similar levels, the *pheno-song* and the *geno-song* (Barthes 1985) "The *pheno-song* (...) covers all the phenomena, all the features which derive from the structure of the sung language, from the coded form of the *melisma*, the *idiolect*, the composer, the style of interpretation: in short, everything which, in the performance, is at the service of communication, of representation, of expression: what is usually spoken of, what forms the tissue of cultural values (...), what is directly articulated around the ideological alibis of a period (an artist's 'subjectivity,' 'expressivity,' 'dramaticism,' 'personality'). The *geno-song* is the volume of the speaking and singing voice, the space in which the significations germinate "from within the language and in its very materiality"; this is a signifying function alien to communication, to representation (of feelings), to expression; it is that culmination (or depth) of production where melody actually works on language – not what it says but the voluptuous pleasure of its signifier-sounds, of its letters (...) *Genosong* is, in a very simple word which must be taken quite seriously: the *diction* of language" (p.270-7)

trilogy I (for disruptive bodies)

My musical and artistic practice entangled with research on these subjects has been trying to shape a singular but diverse musical approach in *trilogy I*. The unutterable mechanism of disruption is a central element for musical creation in this trilogy: how a body falls apart, or how a body, suddenly, unexpectedly pulls itself together, urges into a direction focused. It is all about the electrifying process that provokes this falling apart or this pulling together of the body, an energetic process that could be triggered by what we could conceive as a seismic fault line of the body or of the being. It is the scope of this seismic fault line, which can usually only be felt in musical microtime, that I seek to enlarge and take as a relevant parameter in my musical approach. It is not possible to predict when it clearly occurs nor to have control over the experience. But I would say it is possible to develop an intensification of senses, an intensified listening mode, which is directed towards sensing this imperceptible, but disruptive vibration. A listening mode which is simultaneously a triggering point and which can relate to this fault line feeding back its signal and enlarging its power and its scope for the musical output. A musical approach that brings to foreground this energetic process is one that does not focus on the stable 'music material', on the narrative or semiotic realm. But searches for meaning mainly through the 'in between' possibilities of relation, the possibilities of *touch* that these energetic processes create.

This can all mean, in this context, that the strategy for shaping or the strategy for musical creation itself can be, at the limit, reduced to our initial movements of *falling apart* and *pulling oneself together* along with the idea of *seismic fault line*: a body moving, a body being a body, a body meaning a body. But, in all cases, a body within its invisible shaping and tracing, its velocity beyond itself and either its *areality* (Nancy) or its *virtuality* (Massumi) and their unperceivable but sensing trigger points. A body is not an inside, not a closed entity, and I would add that neither is it just spreading to other entities. It is *the* spreading itself, it is *a point triggering itself, detonation*. It is therefore beyond gesture as it is approached by actual musical gesture studies and beyond the subjective narrative of performance studies. It is a beyond, which is simultaneously a within, having a potential for forging multi-dimensional shapes and further multi-dimensional senses. Everything is in this context not about an organized body against an unorganized body, nor the opposite. This means we're not in a logic of the quest of an 'I' against the *Self* represented by the internal conflict of the Romantic (and its paradigm of composer performer). It is a multidimensionality of the body which, through disruption, resonance/feedback and interference/dampening of the different levels moves towards the more organized or more unorganized experience, always creating either the new, either the expected in a new perspective.... The way these levels relate is what shapes the plasticity of the expansion – how a body moves, how a body is being this body, how a body means this body, which could be the same as how the music moves, how the music is being music, how the music is meaning music. The seismic fault line, felt in microtime, can trigger towards organization or disorganization in an unpredicted way. Paradox occurs: in linear micro-time is shaped the deepest expansion of time and space, plasticity again.

This does not mean that music or the body are *out of control*, freely or randomly going in whatever direction. It probably does not mean the opposite either: that music and the body are (totally) *in control*. It can mean again that the path of trilogy is hinting for a notion of the body and of the music that puts the duality between organized and unorganized body apart, making the notion of *control/out of control* inappropriate. It does not make sense anymore to speak about the parameters the composer controls and the parameters that are left open. *Control* and *out of control* are reducing features for our notions of *pulling oneself together* and *falling apart*, because both movements of falling apart and pulling oneself together can be triggered by a process which is *out of control* and, simultaneously, *within* the realm of the body or of the body of the work.

Again, this means we're not in a logic of the quest of an 'I' against the *Self*. It could mean:

let a body be a body, or a body
be music or music be body or
music be
music or
whatever body music body music music body
or

... and let this not represent a reducing factor, but on the contrary, an expansion of both concepts within and throughout another, for plasticity and possibilities for time space, senses and meaning are endless and tasteful.



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The quality of the Music Room in the domesticity of the Casa dos Patudos, Raul Lino project of 1905

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This text addresses the particular role that music played in a very iconic project of the Portuguese architect Raul Lino (1879-1974), known for his studies and projects around the concept of Casa Portuguesa (The Portuguese House). A Casa dos Patudos property of the Portuguese Republican politician José Relvas (1858-1929) went through an extension process during 1905-1909 led by Raul Lino in close dialogue with the owner.

If the house should shelter with care and detail the valuable art collection of painting, sculpture, furniture and decorative artefacts, also music asked for a very special approach. The music room was a space generally to find at the time in the rich family homes but in the Casa dos Patudos, music and the music room were much more than a tradition's statement. Based upon the epistolary exchange between Lino and Relvas presented in the historical archive of the nowadays house-museum Casa dos Patudos, upon literature review and the authors visit to the house, it is to argue that from the beginning of the project, the music room took a relevant place on the domestic space. In effect, not just one music room but finally three spaces inspired by music were to find in the house during the lifelength of José Relvas. After the first intervention of Raul Lino the music room was the heart of the house, and was known as Salão da Renascença, because of its inspiration in the renaissance style. That room was chosen to receive guests and to give

home concerts to entertain them, namely by José Relvas an amateur violinist, and his son, who was a professional pianist, or by other invited musicians. The music room was also displaying valuable works of art. In this space each detail was carefully considered: the design of the fireplace, the style of the ceiling, the choice of the furniture and other decorative artefacts and not to forget the acoustic qualities in which Lino had a preponderant role. The second room for music, known as Sala das Colunas, had considerable smaller dimensions, an intimate, cosy quality and was meant to be a private space to enjoy music by the family. During six years, due to a family tragedy, the silence took over that home. Only in 1926, a third music room found there its place. The old Sala Corredor was modified to accommodate a new function and redecorated in order to hosting a self-playing piano (also known as pianola). It also received several and remarkable works of art inspired by music as the master piece ordered by Relvas to the Portuguese sculptor Bordallo Pinheiro, the Beethoven's Vase.

Relvas and Lino shared the passion for classic music. Lino argued that there are many similarities between music and architecture by the metric, rhythm, melody, color – timbre, proportion, harmony. This text aims to stress the association between music, architectural quality and identity by interpreting the character of Casa dos Patudos music rooms.

Keywords: Casa dos Patudos, music rooms, musical instruments, domestic interiors

Introduction

With this article we intend to understand the role of Raul Lino in the creation of the domestic space dedicated to music in Casa dos Patudos and their involvement in the choices and option taken, as also the association between music and architecture.

The love for music approached Lino and Relvas, both sharing the same circle of friends. Through the AHCP (Historical Archive of the Casa dos Patudos) there are numerous letters exchanged that refer to music as a common point of interest and discussion.

All his life Raul Lino advocated the architectural importance of the single-family house and his search for the *Casa Portuguesa* made him register the spirit and forms that the Portuguese vernacular architecture was taking, in a direction known as culturalist (Ramos, 2004, p.240).

Also for him the music played a significant role in his work, marked by his reflection and analogy between architecture and music. Structure was the key word between both arts – in time and space.

As a result of the growth of its art collection, Relvas intervenes in his house in three moments. In c.1892 under the guidance of the architect Thomaz Praia and the last two with project of Raul Lino, in 1903 and 1914. However, in between Relvas was always improving the interior space through furniture changes and other decorative decisions so that the domesticity of the Casa dos Patudos could reflect the flow of his interests and taste.

The project that Lino begins in 1903, with constructive period in 1905, will confer to the house the character and functionality intended by Relvas. For this campaign stands out the importance of the renaissance room – the largest room of the house – dedicated to receiving and especially to the music, highlighting the furniture executed by Emydio Maior and the ceiling design by Raul Lino. Still of this campaign of works there is another room dedicated to music, known as the *Sala das Colunas*. The initial space is from Thomaz Praia project, however Lino converted this space into the music room for the family.

In 1914 the new project for Casa dos Patudos still sees a new music room. In this campaign Raul Lino connects the *Sala das colunas* with *Sala D. Eugénia*, a space named at the time as *Sala Corredor*, which later became what currently is known as music room.

The Casa dos Patudos, nowadays transformed into house-museum, mirrors Relvas vision about music and domesticity. The music was so important to him that not even the vicissitudes of life made him leave the music behind. With the project of Raul Lino, the spatial design of the home revolves around the rooms of the music, they are the central space of the house, as can be read in a letter of Lino for Relvas to which refers to the *Sala da Renascença* as the “big room”¹.

This article is based on a guided visit to the Casa dos Patudos – Alpiarça Museum, crossing it with literature review and research in the Historical Archive of the Casa dos Patudos which shelters correspondence between Lino and Relvas and Relvas manuscripts.

1. Raul Lino and the Music

Raul Lino (1879-1974) was known in the history of Portuguese Architecture mainly for his research and definition of *Casa Portuguesa*, but also because music is present in his work (Almeida, 1970, p. 118). This association comes not only from the fact that Lino studied music, but mainly from his interest in approaching music and architecture (Ribeiro, 1994, p. 31).

1 AHCP, Letter from Raul Lino to José Relvas, dated from May 27, 1905. Reference in Historical Archive: PT/AHCP/FR/JMR/B/03/C4681

In effect he ended up by designing many homes for musicians. In this context the writing that most reflects his ideas is “Quatro Palavras sobre Arquitectura e Música” (Lino 1947). This publication is a result of a conference that Lino presented on May 4 and 6, 1947 in the *Conservatório Nacional* in Lisbon, where he develops his own thoughts about analogies and differences between both arts.

The first comparison that Lino establishes is relative to his age by placing them as “sisters”, however “If two sisters in general resemble each other, it is true that they are always quite different, and each time we establish the confrontation, we find both similarities as disparities, except in the case of twins, which is not the case with Architecture and Music, to which we have to attribute very different ages” (1947, p.9). From this thought of the two arts as “sisters” it speaks mainly of history comparing them in time, in its splendour and harmony.

He finishes by stating that the great analogy between the two lies in the structure, that it is only between these two arts that it is possible to establish “the perfect parallelism of meter and rhythm, translated in space and time; and the correlation of the duos: drawing - melody, color- timbre, proportion - harmony” (1947, p.52). Lino chooses to leave the duo proportion - harmony for the latter purposefully by believing that the architecture took some time until finding the proportion in the same way that the music took to find harmony. Lino, and remembering Goethe, presents the “architecture as if it were Music in a state of immobility, static, petrified” (1947, p.9), “we can say that Architecture is Music executed in space, and that Music is Architecture erected in time” (1947, p. 53).

By Lino’s academic education and his references to Goethe, Edward Ayres de Abreu considers that “the music in the thought of Raul Lino fundamentally reflects a German romantic ideology, sensitive to nature as imaginary in some way possible to translate into music (...)” (Abreu, 2014, 169).

For Almeida these analogies could go further and establish a parallelism between the architect and the musician Felix Mendelssohn for “the easiness in establishing the coexistence of the classic and romantic tastes, the lack of bitterness of his romanticism, the absence of rigidity of his classicism, “characterizing him structurally in the same way as Jean Chantavoine characterized the personality of Mendelssohn “Ce n’est pas un romantique militant c’est a dilettante romantique” (1970, p.136).

According to Abreu (2014) there were two musicians in Lino’s life who were very close to him and inspired some of his ideas, namely Ruy Coelho e Alexandre Rey Colaço.

Ruy Coelho (1889-1986) was a pupil of Rey Colaço and by his mediation became friend of Lino. Together they attended several concerts and it was for him that Lino began to develop scenographic projects and costumes.

To Alexandre Rey Colaço (1854-1928) he dedicated his book “Quatro Palavras sobre Arquitectura e Música” and designed the house of Monsalvat.

Together they projected the Beethoven Room, which never came to be constructed. This project had as main objective “to promote the construction of a room for intimate concerts” (Arroyo, 1915, p. 174). According to Lino the “Beethoven Room will be a shelter, a warmth and an attraction for artists” (1916, p. 279), noting that this will not only be for musical interest, but will contribute to the Portuguese cultural mentality. Lino also explain that whole project is Portuguese taste and “its triple cover” was inspired by the opening section of the “fifth symphony, a motive full of energy, full of expectation and fatality, as a prologue to apocalyptic revelation” (1916, p. 281). Also, here we have the analogy between the musical structure and the forms that the Beethoven Room took.

Rey Colaço was also a key in the relationship between Relvas and Lino. Rey Colaço belongs to the circle of friends of Relvas and was a frequent visit in Casa dos Patudos. This friendship will consolidate the trust of Relvas in Lino.

2. *Casa dos Patudos* and the music



Figure 1. Casa dos Patudos, nowadays. Source: <https://www.casadospatudos.com/casa-dos-patudos/>, retrieved in April 15, 2017

The Casa dos Patudos (Fig.1) was inherited by the Republican José Relvas in 1887, after the death of his mother. In 1888 he established with his wife and children at Quinta dos Patudos, which was at the time just one rural house (Noras, 2010, p.17). In c. 1892, Relvas decided for the first remodelling and enlargement of the Casa dos Patudos, under the guidance of José Pereira Thomaz Praia (Bonina Grilo, 2015, p.110).

In 1903, José Relvas intervened again in his house. Relvas knew that this campaign of works would be more significant and required the knowledge of someone who introduced in the building the same ideals that he defended. He chooses Lino as architect. In a letter to Amaro, Relvas reveals that Patudos project reflects his “convictions (...) about issues of styles in houses to project in Portugal, and particular in the province”².

As Silva Bastosf points out, “what the owner and the architect wanted was to harmonize the traditions of Portuguese art, grouping local elements, but without subordination to a hypothetical style or to an epoch”(1906, p.698-699).

The connection to music starts in the façade. Lino designs for that purpose several sets of tiles showing the interests of Relvas: the love for arts (Fig. 2) and the main agricultural activities developed in the farm which are wine production and the wheat’s cultivation (Fig. 3).

² AHCP, Draft letter, manuscript by José Relvas to Amaro Soares, n.º 35, dated from September 20, 1904. Reference in Historical Archive: PT/AHCP/FR/JMR/B/03/C4464



Figure 2. Tiles designed by Lino for Casa dos Patudos representing music, painting, sculpture and literature. Source: Casa dos Patudos - Alpiarça. (2007). Retrieved November 8, 2017, ca



Figure 3. Tiles designed by Lino for Casa dos Patudos representing Farm's production. Source: Liliana Neves on a guided visit in June 3, 2016

The residential project was one of the main activities developed by Lino, and for him the innovation in the field of the interiors relates to the “design of the interior space” making it more comfortable, seeking a good “articulation of the different materials, in the combination of the furniture in harmony with the mural painting and tiles, and especially in the spirit that was intended to instill a certain space, distinguishing the zones of reception, work, conviviality and recollection” (Lino, 1999, p.143).

In the 1903 project, Lino stands out for the design of the entrance hall, staircase, office, Renaissance Room, Column Room, Dining Room and D. João V Room. Two of these rooms are dedicated to music: the Renaissance and the Column rooms.

As reported by Silva Bastos in his article published in the *Ilustração Portuguesa*, about the inauguration of the Casa dos Patudos in 1906, the Renaissance Room “is the largest room mainly devoted to music” (1906, p. 700), which reveals that this is not only the space to receive, but the space where music is appreciated. In this space stands out the ceiling, drawing of Raul Lino, as well as the stove and wood panelling, and the furniture executed by José Emydio Maior.

For the acoustical conditions of this room, which are very important for the functions it performs, the truncated pyramid shape of the ceiling as well as the use of wood in it, on panelling and furniture fulfil the room's acoustic requirements. Also, the use of carpet of *Arraiolos* in the walls promotes a better acoustic avoiding the echo.

The furniture of José Emydio Maior, in particular the chairs and benches of which the style was clearly chosen by the owner, who even gave a book of history of the Renaissance art to the artist to inspire him as the basis of his drawing (Bonina Grilo, 2015, p. 116). Their positioning next to the wall promote the dynamics of the space, making easy for their guests to attend the music sessions in a comfortable way, as if they were in an audience.



Figure 4. Carlos Relvas piano with his portrait nearby. Source: by author on a guide visit in June 3, 2016.

In addition to the structural and functional details, it is to highlight the piano by Carlos Relvas, son of José Relvas and professional pianist, who by testamentary disposition can never be touched and removed from the space where it is and was always accompanied by a post-mortem portrait (fig. 4).

The second Room dedicated to music, in this project is the *Sala das Colunas*, “an extension of the Renaissance Room. There is no pattern: the variety recovers its right to fantasy” (Silva Bastos, 1906, p.702). It is also to read that “Is the most intimate room for music of the Relvas family.” (Silva Bastos, 1906, p.703). This space already existed physically from the project of Thomaz Praia (Bonina, 2015, p.110), but with different functions. The columns that today characterize this space are Raul Lino’s drawing. It is also a small space, cosier, covered with a wood panelling, where the columns separate the space in two. In one photography of this space we can observe the painting of Relvas playing violin from José Malhoa (Silva Bastos, 1906, p. 701), reinforcing that this could be the room where Relvas gather objects related to music.

As we can see in figure 5, both rooms are in the center of the house and stand out for their size and positioning in the domestic flow. The right wing of the building is dedicated to private life and the left wing is dedicated to social life.

Relvas continues to increase his art collection and in 1914 again asks Lino to add a new wing devoted to the exhibition of sculptures, paintings, ceramics, textile, as a museum (Bonina, 2015, p.110).

It is in this 3rd campaign of works (1914) that the last room dedicated to music appears, making a connection between the *Sala das Colunas* and the *Sala D. Eugénia*, known as *Sala Corredor* (Fig 6).

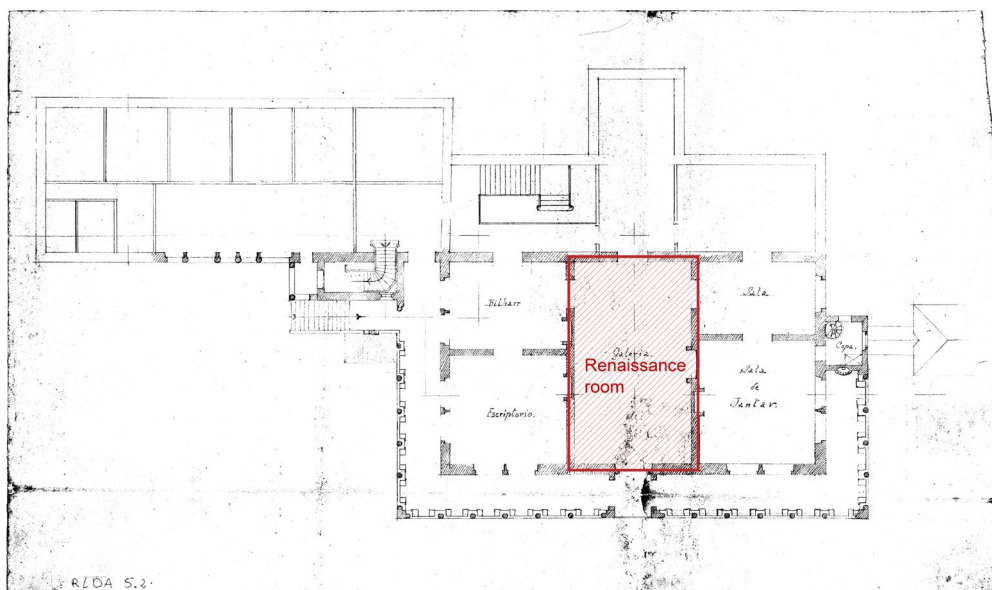


Figure 5. Main floor plan with marking of the space destined to the music: Sala da Renascença and Sala das Colunas. The original plan from 1904. Source: Raul Lino archive, Gulbenkian.

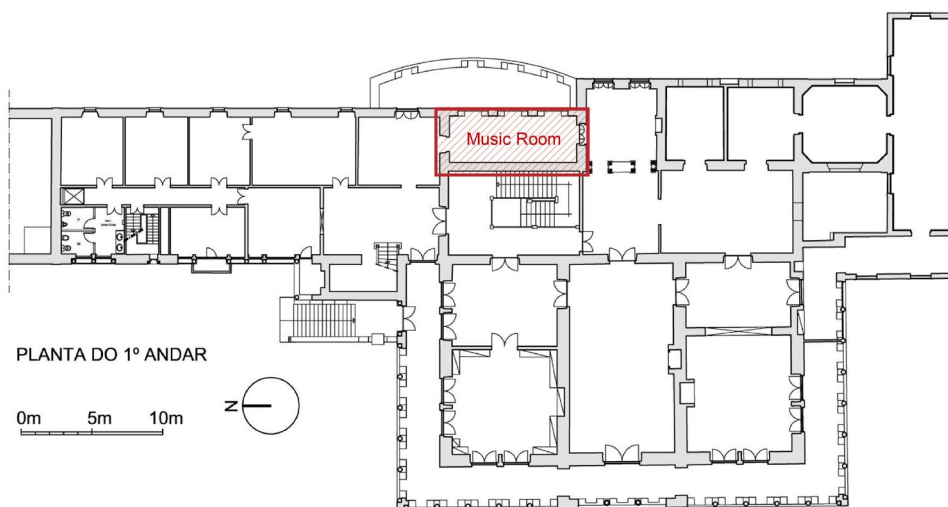


Figure 6. Main floor plan with marking of the new music room, add to the Raul Lino project in 1919. Source plan at Gomes (2012)

Just in 1926 it was renamed Music Room. The appropriation of the Old *Sala Corredor* comes from a “vicissitude of the soul”. The tragic suicide of Carlos (1884-1919) makes José Relvas to determine that from that day on, nobody would ever play on his piano, and music was not to listen to or play at Casa dos Patudos. However music was so important to him that in 1926, Relvas purchased a Welte-Wignon piano (self-playing piano that works with rollers) and as he describes it “is a wonderful application of mechanics, put to the service of the purest art. (...) An intelligent placement of the instrument facilitates the illusion of the artist’s presence”³.

The music room becomes the room of this piano and all the other objects related to music, as well as paintings, photographs and the Beethoven Vase, offered by his great friend Raphael Bordalo Pinheiro. This Vase celebrates the passion for music and the artist attributes to it the name of the favourite musician of José Relvas - Beethoven (figure 7).



Figura 7. Music room with Beethoven's Vase.
Source: <https://www.casadospatudos.com/colecao/>, retrieved in April 15, 2017

This third room of music in between two spaces with identity, gained a new function, certainly the most important for him, since there he could also honour his son. Observing the floor plan (Figure 5), this space is in the central axis of Casa dos Patudos and in the follow-up of the previous ones – the heart of the house.

Casa dos Patudos is above all a space dedicated to art and as described by João Chagas “In this house all arts are loved, but only one is cultivated – the Music” (1910, p 126).

Conclusion

Casa dos Patudos, project of Raul Lino, is an example of an adaptation of a pre-existing space, based upon a privileged and friendly relation between architect and owner. This trust relationship allowed the discussion of many details related with the project, boosting the creation of a place that besides being a domestic space with the specific functions for dwelling, was also a shelter for the art collection and particularly to allow the fruition of music.

The music is the heart and soul of the Casa dos Patudos, and even when Relvas thought there was no place to music anymore, he gave it a new life, with the creation of the third Music room. Lino, when designing his last project for this house, did not know that the old *Sala Corredor* would become so important in the life of Relvas and in the Casa dos Patudos. Nevertheless it is curious to observe the way that Relvas while reappropriating that space kept the music in the center of the house.

Also for Lino music plays a relevant role both in his life and in his architecture projects. His writings about the analogies between architecture and music frame his practice as architect and his perspective of experiencing interior spaces to dwell.

Casa dos Patudos is a symbol of Lino's ideals and is recognized both by its architecture as a great design project and by the place that music performed in Relvas' core life.

Note

All citations were translated by the authors.

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Sound in space as a design feature in workplace interiors

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The digital age came into our lives and settled with determination, thereby changing in a few decades daily life and social behaviour, and forcing the world to rethink daily experience, including spaces and objects. Thereafter, workplaces have become invaded by sounds of printers, keyboards and computers, mobile phone calls, videoconferencing, all blended with other background noises that affect concentration at work. Yet, the quality of space and the optimization of acoustics still remain essential for shaping a positive, focused and productive work environment. As our world is getting noisier, it is harder and far more challenging for designers and architects to establish quiet and peaceful workspaces. From architecture to furniture and objects, every element influences the repercussion of sound in space, which in turn has an impact on how one feels and experiences this space. In response to the expansion of open space concept and the consequent need of acoustics improvement, Robert Propst together with the designer George Nelson, created in the United States the Office II (1968), an office furniture line. The system gained a complete success and influenced the design and the office work back in the 1970s (Pile & Gura, 2000: 410-412).

Nowadays, the availability of the digital devices enables the workplace to be anywhere: on travel, in the hotel, at home, at the cafe or in the office. The development of new materials with soundproofing features, the ways of minimizing

noise and improving audibility (ambient music, video projection, etc.) have evolved not only the sense of responding to acoustic requirements, but also the design of space and furniture in order to support these new forms of work. In addition to floors, ceilings, walls and partitions with acoustic absorption, the feature is also applied in, among others, screens, panels for decorative wall applications, cabinets, sofas, armchairs. The advanced pieces of furniture adapt to flexible spaces supporting a diversity of environments required during the working day: team project work, spontaneous collaboration or mobile working. A workplace opened to innovation and creativity.

The present text is supported by the arguments of authors such as Steen Eiler Rasmussen and Peter Zumthor, among others, and by the analyses of office furniture design as paradigmatic cases for this study. The analysis explores Action Office II (1968), the Stockholm Furniture Fair organised in February 2016 focused on noise reduction in Scandinavian interiors, and Orgatec 2016 in Cologne, the most important trade fair in the world dedicated to the workplace, which trends demonstrated the suitability of spaces for new forms of work, taking into account the acoustics. This article aims to reflect on the importance of sound in space as a structuring condition of interior design and creation of atmospheres, namely in the experience associated with work environments.

Keywords: Sound, Workplace, Experience, Office furniture, Interior Design

Introduction

The digital and technological evolution has changed in a few decades the way of living and working. The relationship between living and technology transformed the daily experience in a permanent reliance on digital connectivity. This reliance on technology has made our lives busiest with digital connectivity and the environments noisiest, affecting concentration.

Once the sound is omnipresent everywhere, and it often can become noisy, noise reduction seems to be a major preoccupation in these days. Designers and architects are forcing to rethink daily experience. To project workplaces and furniture they need to think not only about light, form, surface and colours but also about sound. In a workplace, how can design make the sound pleasant rather than noisy? How can interior design and office furniture improve acoustics in the workplace?

In this context, a special emphasis is given to the evolution and the present interest of office furniture design in order to improve the sound quality of workplaces. This article aims to reflect on the importance of sound in space as a structuring condition of interior design and creation of pleasant workplaces interiors from the analysis of following premises: 1) offices' spaces evolution and 2) paradigmatic cases of office furniture design for this study.

This investigation also intends to participate in the recognition of sound in space as a design feature in workplace interiors, in the improvement of the acoustics and consequent quality in the work.

Offices evolution from 1920's to 2010's

With the evolution of technology spaces became more and more noisy, the social behaviour changed and also the way of working. Spaces and products are constantly reinventing themselves in order to respond to the needs and requirements of society. Offices had to adapt to technologic innovation, new devices and tools which influenced the working routines. Just thinking about objects that changed the act of writing over the last decades it is to say that the pencil was replaced by the pen, then by the typewriter, which gave way to the desktop computer, that was succeeded by the laptop and then by the tablet and mobile phone. Since work tools change so change the behaviour in workplaces and therefore the design of office furniture and interior architecture need to quickly respond to new needs. Looking to the office from 1920s (Fig.1), even being an open space full of people it looks quiet and silent and people are concentrated, the only technology is the phone. In the offices from 1940s (Fig.1) the typewriter's presence is already an object that disturbs silence but the offices from 1970s and 1980s (Fig.1) with computers, printers, keyboards, and phone are even noisier and needed screens for acoustic improvement. In effect, in the 70s, the challenge to improve offices acoustic was a design issue. Robert Propst (director of Herman Miller in 1968) together with the designer George Nelson created in the United States an office furniture line, the Office II (1968) (Fig.2). The system consists of autonomous modules, partitions and removable screens that allow reducing noise, by establishing individual or group work areas in open spaces (Pile & Gura, 2000, pp. 410-412). With the incredible success of this model which also stimulated a flexible work flow the concept was being used by other companies (Cruz & Pombo, 2018, p. 127).

The offices from 1990s and 2000s (Fig.1) considering the evolution of computers and monitors show that the hardware has become smaller and software more friendly, and the behaviour of people changed facing to this reality. The image displays people walking around and talking to each other. In the offices from 2010s (Fig.1) the digital age and the technological portable devices are an unavoidable reality that forced the world to rethink daily work experience.



Figure 1. Offices evolution from 1920's to 2010's.



Figure 2. Action Office II (1968) – Herman Miller, USA.
Source: available in <http://www.hermanmiller.com/products/workspaces/individual-workstations/action-office-system.html>, accessed on April 7, 2017.

The interpretation of office's evolution is essential to understand the transformations and evolution of work scenarios and the new paradigm, based on new knowledge and information generated by technological advances. As the sociologist Zigmunt Bauman (2000) describes, the transition to post-industrial society is the transition from a 'solid' modernity based on physical, palpable materials to a 'liquid' modernity based on immaterial contents. The acceleration of life and its history corresponds to this overabundance of information, so excessive that it changes social behaviour. "With the excrescence of products, images and information, a kind of universal hyperculture was born, that (...) reconfigures the world we live in and the upcoming civilization" (Lipovetsky & Serroy, 2010, p. 11).

This reality is no more than the price of this postmodernity, which produces 'non-places', a concept proposed by the French anthropologist Marc Augé (1992), to designate a space of passage, unable to shape any kind of identity. So, "if a place can be defined as place with identity, relational and historical, a space that cannot be defined as a place with identity, neither as relational nor as historical, will define a non-place" (Augé, 1994, p. 83). Feeling a space and experiencing the environment's atmosphere asks for an interaction between the individual and the place.

As our world is getting noisier, space division and optimization of acoustics are essential for creating a pleasant and productive work environment. Architecture of interiors responds to the transformations of society, meeting the new needs of such working structure.

Acoustics as a design feature

Nowadays noise continues to be a key-problem in workplaces: the clicking of computer keyboards, the constant noise of printers and copiers, phones ringing, people talking on the phone and videoconferencing, conversations between colleagues, background music, all blended are stressful and affect concentration at work. Considering that the quality of space and the optimization of acoustics still remain essential for shaping a positive, focused and productive work environment, doing something about office noise is worth for all. Acoustics is one of the needs in offices that designers should recognize. Create quiet and peaceful workspaces became a challenging for designers and architects.

The Finnish architect Juhani Pallasmaa defends the silence as one of the six themes for the next millennium, according to him: "the task of architecture is to create, maintain, and protect silence. Great architecture is silence turned into matter; it is petrified silence" (Pallasmaa, 2012, p. 305). From architecture to furniture and objects, every element influences the repercussion of sound in space, which in turn has an impact on how one feels and experiences this space. Steen Eiler Rasmussen refers that: "in the same way we hear the sounds it reflects and they, too give us an impression of form and material. Differently shaped rooms and different materials reverberate differently" (Rasmussen, 1959, p. 224). The same noise or the same music is understood from different ways according to the space where it is heard. According to Peter Zumthor, "interiors are like large instruments, collecting sound, amplifying it, transmitting it elsewhere. That has to do with shape peculiar to each room and with the surfaces of the materials they contain, and the way those materials have been applied" (Zumthor, 2006, p. 29). The sound depends on the materials and forms, and also the diversity of possibilities of combinations between them, which creates different atmospheres. "The interiors motivate the experience of material and spiritual elements. It influence the user's life. They create new languages; they report to space and to time: interior and exterior, individual, and collective" (Pombo, 2014, p. 29).

Being everyday life more and more nomad and interactive, the office also becomes nomadic, with increasingly portable digital equipment supported by connected software, the office can be anywhere: at home, on the road, at the hotel, at the café, on the train, in the library. This reality, integrated in the expression of increasingly hybrid lifestyles, in which the lines between private and professional life intersect, requires the rethinking of workplaces. Offices need to adapt to collaborative work, be more flexible to facilitate the work process by supporting a diversity of environments required during the working day: team projects, spontaneous collaboration or mobile work, without forgetting the moments of reflection and privacy. To display and allow such working atmospheres acoustics as design feature is essential.

The Orgatec in Cologne is the most important fair in the world dedicated to the workspace. Here, innovative trends are defined, and the development of workplace design is influenced by it. In an interview during Orgatec in 2016, Rudolf Pütz, CEO of Vitra, says that technological

evolution and demographic change are the main forces that transform our world of work: “(...) at home, on travel, in the hotel or in the office – today, the places for working are diverse, work becomes multi-local. The office of today ought to support these new forms of work such as project work, spontaneous collaboration or mobile working and be an open space for innovation and creativity” (Pütz, 2016). The furniture’s exhibition on Vitra’s stand – “Work” (Fig.3), uncovers the need for workplaces to respond to new forms of work by creating a multiplicity of spaces within one open space. The furniture itself organizes the space and creates quiet and calm areas for meetings or individual concentration. The focus must be placed on acoustics in order to meet these needs. During this event, Michael O. Schmutzer, curator of space “Smart Co-Working Lobby” integrated into the Orgatec and Managing Director of the company Design Office says that coworking is now a key issue, flexibility corresponds to today’s societal needs (Schmutzer, 2016). A simple concentration in work around a table and a swivel chair office, no longer corresponds to these new ways of working. The world of work has definitely become more dynamic and social interaction with colleagues is increasingly important. Therefore, there is a growing trend towards informal work zones and rest and leisure zones to promote rest and socializing essential to collective well-being, creativity and professional performance.



Figure 3.Orgatec 2016. “Work” by Vitra stand. Source: available in <http://news.orgatec.com/2016/10/work-becomes-multi-local-an-interview-with-rudolf-putz-from-vitra/>, accessed on April 7, 2017.

Nowadays, in “a civilization of the slight”, as described by Lipovetsky (2016), highlight a new paradigm.

“(…) A new paradigm that triumphs: before marking an aesthetic quality, lightness means a technical performance, the objects that, miniaturized and connected, allow the mobility, fluidity, ease of informational and everyday operations” Lipovetsky, 2016, p. 133

“(…) monitored and nomadic objects, nano-objects, light products, fun sports, frivolous consumerism - there are innumerable domains that, in different forms, translate the progress of the lightness revolution” Lipovetsky, 2016, p. 227

To improve the acoustic quality in workspaces, designers and architects need to take into account the flexibility, nomadism and connectivity, requirements of daily life nowadays, this “civilization of the slight”. The ways of minimizing noise and improving audibility (ambient music, video projection, etc.) have evolved not only the sense of responding to acoustic requirements, but also the design of space and furniture in order to support these new forms of work. According to that, the development of new materials with soundproofing features is essential.

In addition to the more common application of these materials with soundproofing features in floors, ceilings, walls and partitions with acoustic absorption, the feature is also applied in advanced pieces of furniture which can adapt to flexible spaces supporting a diversity of environments required, like screens, panels for decorative wall applications, cabinets, sofas, armchairs, among others.

As can be seen in the workplace with office furniture by GUIALMI, a Portuguese office manufacture company (Fig.4), a flexible workplace is outfitted with acoustic-absorbing office furniture that creates and organizes the space in several work zones. The cabinets with perforated steel plate doors, lined inside with a canvas render the space soundproofing. The screens covered with cardboard and fabric create barriers to sound and noise. Last but not least, the Marea sofa, with high but flexible arms and backs, lined with noise-minimizing foam and fabric, promotes informal or quiet work meetings.

The Stockholm Furniture Fair in 2016 was focused on noise reduction in Scandinavian interiors with designers, companies and brands launching products aiming to make interiors quieter. Acoustics was in the spotlight as never before from the most common devices to the sound-absorbing portable desktop screens for computer working, spongy wall-mounted booths for phone calls and even a dome like a lampshade that can cover the user’s head. Figures 5 to 8 showcase some pieces exhibited at the Stockholm Fair in 2016.

In the image (Fig.5) we can see “Focus” by Zilenzio, a flexible and portable screen that offers privacy and sound insulation, ideal for professional nomads, people who work in public spaces, library’s, coworking spaces, coffee’s, and often need to turn a table into a temporary desk. There are more and more independent professionals looking for these spaces to escape the isolation of working at home (home office) or in individual offices.

The 100% polyester felt dome: “Tomako” image (Fig.6), by Finnish brand Vivero, is like a lampshade that covers the user’s head absorbing the surrounding noise. In open-plan offices, receptions and other open spaces, this piece of furniture offers privacy, a quiet place without disturbing noises for reading a book or even working.



Figure 4. Workplace with office furniture by GUIALMI, Portugal.

Source: available in <http://www.guialmi.pt/produtos.php>, accessed on April 9, 2017.

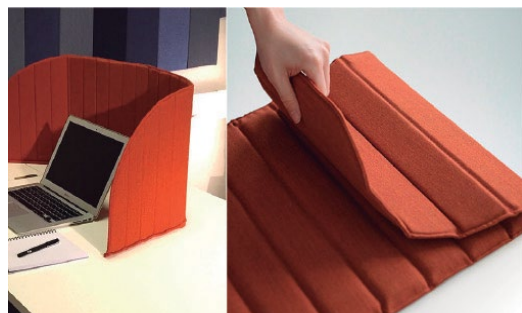


Figure 5. "Focus" by Zilenzio.

Source: available in <https://www.dezeen.com/2016/09/11/note-design-studio-focus-office-divider-acoustic-panels/>, accessed on April 8, 2017v



Figure 6. "Tomako" by Vivero.
Source: available in <https://vivero.fi/en/micro-architecture/acoustic/item/213-tomoko>, accessed on April 8, 2017

Form Us with Love from Sweden Design exhibited a "3D Pixel" (Fig.7), an example with pieces to put on the wall with different colours to customize the shape and a "Hood" (Fig.8), a curved felt dome with the sheltering lamp suspended from the ceiling that creates both room and light over large work and meeting tables. Milano 2017, Salone del Mobile, reveals also concerns about sound in space. The workspace divider lamp: "AK2" (Fig.9) by De Vorm is a telling example of that. This wide rectangular panel in felt, hanging from the ceiling, creates a visual and audio barrier from the person sitting on the other side of it.



Figure 7. "AK2" by De Vorm.
Source: available in <http://www.salonemilano.it/en/trendlab/intro-trendlab/livingScape/The-New-Way-of-Working---Nowhere-Office-Shared-Office-e-WorkSpace-Reloaded..html>, accessed on April 9, 2017.



Figure 8. "Hood" by Form Us with Love.
Source: available in <https://www.dezeen.com/2016/02/12/noise-reduction-acoustics-scandinavian-interiors-stockholm-design-week-2016/>, accessed on April 8, 2017

Another example, that also responds to the exaggerated dependence on technology is Offline Chair (Fig.10) by Agata Nowak, a polish designer. In this particular chair, people can relax, read a book, and enjoy the silence without digital interference. The high back and sides screen off the surrounding noise.

Still at Salone del Mobile in the Workplace 3.0 pavilion could be seen "A Joyful Sense at Work" (Fig.11), a scenery that gave form and life to the latest theories of office's products and workspace design. And as can be seen in the image, the acoustics and the need to create quiet and silent places for informal meetings was present.



Figure 9. "3D Pixel" by Form Us with Love

Source: available in <https://www.dezeen.com/2016/02/12/noise-reduction-acoustics-scandinavian-interiors-stockholm-design-week-2016/>, accessed on April 8, 2017



Figure 10. "Offline Chair" by Agata Nowak.

Source: available in <http://www.salone milano.it/en/trendlab/intro-trendlab/livingScape/Cosy-Home-Digital-Detox.html>, accessed on April 9, 2017.



Figure 11. "A Joyful Sense at Work", Salone del Mobile, Milano

Source: available in <https://www.cfn.news/news/2017/4/7/a-joyful-sense-at-work>, accessed on April 7, 2017.

Last February at the Stockholm Furniture Fair 2018, the central focus continued to be acoustic features and new materials to give comfort and make the sound pleasant in workplaces' interiors, taking into account the new forms of work. (Fig. 12).

Nowadays, in a workplace interior the acoustic design is as important as visual design. As Pallasmaa notices: "a space is understood and appreciated through its echo as much as through its visual shape, but the acoustic percept usually remains as an unconscious background experience" (Pallasmaa, 1996, p. 50).



Figure 12. Stockholm Furniture Fair 2018, by Rita Cruz, Feb. 2018.

Conclusion

Digital nomadism interacting with the need for work mobility and flexibility, and the valorisation of lightness (Lipovetsky, 2016) requires a design that is able to respond to these necessities. Given the current relevance of acoustics in work spaces and the new forms of work, the development of new materials with soundproofing features inspires the design of office furniture and accessories. Design dealing with sound as feature acts not only to protect us from unpleasant noise but above all to turn sound into something pleasant. The most recent international furniture fairs make evident that acoustics in workplaces is becoming a concern for designers and a challenge to project. The responses highlight the important aspect of sound in experiencing space, namely the workplace environment.

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Symbols – Sign – Sounds

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In this paper the author addresses questions about relations between visual signs and symbols, and sounds. Philosopher Ludwig Wittgenstein once wrote: “All that a symbol CAN express, it MAY express”¹ (Monk, 1990, p. 151). meaning, e.g. that the standard musical notation symbols are a convention. They are symbols that might be interpreted in many ways. Is there an obvious relation between symbols and signs on the one hand, and sounds on the other? Can be but must not. Humans tend to interpret higher up on an image equals higher pitch, and that bigger means louder. Cornelius Cardew’s seminal piece *Treatise* (Cardew, 1967) takes Wittgenstein’s works as a as point of departure. The score consists of abstract graphics, and at the outset he gave no instructions how to interpret and play the piece. One composer that is linked to graphical scores is John Cage. One example is *Imaginary Landscape no 5* (Cage, 1952), where performers are asked to

bring a number of favorite jazz records as sound sources. The score contains of a timeline with “channels” for each player, which instruct players to be silent or play. Cage’s score was outlined on a paper, which allowed participant players to prepare upcoming actions in advance. What happens if the score is replaced with a real time video score that cues sounds and silences in the same manner, with the difference that future information is hidden.

The Bucket System (Dahlistedt, Nilsson, Robair 2015) is an open structure of optical signs in the form of LEDs that either light, blink or are black. It is up to the participating musicians to make up rules what the given signs means in each particular performance. In this system, a player receives a new instruction where (s)he is forced to halt or change whatever going on, and since the participant musicians are interrupted all the time, no one will be able to develop things as usual.

Introduction

In the Japanese author Haruki Murakami's novel *Sputnik Darling* (Murakami, 2001) an unnamed narrator (once named "K") is in one-sided love with Sumire, a disordered girl whom the narrator meets in college. Sumire is dreaming to be a novelist, and she drops out of school to read and write more, and in a call to K at 3 a.m. she poses the following question: "What is the difference between a sign and a symbol?". (ibid 151) The classic definition of a sign is: "something that stands for something else".² The "father" of semiotics C.S Pierce developed this definition as: "something which stands for somebody for something else". (in Chandler, 2017, 2). Eventually, semiotician Umberto Eco further developed this, by saying: "The sign is a gesture produced with the intention of communicating". (Eco, 1984) Oxford dictionaries defines a sign such as: "an object, quality, or event whose presence or occurrence indicates the probable presence or occurrence of something else"³. A sign points to something else, and a form of communication is embedded within the sign in order to do be able to do so. For instance: dark clouds in distance is a sign of rain approaching; the first yellow leaves are a sign of autumn. What about a symbol? A symbol is a subordinated sign: "a mark or character used as a conventional representation of an object, function, or process, e.g. the letter or letters standing for a chemical element or a character in musical notation"⁴. As example a symbol can be a sign or shape, like the Christian cross, which symbolizes a religion; or a dollar sign, which may symbolize richness, as well being a sign for a currency, if in front of a number.

A forerunner of modern semiotics is the French linguist Ferdinand Saussure who named his theory semiology. At the core of Saussure's thinking is the dual nature of a sign: the signified and the significant (*signifié* and *signifiant*). In short, the signified is the reference to what the sign points to, and the significant is sign itself. E.g. red at a traffic light: the color red is the significant, and the signified is to stop. For Peirce, representation of a sign is triadic, which Fig. 1 shows.

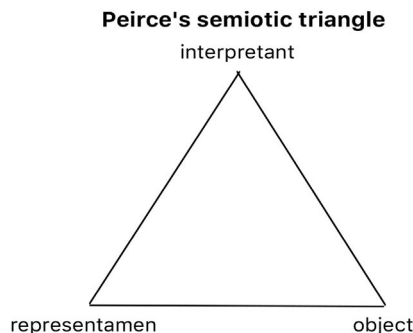


Figure 1: Pierce tripartite model of a sign

A sign is a unity of the thing that does the representing (the representamen), what is represented (the object), and how it is interpreted (the interpretant): "The meaning of a sign is the sign it has to be translated into and that the meaning of a representation cannot be other than representation". (Chandler, 2017 p. 33). The Saussurian sign relations are between the signifier and the signified, whereas Peirce's tripartite model is referential: 1) symbolic; 2) iconic;

1 Wittgenstein answer in a letter to Bertrand Russell 1919.

2 Aliquid stat pro aliquo.

3 <https://en.oxforddictionaries.com/definition/sign> (01/29/2018)

3) indexical. Nothing is inherently a symbol, an icon, or an index⁵. The same sign vehicle can, in different contexts, involve different sign relations. Remember Wittgenstein.

Symbolic: Are based on arbitrary relationships, and must be agreed upon, and/or learned.

Examples are languages, alphabetical letters, words, phrases, and sentences, as well as Morse code, traffic lights, and national flags⁶.

Iconic: Are based on perceived resemblance or imitation, (such as appearance, sound, feeling, taste or smell). A portrait, a scale model, onomatopoeia, metaphors, sounds in program music, dubbed film sound track, imitative gestures.

Indexical: Are based on direct connotation (physical or causal). The link can be observed or inferred: natural signs (smoke, thunder, footprints, echoes, non-synthetic odors and flavors), medical symptoms, measuring instruments; 'signals' knock on door, phone ringing, a pointing index finger, recordings, photo, film, video; personal trademarks: handwriting, catchphrases⁷.

Sign and Symbols in Electroacoustic Music

In electroacoustic music, symbols and signs has been, and is used, as 1) analytical tools of works, and 2) scores for producing or diffusing music.

Analysis: there are two objective forms of representing sound: waveform and sonogram. Neither of these forms are based on human perception of sound, rather it is a graphic representation of the physicality of sound measured. Nevertheless, both of them can be very helpful, and for a trained reader provide hints of the nature of the sounding content. Denis Smalley (1997) describes three types of scores used in electroacoustic music: productional scores, performing scores, realization scores, and diffusion scores (p. 108). As an example of a diffusion score, an extract from Trevor Wishart's own score of *Tongues of Fire* (Wishart, 1994⁸) is showed.

Wishart uses some common musical notation signs, such as the swell sign in magenta, which is both symbolic and iconic. But there are also a number of idiosyncratic signs that are iconic, like the first two shapes, and symbolic such as the third shape with diagonal stripes. The score also employs signs in form of plain text, e.g. the abbreviation for decibel from the field of acoustics and sound engineering, dB. From personal experience, this kind of partition is made for remembering, and demand a certain amount of pre-concert listening and practicing to perform a good sound diffusion in a concert situation.

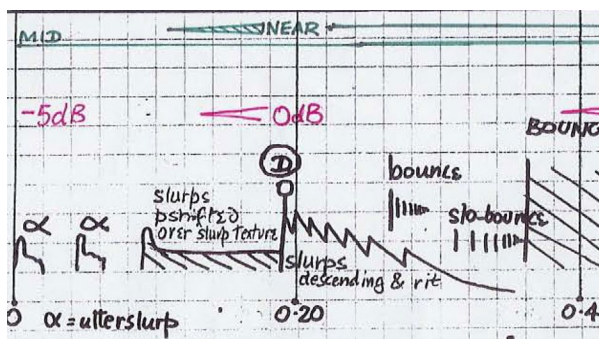


Figure 2: Excerpt of the opening of Wishart's *Tongues of Fire*.

4 Ibid.

5 Ibid

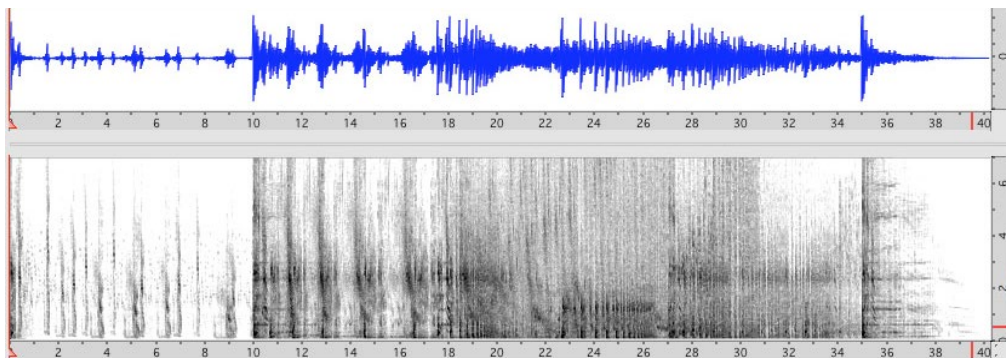


Figure 3: Waveform and Sonogram of the above example.

Another example of an analysis tool is the Aural Sonology, (AS), by Norwegian Lasse Thoresen (2015). AS is a complete system of signs for analysis of electroacoustic music. Thoresen's system is built on several sources: the work of Pierre Schaeffer and his scholars (such as Smalley), Gestalt Psychology and Semiotics. In short it takes, as point of departure, Pierce's trisection of music: 1) Poeisis (intention of creation, compositional), 2) Esthesis (creation of meaning), 3) Neutral (observation of poeisis and esthesis). Figure 4 shows examples of signs in Aural Sonology⁹.

	Vingelklang	Spalteklang	Haldne	Impuls	Itererte	Samansette	Mylderklang
Stabil							
Toniske							
Dystonisk							
Kompleks							
Varierende							
Toniske							
Dystoniske							
Komplekse							

Figure 4: Example of signs in Aural Sonology. Here with names in Norwegian.

6 In Chandler, 2017, in chapter Models of the Sign.

7 Ibid. Indexical signs are widely used in electroacoustic music, I rather claim an essential part is to "play" with, and to force re-interpretation of, indexical signs by processing sounds. However, it is beyond the scope of this article.

8 Excerpt taken from Wishart's diffusion score made for the world premiere of Tongues of Fire at the Synthese Festival in Bourges in 1994.

9 Example taken from the PhD thesis *Fra sma teikn til store former* by Norwegian Njål Øines (2016, 83).

Signs employed in AS are iconic to a certain degree, however, they are not entirely self-explaining, a potential user of AS must be prepared to spend a good amount of time to learn the signs. Fig. 5 shows example of AS analysis from Swedish EAM-composer Åke Parmerud's *Les Objet Obscure*. (Thoresen, 2009)

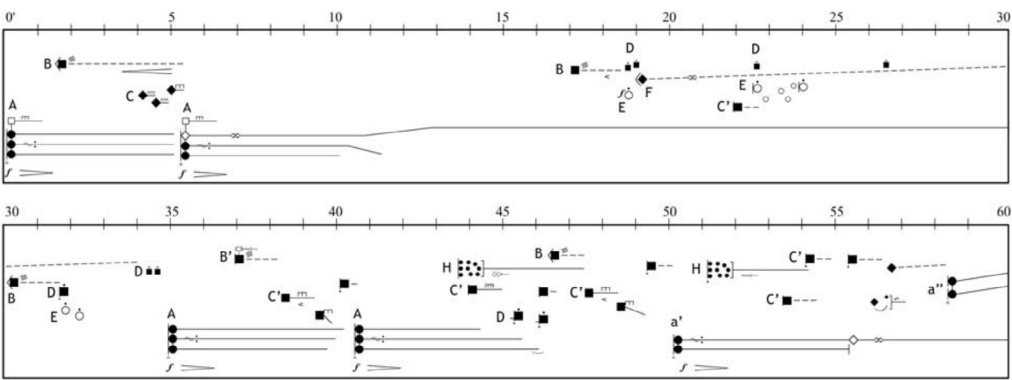


Figure 5: Excerpt from an AS analysis of Åke Parmerud's *Les Objet Obscure*.

Signs and Symbols for Musical Performances

The most obvious, and most used, symbol system for music is the conventional notation system that has been in use in Europe for nearly 1000 years. It has its roots in the system of *Neumes*, which means hint. At the outset, the standard musical notation system was an invention by Guido d'Arezzo around year 1050, and about 1400 it become the generally used system in Europe¹⁰.

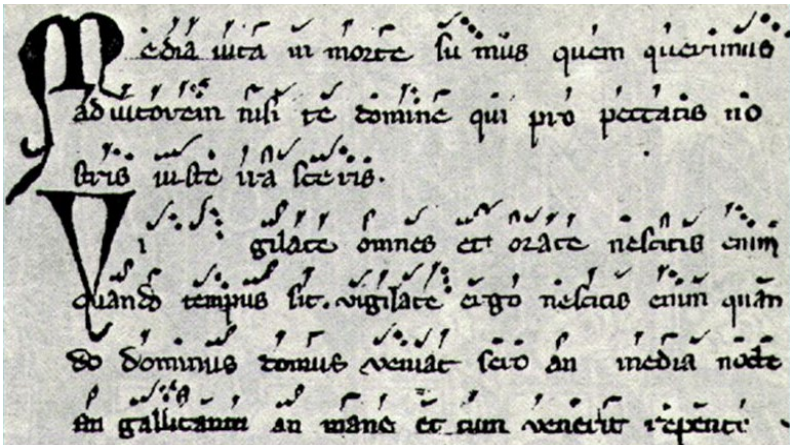


Figure 6: Example of Neumes.

¹⁰ Note symbols offered new ways to make music. Rather than working with sounds at an instrument in real time, one may manipulate symbols out of time.

Since standard music notation is common knowledge, examples of more contemporary notations will be discussed.

For 1, 2 or Three People

One example of sign use in more recent days is Christian Wolff's piece *For 1, 2 or Three People* (Wolff, 1964). One might call Wolff's partition *neumes*; signs for actions rather than specific signs for sound production. Fig. 7 shows example of signs to be learned, *symbolic*, and all players must agree and learn what the signs signify.

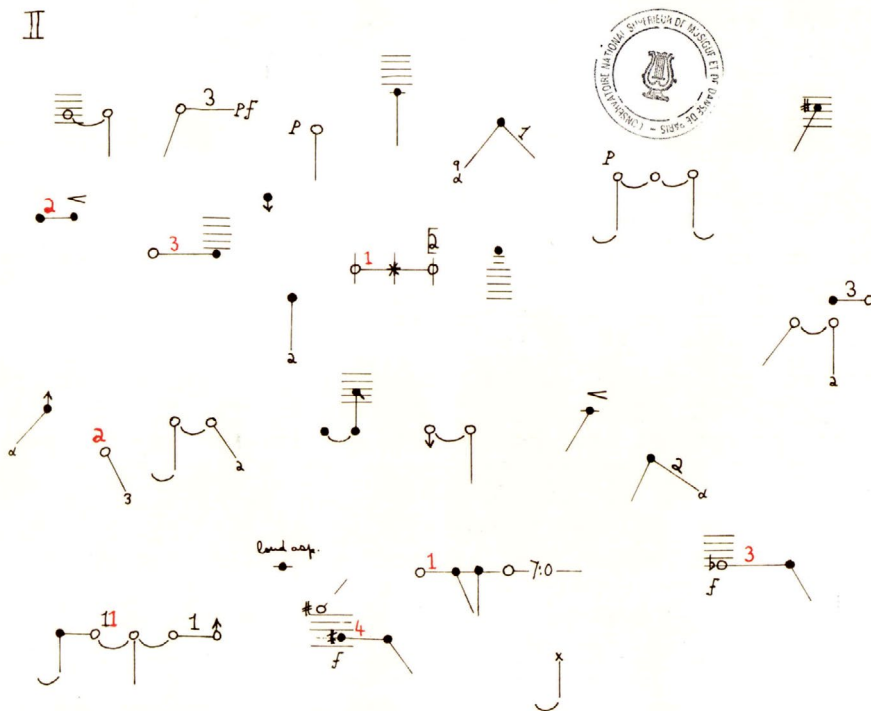


Figure 7: First page of For One, Two, or Three People (Wolff, 1964)

These neumes, eventually become Wolff's distinctive scores style, is called *ratio neumes*: each action has a numeric ratio. (Hicks, Asplund, 2012, 24) The first number in the ratio refers to duration in seconds. The second number refers to how many of the given group of pitches (or pitches chosen ad lib by the performer) to play.

Treatise

Another example is Cornelius Cardew's *Treatise* (1967), which was composed during 1965 - 67, is inspired by, and mirror Wittgenstein's writings. Going from consistency and logic, which mirrors *Tractatus Philosophicus*, towards freer forms, reflecting the late Wittgenstein's *Philosophical Investigations*. Fig. 8 displays one page in *Treatise*.

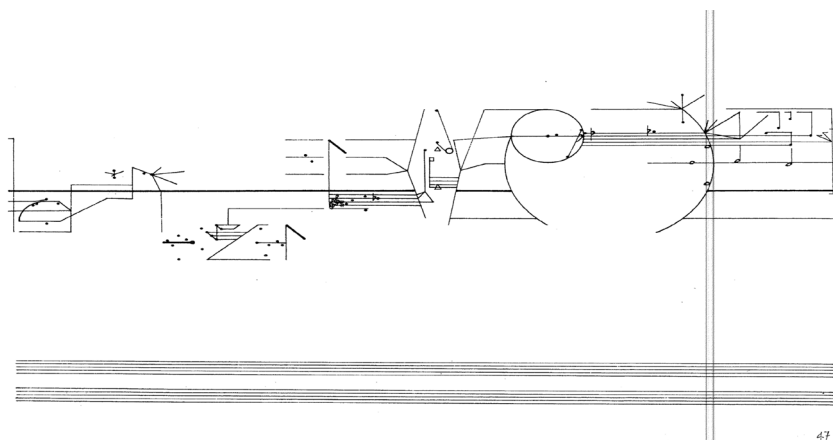


Figure 8: Page 47 in Treatise.

Cardew did not give any instructions of how to interpret the signs at the outset¹¹. Therefore, a performance of *Treatise* will most likely start with a discussion of the meaning of signs given. However, a tradition of interpreting and performing *Treatise* has emerged, and there are many ways to perform *Treatise*, from a strict and repeatable version, to using the score as inspiration for improvisation. The following anecdote sheds light to the way one may approach *Treatise*: in connection to an early performance, the participant players, among them saxophonist Evan Parker and guitar player Keith Rowe, discussed with Cardew about the meaning of some big black spots (Ibid, 133) in the partition. After a while Rowe says: - it must be something significant. Cardew responds: - you're right, it must be something significant!¹² Eventually, Cardew published the *Treatise Handbook* (Cardew, 1971) where experiences of interpreting and playing the piece was presented and discussed.

I, Norton

One composer who has experimented with signs in improvised music is American Gino Robair. In his piece *I, Norton* he has taken a proclamation by Joshua Norton, published in San Francisco Chronicle 1849, where Norton declared himself president of United States¹³. From this short text Robair has distilled information in various ways that is used as instructions for improvisers. As example, Fig. 9 shows the aria *My Dear Miss Wakeman*, where a singer is instructed to combine syllables and Morse rhythms displayed.

Each sign in the Morse code, in its normal use, has to be learned. Robair however, break down the proclamation to graphemes/morphemes, and Morse code, and then it is up the performer's discretion to improvise the aria, by combining these elements: it results in an improvised aria with nonsense speech, however informed by the original text.

¹¹ *Treatise* is meant to be read in a linear fashion, from left to right, in consecutive pages, however, quite often a selected, limited number of pages are interpreted and performed. The score is divided in three parts, the upper part, the lifeline, and the lower part. According my experience, players use to decide to play one of these parts.

¹² Personal conversation with Evan Parker, August 2009.

¹³ For further information: <http://www.ginorobair.com/inorton/inorton.html> (02072018)

MY DEAR MISS WAKEMAN

(solo version for Aurora Josephson)

By Gino Robair

-nd	rā	u	-L	nā	plē	mə	di
bə	Lu	mā	yě	-p	kri	sē	pēr
-v	ti	ē	in	-Z	-r	ā	Le
sā	-n	thə	al	ə	wi	in	th
ī	wā	-s	bē	fô	-m	ēr	nō
-k	dê	pūr	ū	i	b	too	mē
mī	sh	Lī	-t	kē	ō	pri	-f
fre	iz	-nj	mī	shoo	em	-d	vō

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January-July, 2004
Walnut Creek, CA

Figure 9: Aria in Gino Robair's I, Norton. © Gino Robair

Composing and Playing with Signs

Triangles Piece

For Cardew, the triangles in Treatise were important and meant triads (Cardew, 1971, Dec 13 notes)¹⁴. Treatise triangles generally occur with at least one side vertical or horizontal. If two properties occur, e.g. top-left oriented, both mappings have to be taken into account. In order to investigate triangles, the way Cardew prescribes, I made a patch in Max that generate and display triangles in real time in a random fashion, one variation at the time, as described above, with the following Cardew inspired interpretations:

- Left oriented - all three elements have equal dynamics
- Top oriented - all three elements have equal duration
- Right oriented - the three elements span two equal intervals
- Bottom oriented - all three elements are in the same register



Figure 10: Examples of triangles.

¹⁴ The copy at my disposal shows no page numbers

¹⁵ The title is inspired by Cage's Cheap Imitation, a dance piece for Cunningham that took durations from Eric Satie's opera Socrates, however with other pitches.

This experiment did not come out well, it turned out to be too difficult to remember for the players. At the outset, triangles can be classified as *empty signifiers*. According to Chandler: “they may mean whatever the interpreters want them to mean” (Chandler, 2017, 90). Although, any triangle connotes three of something, like Cardew who treated them as triads. I do believe, when a symbol gives no or weak clue to what to do, one does not feel any connection between present sign and prescribed action. Cardew, interpreted triangles in a very precise way, however in many later renderings of *Treatise* the triangles have signified different things. And according to my opinion and experience, it is more artistically fruitful to keep signs employed open for interpretation, and rather see the interpretation process as part of the performance.

Imaginary Imitation

*Imaginary Imitation*¹⁵ is a graphic control system that prescribes when participant players are allowed, or not allowed, to play. An inspiration is John Cage's *Imaginary Landscapes no 5*, where performers are asked to bring a number of favorite jazz records as sound sources. Cage's score contains of a timeline with “tracks” for each individual player, where presence of a thick line means “play”, whereas absence means “be silent”.



Figure 11: Screen dump from *Imaginary Imitation*. Here for two players.

The symbol employed in *Imaginary Imitation* is hard not to understand and agree the meaning of: the color coded moving dial represents a clock means “play time”, and black means “silent”. On the one hand, Cage's score was outlined on a paper, it allowed participant players to prepare upcoming actions in advance. A real time generated score on the other, will make players more attentive listeners, be more aware of the present. One parameter of importance is the durations of time frames and use to be set to 3 – 45 seconds. With longer durations, the piece tends to sound like a conventional free improvisation, since musicians is given time to develop ideas, with the shorter setting you are interrupted all the time and the constant change and fragmented playing become the identity of the piece.

The Bucket System

The Bucket System (Dahlstedt, Nilsson, Robair 2015) is a system for computer-mediated ensemble improvisation, designed by improvisers for improvisers. Coming from a tradition of structured free ensemble improvisation concepts (such as *conduction* and *comprovisation*), influenced by post-WW2 experimental music practices such as the music of Cage, Wolff and Cardew. It is a signaling system implemented with a set of McMillen QuNeo¹⁶ controllers as input and output interfaces, powered by custom software programmed in Pd. It allows for a new kind of on-stage compositional/improvisation interaction. It is up to the participating musicians to make up rules what the given signs means in

16 Link: <https://www.keithmcmillen.com/products/quneo/>

each particular performance. In this system, a player receives a new instruction where (s)he is forced to halt or change whatever going on, and since the participant musicians are interrupted all the time, no one will be able to develop things as usual.

The Bucket System features

- Synchronous instant changes in musical output
- Negative freedom for participants (freedom from freedom to make decisions)
- Performers are composers and performers at the same time

In order to play with the Bucket System, participants have to make up, and agree upon, rules how to interpret signs displayed. There are four states: no light, fixed light and slow and fast blinking. Black is silent. At the outset, a number of pre-made interpretations has been used.

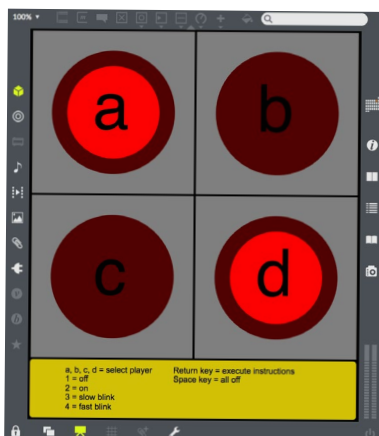


Figure 12: Max-version of the Bucket System interface.

The Bucket System signs can be described as symbols since the meaning of the different signs are arbitrary. However, the signs can be seen as iconic as well, since fixed or slow blinking may point at, or signifies, less energetic playing compared to fast blinking. One example is the *metaphorical* interpretation: Fast = busy; medium = simple; and fixed = extended, which makes the signs iconic. Another one is *behavioral*: Fast = solo; medium = interact, fixed = vacillate. These rules are deliberately chosen to be vague; to force players to reflect and to make active choices, and not blindly following instructions. Both interpretations exemplified however, are indexical to a certain degree, they point to a type of musical outcome with respect to given sign.

Conclusion

Viewed through a lens of basic concepts taken from the field of semiotics, the role and meaning of visual signs in music can be better understood. In this paper however, a very few terms are brought in, serving as examples. Signs have been used in music in many ways for many years; in the western part of the world e.g. as *nuemes* and the standard notation system we use today. It exists no objective and regular relationship between the shape of a sign and sound, rather interpretation is based on agreement. As Wittgenstein claims: All that a symbol CAN express, it MAY express. Most signs employed in music are however symbolic to a certain degree, e.g. in the standard notation system, higher signifies higher pitch, bigger means longer or louder, or as in Treatise, significance. A convention is also to interpret time going from left to right. Abstract

empty signifiers, such as triangles, according to my experience, make a particular sign harder to remember compared to iconic signs.

There is indeed research made on semiotics in music, one may mention articles and books by Dunsby (1983), Tagg (1987), Molino (1999), and Worthen (2010).

Most of research made however, are made for and about music analysis. What interests me however, is to research semiotics in music from an artistic point of view, to experiment with signs for music making rather than analyzing. For the time being the author is working in research team based in Sweden that consists of Palle Dahlstedt, Tim Perkis, and Gino Robair, who develops a Bucket System II, where role and function of signs employed are at the forefront.

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Synchronizing to Visual Cues in a Networked, Real-Time Notation Environment – Comprovisador

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Comprovisador is a system designed to enable mediated soloist-ensemble interaction using machine listening, algorithmic compositional procedures and dynamic notation. In real-time, as a soloist improvises, Comprovisador's algorithms produce a score that is immediately sight-read by an ensemble of musicians, creating a coordinated response to the improvisation. This interaction is mediated by a performance director who does so by manipulating algorithmic parameters.

Implementation of this system requires a network of computers in order to display notation (separate parts) to each of the musicians playing in the ensemble. More so, wireless connectivity enables computers – and, therefore, musicians – to be far apart from each other.

Both paradigms – networked music performance and real-time notation – face synchronization problems for different reasons. The former must cope with network latency, acoustic delay, lack of eye contact, etc., and the latter must deal with the inherent difficulties of sight-reading. However, this synchronization problem can also be viewed as an opportunity for further development – which this paper hopes to address.

Software for this system is being developed in Max 7, with extensive use of Bach library (Agostini & Ghisi, 2010) for its notation features, computer-assisted composition tools and Max integration. The system consists of two applications: one running on a host computer and another instantiated on each of the client computers.

The host application is responsible for receiving and analyzing the input from the soloist(s), calculating compositional procedures and responding to commands from the performance director.

The client application is in charge of rendering the generated score and displaying it to musicians. It features a visual synchronization strategy consisting of a bouncing ball. Three different implementation approaches were used, each of them assessed by musicians during rehearsals and performances. Poor graphics performance on slower machines was noticed to have a negative impact on synchronization where, by using a technology that takes advantage of hardware acceleration (OpenGL), we were then able to reverse those impacts, while enhancing other aspects of the interface regarding information detectability and legibility. Furthermore, an adaptation of Roger Dannenberg's "Time Flow" concept was implemented in order to deal with network latency by time-stamping the responses, allowing for latency compensation when needed.

Apart from assessments made by performers, an experiment was laid out so the effectiveness of the synchronization strategy could be measured: events were recorded simultaneously in various steps of the chain and timing was evaluated through waveform analysis. Results will be discussed herein.

Keywords: Dynamic Musical Notation, Visual Synchronization, Real-Time Algorithmic Composition, Network Musical Performance, Graphical Interface.

Introduction

Comprovisador is a system designed with the goal of coordinating musical performances in which a soloist improvises and an ensemble of musicians sight-read from a staff-based dynamic score. This score is therefore generated by algorithms that feed on the soloist's improvisation and displayed on computer screens, in a local area network. Thanks to wireless connectivity, musicians can be placed far apart from each other, enabling space as a compositional element (Louzeiro, 2018).

For a coordinated musical gesture to be perceived as such, some kind of synchronization strategy must be at play. In a traditional context of ensemble playing, musicians simply react to each other's movements and/or those of a conductor – and this is possible due to the physical proximity in which these interactions occur. In certain cases, proximity may allow a musician to effectively react to sounds produced by another musician, be it breath sounds, attack transients or dynamic nuances.

Evidently, this strategy becomes useless when musicians are tens of meters apart or when their vision is blocked by columns or even walls, as is often the case in performances carried out with Comprovisador. The use of a graphical synchronization strategy – a visual cue – may address this problem but, as we shall discuss, there are many issues to consider if we aim at a musically satisfying solution. These issues are intrinsic to the networked music performance paradigm (e. g.: network latency, acoustic delay (speed of sound), lack of eye contact) and the real-time notation one (e. g.: timing discrepancies induced during the individual process of sight-reading, lack of experience with graphical cues, hesitation).

Comprovisador uses a bouncing ball approach as synchronization strategy. Compared to other common strategies (e. g.: scrolling score, linear cursor, etc.) it has the advantage of using downward vertical acceleration and ricochet to convey a sense of pulse, of arsis and thesis, simulating the motion of a conductor's hand. At the same time, by bouncing towards the appropriate note or bar-line, it enables score navigation.

In our previous research (Louzeiro, 2017b), we have found poor graphics performance on slower machines to have a negative impact on synchronization – in cases where the frame rate dropped below a certain value, musicians reported they were no longer able to perceive the bouncing motion and, thus, the moment of attack. In the first two versions of our bouncing ball implementation (based on Max's [lcd] and [jsui] objects, respectively), graphics were rendered in the CPU and this fact did not allow for a better performance. After switching to OpenGL, a technology that takes advantage of hardware acceleration by rendering in the graphics card, we were able to reverse those impacts, easily achieving rates of 60 frames per second, while enhancing other aspects of the interface regarding information detectability and legibility (dynamics and textual instructions). This improvement was assessed by musicians who had rehearsed and performed in “Comprovisação nº 5” (using the [jsui] implementation) and continued collaborating in the project (Louzeiro, 2017c). Musicians who performed in the subsequent three “Comprovisações” also reported being able to synchronize to the bouncing ball without effort.

Although musicians' reports were encouraging, we felt there was still room for improvement, namely regarding the issue of network latency – which we will explain bellow. Also, we devised an experiment in order to measure the effectiveness of our synchronization strategy, which will be subject for discussion herein.

1. Development

The system consists of two applications: one running on a host computer and another instantiated on each of the client computers. Both applications are developed in Max 7, with extensive use of Bach library for its notation features, computer-assisted composition tools and Max integration. JavaScript is also used for automatic configuration tasks, particularly with regards to instrumentation and network connections (using TCP and UDP protocols) (Louzeiro, 2017a).

The host application is responsible for receiving and analyzing the input from the soloist(s) (machine listening), calculating compositional procedures (algorithmic composition), responding to commands from the performance director (mediation) and generating score data (dynamic notation).



Figure 1. Comprovisador.
client notation interface: detail
of bouncing ball and grid.

The client application is in charge of rendering the generated score data into staff-based notation and displaying it to musicians. It features the visual synchronization strategy that was mentioned above: the bouncing ball (see Fig. 1). This feature is used in Comprovisador's algorithms 'Harmony' – to help sync individual instrumental notes (to result in chords) – and 'Contour' – to convey a pulse for synchronization in standard rhythmic notation (see Fig. 2).



Figure 2. Comprovisador.client
notation interface: dual-instrument
layout (standard notation mode).

1.1. Reading time window

In order to have synchronized attacks in an extreme sight-reading¹ context, the issue of time is of great importance. Firstly, musicians need time to recognize each note or group of notes (or, as John Sloboda (1976) would phrase it, to register pitch symbols in memory); secondly, they need time to prepare the notes on their instrument; lastly, they need to be precisely cued – and effective cuing involves very specific timing. And motion (see Colson, 2012). In any of these three steps, problems may arise leading to delays and jeopardizing synchronization. Hence,

establishing a reading time window and implementing a visual cuing device (the bouncing ball) were our first design choices (algorithm Harmony).

The reading time window (r.t.w.) is adjustable according to musical goal and/or technical difficulty. The period of the bouncing ball must be less than or equal to the length of that window. Also, it should not be greater than 1 second as the bouncing motion would become too slow to be effective.

To give a practical example, if the reading time window is set to 1600 milliseconds and the bouncing period (b.p.) is set to 1 second, from the moment a given note is displayed there is a pre-bounce time of 600 ms followed by a bounce time of 1000 ms (see Fig. 3, note E). Although the interval between the display of a note and its actual onset is always the same (r.t.w.), in many cases, previous notes are still displayed on the screen and have to be played during that window of time; likewise, new notes might be appearing meanwhile. In these cases, pre-bounce time and bounce period change dynamically, depending on the inter-onset intervals (i.o.i.): if i.o.i. is less than r.t.w. but greater than b.p., then pre-bounce time is shortened; if i.o.i. is less than b.p., then pre-bounce time equals zero and the bounce period is shortened.

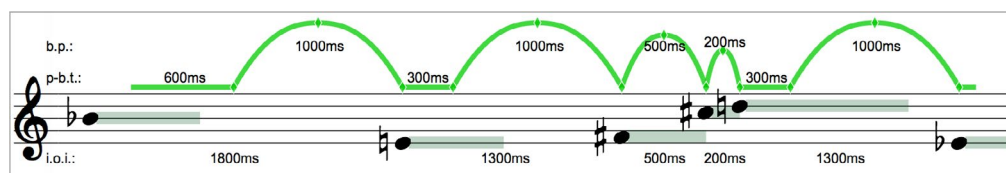


Figure 3. Bouncing ball path – bounce period (b.p.), pre-bounce-time (p.b.t.) and inter-onset interval (i.o.i.). Note: although all notes are visible in the image, individual notes are displayed in left-to-right sequence, according to their inter-onset intervals; assuming a reading time window of 1600ms, each note is displayed 1600ms before it should be played (i.e. ahead of the bouncing ball's current horizontal position by a horizontal distance representing 1600ms).

There is another special case: when there is a metronomic tempo underlying all onsets – a mode in which a grid representing the set tempo is displayed (see Fig. 1) – b.p. must be a multiple of the grid interval (g.i.) (in Fig. 1, the visible bounce path corresponds to $2 * g.i.$ while the bounce for the second note would have to be $1 * g.i.$). The same is true for the reading time window, which must also be greater than or equal to b.p.

1.2 Latency compensation

Latency is one of the most frequent problems in systems for networked music performance. If we consider performances over the internet with musicians connecting from different continents, latency may reach average values of over 100ms, which render rhythmic interplay a true conundrum. This fact alone has major implications on the aesthetics of a performance.

In local area networks, average latency values tend to be much smaller, especially when using cabled ethernet. Nevertheless, it is not possible to predict its exact value – and more so with wireless connections. This uncertainty causes problems.

From the beginning, we opted for wireless connections because they are easier to set up and do not involve extra cost in network cables. Soon, we discovered that although average latency values would be below 20ms, it was not uncommon to have messages arriving up to 200ms later.

In algorithm Harmony, as soon as a chord is generated in the host application, data representing each note are immediately sent to clients to be rendered and displayed (and to be played after the length of r.t.w.). If we could assume that latency values would always be below 20ms across different machines within the network, there would not be a real need to manage it because

1 'Extreme sight-reading' is a term coined by Jason Freeman (2008)

it is within an acceptable threshold for this kind of network applications (see Lago, 2004). An onset threshold of 50ms is usually acceptable in the context of ensemble music (see Rasch, 1979) and, although keeping in mind musicians would not be able to play perfectly in sync with the bouncing ball, there would still be a margin of at least 30ms.

In this scenario, a latency compensation approach based on the average latency value for each client could potentially increase this margin. But if very occasionally a given note on a given client arrives 200ms later than other notes on other clients (i.e., with a delay 10 times greater than the average), we would have an undesired discrepancy despite the implemented latency compensation. Thus, this approach would not solve the problem of occasional outliers.

Thus, we have looked into Dannenberg's concept of "Time Flow" (Dannenberg, 2017) which aims at solving synchronization problems in real-time music and media systems. The author describes four approaches to synchronization in increasing levels of sophistication: Synchronization Levels 0 through 3. Level 0 approach "is simply to eliminate as much latency as possible, assume that latency is zero, and operate in real time" (Brandt & Dannenberg, 1999) – so, our previous approach relates to this level.

While the higher sophistication levels of synchronization are conceptualized for more complex systems involving different kinds of media processing and timing accuracy needs, level 1 is most relevant for addressing the differences in the communication time we were experiencing. It consists on applying time-stamps to events, computing the events in advance within a "control stage" and delivering the computed events with time-stamps to a "rendering stage". There, events are delayed according to time-stamps in order to produce accurately timed output. Since it presupposes a delay in the rendering stage and our algorithm already has a delay in that stage (the reading time window), it was possible to implement this approach. But for time-stamps to have actual meaning within a network, all machines must agree on the time. This issue can be addressed with the use of a clock synchronization protocol such as the one described by Brandt and Dannenberg (1999). We have implemented an adaptation of their approach which was then tested in the experiment described in section 2.

Our implementation consists on setting a master clock on the host and a slave clock on each client. The slave clock continuously adjusts itself to match the master clock, which is done in timed intervals, via clock messages. In between those clock messages, the slave clock tries to predict when the next message will occur. Median latency values (instead of arithmetic mean) are used for latency compensation and a prediction threshold is used in order to detect outliers: messages arriving outside the threshold are ignored.

2 Method

In order to assess the bouncing ball's effectiveness as a synchronization strategy, the following experiment was devised: four musicians were placed in two separate rooms in such a way that none had visual contact with their neighbor (see Fig. 4). Each musician had a computer running a client of Comprovisador. Another computer was used to run the host application of Comprovisador and to record audio. Participants were professional musicians – a saxophonist, a trombonist, a guitarist and a pianist, and they had no prior experience with real-time notation.

Musicians had to sight-read dynamic notation displayed in their computer screens. Staff-based proportional notation (without meter or traditional duration symbols) was used (see Fig. 5). The notes were generated in the host computer – by Comprovisador's algorithm Harmony – and were to be played homophonically as chords².

Without reference of any kind other than the bouncing ball, musicians had to rely solely on this graphical cue in order to know when to play a note. In this manner, if musicians were able

to play in a fairly synchronized way, our experiment would determine that the bouncing ball approach was suitable for its goal.

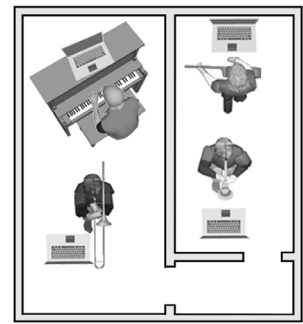


Figure 4. Recording session – separate rooms, no eye contact.

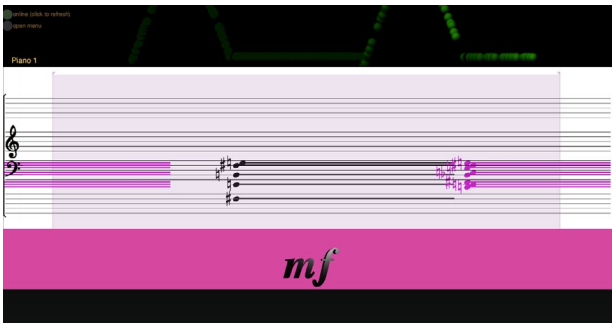


Figure 5. Comprovisador.client notation interface: single instrument layout (proportional notation mode, no grid).

In order to measure the onset thresholds of each chord and, at the same time, to assess the improvements enabled by the “time flow” implementation, sound was recorded simultaneously in 12 tracks: four tracks recorded the host computer’s own rendering of the score (internally/ digitally); another four tracks recorded the output of each client computer (mini-jack out); and the remaining four tracks recorded the live acoustic instruments (see Fig. 6). Each instrument had its own microphone, each client computer had a cable connecting from its headphones output, and all 8 cables were connected to the host computer’s audio interface, so everything was recorded in sync in order to be measurable through waveform analysis



Nonetheless, although 20ms might be considered an adequate value for this application, it is not as good as the results obtained by Brandt and Dannenberg (1999). Also, the bottom stack (internal host rendering of the score) shows discrepancies of the same order of magnitude. This suggests variable latency is being induced at an earlier stage – during the chord generation or, more probably, during the polyphony constraint solving (used for piano and guitar chords).

Comparing the bottom and middle stacks, we see a delay of around 70ms. This could be owing to audio processing latency induced by the clients' sound cards (digital-to-analogue conversion) and the host's audio interface (analogue-to-digital conversion), since the audio of the bottom stack was internally recorded without any D-A or A-D conversion (hence, no latency). Furthermore, all client computers had different specifications which could also explain the 20ms onset span observed in the middle stack, considering latency induced at the audio processing stage.

Looking into the top stack (acoustic instruments), we can see on this example an onset span of around 150ms. But if we were to ignore the piano (the fourth track), we would have all onsets within a 30ms window. In the following chord (not visible in Fig. 6), all onsets were evenly distributed along a 60ms window (with intervals of around 20ms between onsets).

These examples were selected from a section of the recording where the sight-reading context was not very difficult. During this section we observed typical onset spans of 100ms or less, averaging to around 80ms. In more difficult contexts (for example, with a fast note rate or with unexpected melodic leaps), average onset spans tended to be larger.

Conclusions and future work

Considering the outcome of our experiment, we find that the bouncing ball approach can be safely used in sight-reading contexts of moderate difficulty yielding synchronization results that we judge as musically acceptable. If we take into account the fact that participants had no prior experience with real-time notation, we think it is safe to assume these results can be improved through practice. It would be interesting to repeat this experiment in similar conditions and with the same musicians after a practice period in order to compare results.

Regarding factors that create difficulty in sight-reading, and although this experiment was not designed to assess this issue in particular, we were able to observe four difficulty vectors: note rate, melodic leaps, polyphony, and reading-time window.

Reading-time window is easy to assess: the musician needs time to read ahead to be able to decipher a note and prepare it in their instrument. Values under 1 second are insufficient; values over 2 seconds become unnecessarily large. From trial and error, we have found the sweet spot to be around 1600ms.

Polyphony should also be easy to determine: a single note is always easier to decipher than a pair of notes, which is easier than three notes, etc.

Regarding melodic intervals, unisons are arguably the easiest to sight-read; large leaps are generally considered more difficult than small steps, but there are exceptions (e.g.: a restricted pitch set might facilitate sight-reading large leaps, thanks to pitch recurrence).

We find note rate harder to assess. On one hand, if we consider an isochronous stream of notes, then, for a given musician, there should be a given threshold beyond which he or she will start feeling stressed. In this case, we can say that difficulty is proportional to note rate. On the other hand, with small groups of two to four notes followed by rests, we can achieve smaller inter-onset intervals than in the previous case. With larger groups of notes, difficulty levels will rise quickly. Hence, note rate should be analyzed as a two-dimensional vector where we can not find a single threshold point but a threshold curve instead.

In order to determine thresholds for these vectors – or combinations of vectors – another experiment would have to be designed, using a similar method but organizing algorithmic parameters in a linear way. Then, it would be possible to collect sufficient data to perform a thorough analysis that could yield more conclusive results.

Finally, taking into account the main results of this research, since we were able to observe that the average onset span was fairly stable for easy-to-moderate sight-reading contexts (around 80ms) tending to ramp up in more difficult scenarios, it would make sense to use this parameter to signal the threshold for a given difficulty vector.

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Sound as a medium, the performer as a medium

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This article intends to cross the vast and fascinating panorama of the graphic notation. The evolution of electronic music requires a new system of notation where, among other things, we seek to understand the new phenomena, such as the relationship between sonority and plastic manipulation in performance; the unpredictability and the error as ways of generating non-linear readings and/or new graphical forms of notation.

In this article we intend to discuss the possibility of experiences' systematization and concepts of ephemeral time, as well as freedom in the improvisation methodology and in real time composition, which has revolutionized the traditional system of musical graphic register.

Usually, graphic notation as a musical representation aims to be interpreted by the musician/performer, whose reading can be linear or non-linear, even when is a result of concrete composition techniques. Otherwise, graphical

notation arises as a result of the fusion between sound and graphic matter during the performance; a fusion that creates a close object - the score – that even so remains open, to the possibility of a new interpretation (possibly by another performer).

Methodologically, we will analyze the contemporary artistic object from the performative practice, considering the reflexive approach of understanding sound as a material providing services to the performer himself and, simultaneously, the performer as a medium fused with the drawing - an object that creates crosses between form, body and duration.

We propose the analysis of a case study, where the artistic object is assumed as a score, i.e., as a result of the sound register and the drawing as a visual entity, as an object of change, a game that provides new sound readings.

Keywords: graphical notation, sound, performance, wanderin

Introduction

It is with this quote made by Stockhausen “Music is to perceive vibrations of sound, it’s a mental activity, but also a sensitive physical performance of pleasure order. Making music goes far beyond intellectual talent, though always requires it; in music we think with the body.” (Barreto, 2000, p. 218)¹. That I begin by presenting the project *Partidura*. This project is part of another drawing project, and arises with the need to unite the visual arts and music, and start working with a live musician in performance. This is how I start working in collaboration with Bruno Gonçalves (aka ‘agendas obscuras’).

Partidura results from the meeting between a performer and a musician.

The project is a proposal of real-time composition, in which the notion of graphic notation within its conventional design structure is called into question. In part the process destabilizes the static definition and restricted to the reading of a graphic notation.

It is within this context that I propose some questions:

What procedural composition can give rise to the drawing and graphic notation in which these are taken as extensions of the body?

How can graphic notations open to the free exploration of other unconventional interpreters or composers?

How is generated the dynamic that inserts performance into a composition in real time that we define by graphic notation?

I propose a new look into the non-linear reading that circumscribes the graphic notation system and the drawing.

Graphic Notation

We can point out some concepts thought like forms where relations are settled in the connection of the punctuation or graphical notation and the sound.

The world of graphic notation is still quite unknown, and graphic notation is a way of representation and expression that reflects its own evolution / revolution, in relation to the traditional musical notation and the processes of translation and musical-visual presentation.

We must consider graphic notation as a renewed form of expression and approach within the twentieth century. It began to stimulate a new expression based on flexibility and greater subjectivity and freedom of interpretation or creation and expression on the side of the composer as well as the interpreter.

It is a more open and not so codified and limited interpretation, as in traditional notation from the baroque period. Graphic notation begins to use abstract symbols, text, images and drawing as a form of expression.

As an example of the use of abstract symbols, we take as reference the graphic compositions of Morton Feldman, composer of an impressive capacity of containment

¹ Original text: “A música consiste em perceber as vibrações do som, é uma actividade mental, mas também uma actuação física sensível, da ordem do prazer. Fazer música está muito para além do talento intelectual, embora sempre o exija; em música pensa-se com o corpo.

Around the fifties in twentieth century he wrote the plays *Projections* and *Intersections* (Fig.1). Paul Griffiths describes these pieces as:

“Time is represented by space, and in which the spaced boxes specify only instrument, register, number of simultaneous sounds, mode of production, and duration. The two series differ in that the *Projections* are to be consistently quiet, while in the *Intersections*’ the player is free to choose any dynamic at any entrance but must maintain sameness of volume ‘- though’ what is desired in both ... is a pure (non-vibrating) tone”. Griffiths, 1995, p. 303

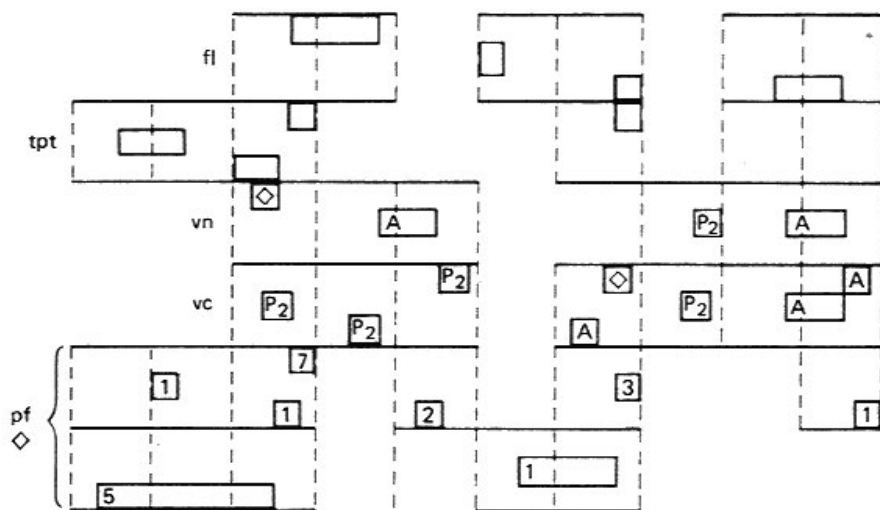


Figure 1. Morton Feldman, *Projection II* (opening), 1950

Another reference exploring the boundaries of graphic notation, which displays an open structure to incite greater freedom in creativity and interpretation on the part of the artist, is the piece *Treatise* - composition of Cornelius Cardew (Fig.2), during the sixties. *Treatise* is a dense piece of one hundred and ninety-three (193) pages, and consists of a score of abstract figures, numbers, and some musical symbols. In the interpretation, few instructions are given, allowing a great freedom of execution to the interpreter, and it can be interpreted by any instrument. The interpretation is decided at the beginning. On each performance and between each interpreter, a subjective reading, alterable, is a new possibility and combination in the next performance to be executed.

We observe that there has been a growing appeal in some composers to this kind of notation. An interest founded on the inability and limitation they felt in relation to traditional musical notations, which they described as being inadequate to express their ideas and feelings.

There is an extraordinary variety of graphic notations, which open up new possibilities, and points to a free exploration that makes possible to cover other unconventional interpreters or composers. That has transformed the way we think of drawing, the image within the graphic notation. In the sense of freeing up ways of thinking, execution, interpretation and even composition in real time, taking on truly transformative forms.

But not only in music graphic notation happens: in dance this kind of score also occurs. There is a plastic dimension in the choreographies of Anne Teresa De Keersmaeker (Fig. 3 and 4), - here plastic and spatial possibilities are constructed as they are drawn by the gesture of each dancer in movement. A game between two and three-dimensional space that refers to a score that is generated and evolved with dance, and becomes the object. This is very clear in *Cesena*, a circular choreography, a circle that is redrawn on the stage floor, a cross of silences, repetition and difference.

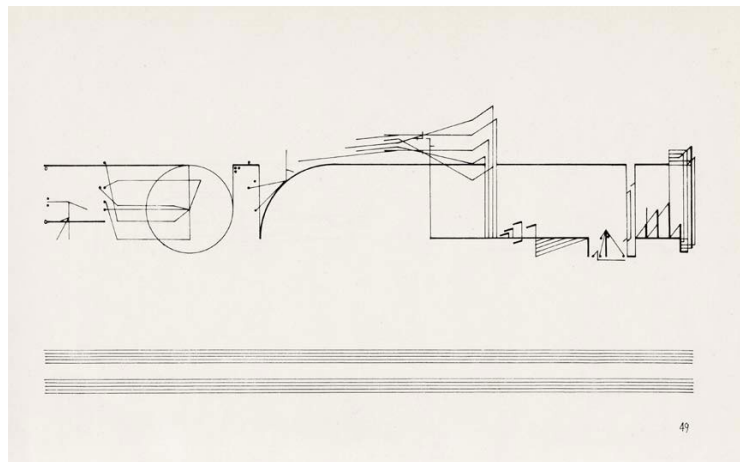


Figure 2. Cornelius Cardew, *Treatise*, 1963-1967

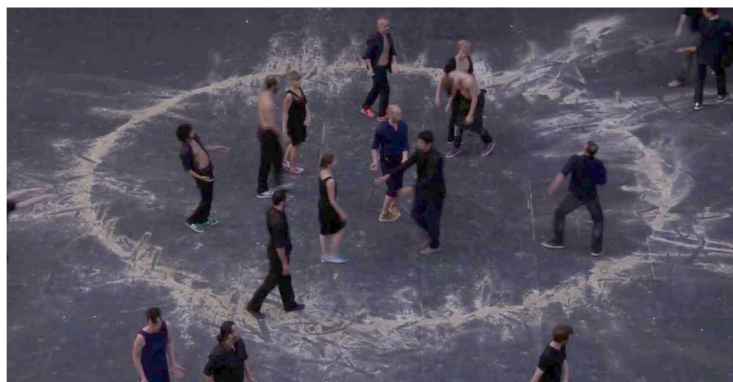
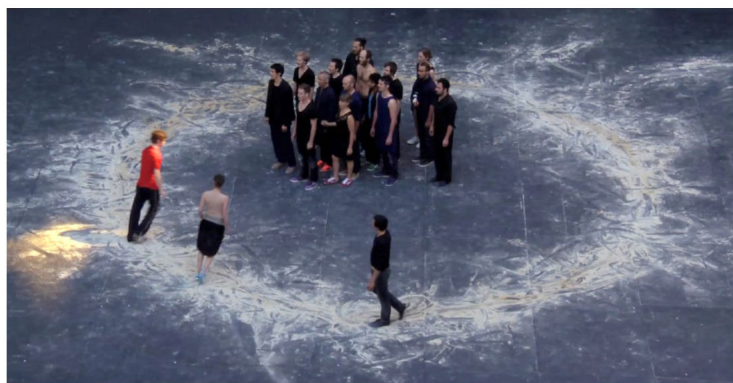


Figure 3 and 4. Anne Teresa De Keersmaeker, *Cesena*, 2012

Performance *Partidura*

What happens when we are matter?

In real-time, the drawing happens as recognition of a drawing that is lived, its process, and during the transformation in that time. The body is involved with all the possibilities and plastic powers that surround the same space, and the becoming is constant, unpredictable and uninterrupted presence.

During the performance *Partidura* (Fig.5), several times are present: time-performance, the time-sound, the time-matter, the time-body, the time-process.

Are these times a kind of adaptations that coexist in order to locate and integrate us?

When direct experience is established between all these times, an anticipation is managed, and it is always under this anticipation, under the becoming, managing decisions that happen as propositions of affection. There is an integration of the mediator information as an operative mode, the unpredictability and the error occupy the space of this encounter and only the encounter takes place while it exists, in the impossibility of not creating drawing. Be a matter.



Figure 5. Eunice Artur, *Partidura*, 2016, musician: agendas obscuras, performance, paper, coal and sound system, Music Academy of Coimbra

Sound as a medium, the performer as a medium, begins with magic, for us getting used to the echo. The chant that is scream. This almost silent sound, the uselessness and temerity of creation, the return of this creation, the scream, the depth of a force, a power, a double time, a time that is affected by mediation, and a relationship with the time of it itself, when generated. The echo.

The echo, in the sense that Le Clézio would say: "One, goes from the inside to the outside, the other, makes penetrate the external forces in the internal sense." (Le Clézio, 1987, p. 73)².

2 Original text: "Um vai do interior para o exterior, o outro faz penetrar as forças exteriores no sentido interno"

The fusion, transfusion, are flows of pulses that happen in the performance Partidura (Fig.6 and 7), like a relation in which the sound and the performer are manipulated and manipulators as medium. In this sense actions are generated by the unpredictability and error in the behavior of both actors. A synesthetic condition of movement echoes in both directions and is in both reciprocal.

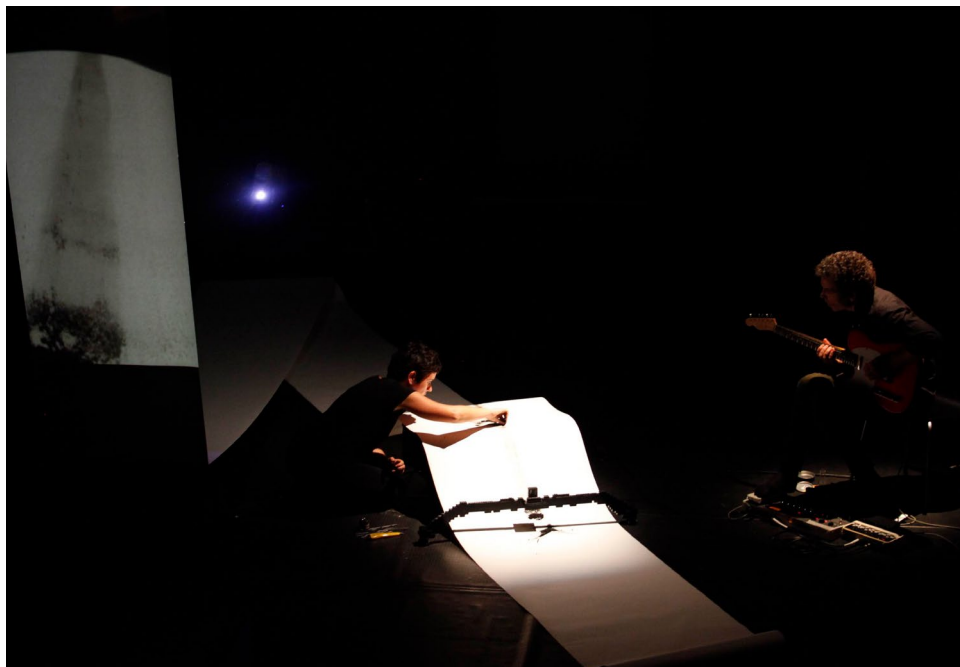


Figure 6 and 7. Eunice Artur, Partidura, 2015, musician: agendas obscuras, performance, paper, coal and sound system, Theater Esther de Carvalho, Montemor-o-Velho

The embodiment as an end enclosed in itself is very present in the composition in real time. In *Partidura* it is a phenomenological time, an abstract time present in the process. A time itself, which is present, which is not the same time as sound-time, nor is it the same as time-performer, being this indeterminate time, transcendent in its subtlety and stillness. Here sound and performance are grounded on the context of contemporary art as a practice and object-process, making a proposal of translate sound and body (I add the performer) as a state of spatial modulation, addressed here in a plastic and material category. In this sense, we consider the performance *Partidura* (Fig.8), as a modulation that is due to the derivation of the sound that comes out of the amplifier, and to the expansion of the body-performer in the drawing.



Figure 8. Eunice Artur, *Partidura* (detail), 2016, musician: agendas obscuras, performance, paper, coal and sound system, Music Accademy of Coimbra

Sound and performer as medium, that takes shape a set of phenomenological elements that structure a proper time, that is present during the performance and generate a nonlinear dynamic that inserts all this operative mode in a composition in real time, that we define it by graphic notation. However, as a consequence of this same dynamic, the drawing is not defined as an end in itself. Being considered graphical notation, itself generates an open and non-linear interpretation by the interpreter.

Conclusion

This graphical presentation it's an almost anti-score, in the sense that it's the opposite of regular scores; but mainly because it is, at the same time, generating sound/music, and, vice-versa, and being generated by sound/music vibrations - in real time.

The direct printing of graphic notation (the drawing) is defined as object-result. However, it is not just a matter of closing that impression: from there new interpretations may emerge. The action of the medium (or simply the medium) constitutes as space-drawing-sound where dual collaboration is lived in time, in which is read and triggered the score.

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Perceive to perform: Temporal indeterminacy in music for instrument and live electronics

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Abstract. This work consists in a study case on two pieces for guitar and live electronics. This approach provided discussions on how the technological means can interact in order to condition and indeterminate the performance in relation to the time in the musical discourse. According to Pestova (2008), the performance of music for instrument and live electronics provides less difficulties in the interaction with computer systems in relation to the synchronization of sound events due to the temporal flexibility, as opposed to the rigidity imposed by the Tape. In this work, I investigate how this attributed flexibility can implicate in the indetermination of the sound events proposed in the score and how perception works in this context. Robert Rowe (1992) attributes three dimensions to

interactive musical systems, and the third is the most important for the discussion proposed here, in which the author subdivides the behaviour of systems into two paradigms: instrument and player. In the first, the musical system behaves as the extension of the musical instrument and in the second, the musical system has greater autonomy during the performance, generating more complexity in the interaction with the musician and a less evident relationship between cause and effect. Through the case study we identify the presence of these two paradigms proposed by Rowe in the approached works, and we try to understand how some sound events written in the score, when played, interact with the systems and how this interaction can influence the time of the musical discourse.

Keywords: guitar and live-electronics; performance; interaction; mixed music

Introduction

In this work we approached the study process of two written pieces for guitar and live electronics. Firstly, we identified academic discussions regarding the temporal issue in the practice of mixed electroacoustic music. Then, considering that some authors prefer real time diffusion, we searched for ways to investigate how the temporal flexibility can be explored by the performer in the chosen repertoire. For this, we carried out an auto-ethnographic study where, through study notes and audio-visual recordings, the process of preparation for a public performance at the University of Aveiro in July 2016 was recorded.

According to Pierangeli (2011), in the context of mixed electroacoustic music, time is probably the most usual factor in the distinction, usually dualistic, between the repertoire for Tape and for Live Electronics. At the end of the 20th century Manoury (1998) named the discussion around these forms of diffusion as the “querelle des temps”. Due to the dimensions of this work it will not be possible to deepen the scope of this question. So our focus will be on the field of musical performance.

The inclination towards tape by the perspective of the performer found in Rocha (2010), relates to the idea that tape offers greater security when operated. However, it is in the field of performance that we find a greater number of musicians defending the practice with live electronics.

According to authors such as Hamm (2003), McNutt (2003) and Pestova (2008), the performance of music for instrument and live electronics provides better conditions of interaction due to the temporal flexibility of this support, which, according to them, facilitates synchronization with sound events, more rigid and complex in the works for tape. According to Hamm (2003):

The interpretive and musical freedom available to performers of interactive compositions marks a significant reduction of interference from prior means of integrating technology into live performance. Interactive works often free the performer from a number of problems that arise in performance of works involving prerecorded sound. (Hamm, 2003, p. 3)

Despite this discussion, mixed electroacoustic works can make use of both types of diffusion. A single work can contain moments when time is deferred or processed live. The negotiation within this dichotomy is still a current practice of mixed repertoire. On this condition, Ferreira (2014) claims that:

[...] the choice of a method or system for the electroacoustic medium not only conditions the performance but also the creative act. Any composer must have the notion that there is not yet a system free of constraints, and that he must find a compromise with the possible disadvantages inherent in the chosen system in order to better serve his intentions. We thus establish for both strategies their advantages and disadvantages with respect to creation and performance. We realized that in the time-delayed systems the freedom of performance depends on the malleability of the electronic medium. As we approach real-time, with the use of hybrid systems, this expressive freedom increases. Although in the real-time systems we have verified that the freedom of performance is greater, both strategies, real time and differd time, can equally offer constraints. (Ferreira, 2014, p. 109)

Given the advantage of the practice point of view attributed to live electronics by academic production due to temporal flexibility, we chose to investigate how this flexibility can occur in the approached works and how the performer can artistically enjoy this type of interaction. Next, we will present a study case where they were approached.

Research Processes

The present work approached through an autoethnographic method, common in the area of artistic research, two works for guitar and live electronics. Therefore, the data collection was obtained through audiovisual recordings, test notes and reports about the study.

The works submitted to the case study were written by two Brazilian composers, Rael Gimenes and Wellington Alves. Before the beginning of the research, I was instructed by these composers on how to operate the sound processing and I looked for ways to do this by myself. Thus, the independence of other musicians operating the software during the study process and performances was a criterion for selecting the objects of study.

Both works were designed using Supercollider software that is a language and open source programming environment for synthesis and real-time algorithmic composition released in 1996 by James McCartney. Besides the PC for the operation of the software, the performance of the two works requires at least two speakers and microphone.

Therefore, an LG cm2460 system with 100ms RMS for diffusion and a TASCAM DR-40 digital recorder for sound pickup were used (using the two condenser microphones of the recorder in a direct line). Although quite simple, the choice of the system used intended to create during the study conditions that would be maintained in public performance. The instrument used was a double top cedar guitar built by Geraldo Silva in 2011.

Both works were prepared and presented in public by the first author, within the scope of Recital II, an evaluation of the performance area of the doctoral program in music of the University of Aveiro. The study of the works took place between June 1 and July 2, 2016 under the supervision and guidance of second author. The public presentation of the works took place on July 5, 2016.

Before the study of the instrumental part along with the interactive system, 4 study sessions were performed with approximately 50 minutes duration each. In these sessions, the reading of the works and the definition of the digits to be used were carried out. With this stage of study, still dissociated from the electronic part, we intended to prepare the realization of sound events described in the score that demonstrated greater technical difficulty in the guitar. This strategy was conducted to better take advantage of the study time along with the electronic part. At this moment I also made notes on the characteristics of the events noted in the score, describing dynamics, attack types, duration of sounds produced and temporal indications.

On June 10 and 11, 2016, the first sections of the study were carried out with sound processing during 115 and 65 minutes each. On the first day the piece “Mutazione” was approached, and on the second day the piece “Have the days made you so unwise?”. In this first contact with the electronic part, different behavioral responses were explored to the different patches contained in the works. Thus, the focus of these sessions was to identify and make notes about the possible computational reactions to the different types of dynamics, attack, timbre and speed performed on the guitar in the patches. The documentation of this approach guided the following study sessions until the performance moment.

According to Miskalo (2009), Robert Rowe (1994) describes how interactive systems deal with the data (transformative, generative and sequenced) and how the system behaves itself (instrument or player). We chose to perform a simple description of the behavior of sound events, using time as a parameter, so that it was possible and effective to guide the study and performance of the works taking into account the causal relationship and its interactive system variables.

After this stage, another 4 sections of study were carried out with a duration of 50 minutes each, in which the works were studied together with the electronic processing. Reports were made on this study process as well as the creation of study notes.

Rocha (2014) points to the subjective condition of temporal perception. According to this, the autoethnographic profile of this study is not intended to determine for other musicians how to interact with sound systems, but to explain which ways and which types of question were part of my study process. Regarding temporal perception, Rocha (2014) claims that:

[...] The time effectively close to human consciousness is therefore the fruit of levels of concentration; the events, internal or external to this concentration, alter the perception of the same. It may be said that in deeper levels of concentration, as provided by aesthetic experiences, time lived is essentially time experienced. (Rocha, 2014, p. 16)

Next, we show the material collected in this work. It will not be possible to expose all the data collected, so we will focus on some more relevant points, especially those related to interactive systems and temporal flexibility.

Mutazione

This piece was designed with 7 different sound processing. The 7 patches must be activated in order by only one command, with no overlap or repetition of the process. This feature is also present in the other piece addressed, which helped the performer's study because there was no need for more complex computer operations controlled by someone else.

In a quick analysis of the work it is possible to identify several notes with indication of the duration in seconds. However, the composer indicates that the duration are relative and even those with indicated time have "high degree of freedom". Another important indication is that: "The player must consider the sound result coming from live-electronics, giving them time to exist and then proceeding, especially in the notes of support with *fermata*"

In the first section of the play, P01, a sound event generated by the processing was identified whose beginning occurred with a time lag of 2 to 5 seconds after the guitar playing. In this time variation of the time lag, no casual link was identified with some parameters tested such as: dynamics, timbre or duration of instrument sound. The behavior of this sound event always had a parabolic profile, that is, an initial attack followed by an increase of density and dynamics with a later decay. In this sonic event, it was possible to identify a relation of its duration proportional to the dynamics realized in the instrument. Depending on the dynamics used, between pp and ff, the "parabolic event" lasted from 3 to 20 seconds. Also in section P01, it was noticeable that the type of attack in the guitar changes the type of sound event generated. The previous example referred to the attack of a single string, the bass of the instrument, but other technical actions like the tremolo and arpeggio chords generated different behaviors of the systems. The arpeggio chords in ff generated sound events with a strong dynamic attack and direct decay, without sustenance, lasting approximately 8 seconds.

In section P02 when the "ENTER" key is pressed a pre-recorded sound is triggered. Of course it keeps the same duration every time it fires, in this case, 15 seconds. In the same section, in addition to this sequenced behavior, the guitar sound is transformed by a delay effect. We believe it is useful for the performer to be aware of the profile and duration of this sound event triggered in this section to know the possible ways of playing together. For example, if the event will have the morphological behavior accompanied by the guitar with a similar decay, if the attacks performed on the guitar have more or less extension, suggesting greater independence of the layers heard, etc.

In P03 patch, a relation was identified with the dynamics of the instrument and the duration of the generated sound events. The sounds made on the guitar with dynamics in ppp generated

sound events with about 9 seconds, and those performed with *ff* dynamics had an average duration of 15 seconds.

In section P04 it was not possible to establish a causal relation with the sounds generated by the guitar and the interactive system. Briefly, a sound profile of white noise was almost constant, as a sort of pedal and other sounds overlapped the instrumental part with no causally identified.

In section P05, a transformation of the guitar sound was perceived. It was also noticed that granular sound events with defined height were generated after the Harmonic sounds of the guitar. However, the temporal variation and even the occurrence of these events shifted a lot and it was not possible here to establish some causal link between the acoustic sounds and the computational processing.

Throughout the section P06, we perceived an independent and continuous synthetic sound event, along with the sounds produced by the guitar. We also perceived sound events generated by the notes in *ff* dynamics, these events lasted between 6 and 10 seconds.

In the last section of the work, P07, the relationship of the time duration of the electronic generated sound events is quite evident, because they are proportional to the dynamics produced in the instrument. The dynamics in *ff* can generate effects lasting between 10 and 15 seconds. It's necessary to press the "ENTER" again to turn off P07 to generate a fade out in the events that occur and in the dynamics of the amplified instrument.

Have the days made you so unwise?

This piece by Welington Alves is titled based on 'Tarkus', a song by the British progressive rock band Emerson, Lake & Palmer. The work has 4 electronic processes to be engaged in order. It is worth noting that in the two works, the instrumental sections attributed to different patches are quite different in terms of texture, density and other sound characteristics. The composer wrote instructions on how to operate the software and there is no specific indication as to how the performer should interact with the sound processing.

The work has three sections: The first, in 7-by-8 measure, consists mainly of eighth notes in staccato articulation; the second, still in 7 by 8, has the presence of a pedal note that is juxtaposed by acute notes in *marcato*; and the third section has no bars and is mainly made with fast arpeggios in the guitar with indefinite pitches. Regarding the time, there is an indication of 130 bpm in the first section, "poco meno" in the second and none in the third, except for the indications in seconds between the "fermatas" and the later events.

In the section where processing S01, a frequent pedal is noticed, which occurs independently of the action in the instrument. When the guitar is played, such sound event has its density and dynamics reduced. Still on this patch, it is quite noticeable the transformation of the instrument's sound. That is, the cause and effect relationship in this section is quite obvious and, temporarily, processing does not take many adaptations of what the score brings.

In the second section of the work, S02, it was possible to perceive that in some moments where there is the staccato articulation a sound of parabolic profile was generated with about 2 seconds of time delay after the attack of the sound in the guitar. This sound event seemed to have its duration proportional to the dynamics performed on the instrument (approximately *f* for the longest sound event, and *p* for the shortest sound event). However, during the later study sessions it was not possible to find this relationship, the generated event appeared rarely and therefore it was not possible to support the idea of causality of the interactive system in the section.

In section S03 something happens that requires the anticipated awareness of the performer: As soon as the “ENTER” key activates the patch, the first 4 seconds captured are recorded. This recording will be used throughout the section and will be subject to various programmed sound manipulations. Therefore, with the exception of these initial 4 seconds, the whole section S03 happens in a deferred time, diffusing the recorded sound and using various treatment techniques (reversal, height transpositions, enlargement and shortening, overlays, etc.). So, it is important that the performer is aware of the timing and duration of such recording because it will determine the sound material used in the entire section.

Conclusions

An important initial observation is that, in the two pieces selected for this research, the sound processing can behave differently according to the tone and dynamics qualities of the instrument. Thus, not only different devices used for sound pickup but also different technical approaches of the instrumentalist and even the particular characteristics of the instruments can interfere in the final artistic result. Therefore, in this work we focus the discussion on the preparation for the performance through the understanding of possible ways of exploring the interactivity of the different systems, instead of suggesting or systematizing specific interpretive solutions. We believe that the exploration process discussed here using time as a parameter, can be useful to understand the possible artistic results in the practice of mixed electroacoustic music with sound diffusion in real time.

In the works approached, we identified how different instrumental actions influence the behavior of interactive systems. In this process, we seek to understand how time can be used as a parameter in the orientation of the study of a mixed electroacoustic music performance in real time. In some section, the interaction and temporal behavior of the systems was very noticeable (for example, in the two works studied there were moments in which the duration of the sound events generated after the guitar pluck were proportional to the dynamics used in the initial attack of this instrument). In the sections where electronic processing did not show a relation of perceptible cause, the study was carried out aiming at the awareness of the sound possibilities that would be generated by the system.

As discussed, authors such as Hamm (2003) and Pestova (2008) argue that mixed music for real time, rather than tape, brings to the performance a temporal flexibilization that can be quite effective for the interaction of the instrumentalist with the electronic part. In this type of repertoire Rocha (2010) claims that the performer must be aware of the functioning of interactive processes. In this sense, through this work we found ways to understand possibilities to study and perform the pieces approached considering the temporal flexibilization. Such an understanding of the temporal behavior of the sound processes may allow the performer to recognize situations where causality allows some instrumental actions or that more independent sound events be mapped, allowing a greater awareness and decision-making capacity during the performance.

We emphasize that the understanding of the sound behaviors resulting from interactive systems may be fundamental for the performer to work with the sound material of each piece and, thus, to develop the performance according to the specificities of each interactive system, aiming at different artistic results.

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Why Xenakis Never Wrote an Opera

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University of Rouen, Centre Iannis Xenakis

“The only thing contemporary about opera today is the word ‘contemporary.’ There may be creation, but there is no novelty.” These condemning words from Iannis Xenakis (1922-2001) in 1989 are a retrolection following first his early works involving Ancient Greek theatre and later his five groundbreaking polytopes. This paper seeks to

unveil why one of the most important composers of the second half of the XXth century (and some of his peers) deliberately transgressed specific media, such as opera, in order to create environments and increasingly participatory and immersive processes combining time, space and sound thanks, in particular, to new technologies.

Keywords: Iannis Xenakis, Ancient Greek Theatre, Polytopes, Contemporary Opera, Immersive Art

Nota Bene: Before reading this article, it is strongly recommended to watch the eleven-minute montage created by the Centre Iannis Xenakis: <https://youtu.be/0tT-oCcHB50> (This video, as well as all the others suggested in this article, are “unlisted” on Youtube and therefore one must enter the url directly into the internet browser).

Opera *versus* Polytope

“I’ve been asked to write an opera but I feel I can’t because the style has no validity today,” Xenakis stated. (Varga, 191) He proposed to “replace” the opera he was invited to write for the first Festival d’Automne in Paris in 1972 with his *Polytope de Cluny*, actually the second of several multimedia works to follow¹. But, from the beginning, opera was, by definition, already multimedia and transdisciplinary. According to Jean-Jacques Rousseau, in his Dictionary of Music (1779):

The elements of opera are poetry, music, scenery. Poetry speaks to the mind; music to the ear; painting to the eyes; all must join together to move the heart, to impress upon it one impression conveyed through several organs.

But the *origin* of opera, as we’ve come to know it today, dates back nearly two centuries before that definition, with the lost opera of Jacopo Peri, *Dafne* (circa 1597), preceding by only a few years the oldest opera still in circulation, Monteverdi’s *Orfeo* (1607). But let’s insist a moment on Peri and his *Dafne*. As the title suggests, this was an attempt at a revival of the Greek myth of Daphne and Apollo, the latter struck by the golden arrow of Eros. At the time, amongst Italian humanists, there was keen interest in reconstructing a return to the musical and literary ideals of Greek Antiquity. But it seems, from the scarce fragments that remain, that the musical style was typical to other early Baroque music, much like his following opera, *Euridice*, extended fragments of which have survived. [Hear an excerpt here: <https://youtu.be/99rUpapu48k>]

Xenakis too, as a Greek, was deeply interested and well-versed in Ancient Greek philosophy, mythology and music. He did write some stage music for, for example, Seneca’s *Medea* (1967), Euripides’ *The Bacchae* (1993) or Aeschylus tragedies such as *Hiketides* (*The Suppliant Maidens*) (1964), or especially, the *Oresteia* (1965-66).

Originally, Ypsilanti, a town in Michigan, USA, sought to honor the Greek origin of its name and wanted to erect an ancient styled amphitheater. They hired a Greek director, Alexis Solomos, and commissioned Xenakis to write the stage music for Aeschylus’s *Oresteia*. Xenakis, who early on in his career imagined pursuing his career as a sort of Greek Bartok (Mâche, 2000), reprising themes from Greek folklore or what he could discover of ancient Greek musical practices, jumped at this opportunity, that ended up being a fiasco. The architectural project fell through and the performance took place on the local baseball field! Neither Xenakis nor the director were ever fully paid for their work, and, in the end, it turns out that Ypsilanti, originally a trading post

¹ Xenakis’s first polytope, took place in the French pavilion at the Montreal World’s Fair in 1967. For further information on this and all the polytopes, see (Xenakis, 2008, in particular, Part IV)

established by a French-Canadian fur trader, was somewhat surreptitiously renamed after an obscure hero from the Greek War of Independence, Demetrios Ypsilantis. However, from this full staging of the tragedy, Xenakis extracted what he titled the “Oresteia Suite” for children’s chorus, mixed chorus (also playing musical accessories) and 12 instrumentalists, that lasts about one hour. This is also the sole work from his entire catalogue that Xenakis ever revisited, adding *Kassandra*, for baritone and percussion solo in 1987 and the *Déesse Athéna (Goddess Athena)*, for baritone and 11 instruments in 1992, some 22 and 27 years later, respectively. In this work, Xenakis strives — and succeeds, in our opinion — especially with the voices, to re-imagine an original Ancient Greek theatre experience. [An excerpt can be heard here: <https://www.youtube.com/watch?v=1c4uzHjFs4U&feature=youtu.be>.]

Although Xenakis’s *Oresteia* has been set several times as an opera or even as a ballet², in 1989, Xenakis stated in an interview: “Nevertheless, the *Oresteia* is not an opera; there is no action nor protagonists, just the choruses.” (Segalini, 1989).

Also, one will note that Xenakis shuns away from ‘normal’ or ‘traditional’ operatic techniques and voices. In the same interview, he states:

I have a particular relationship to the voice – it poses a problem for me since it is lodged in the human body and is not exempt of numerous sentimental parasites. [...] When one cries or screams, there is no ambiguity, but when it’s a question of expression of a feeling, one tends to fall into the most blatant expressionism. That’s why I prefer non-trained voices [...]: they are more beautiful because they don’t try to imitate *bel canto*. Think, rather, of peasants singing, or of Russian choruses.

As in his instrumental writing, Xenakis requires the singers to project *senza vibrato*, for, as he states in still the same interview, with vibrato, “one no longer knows where the sound is. It needs to be purified, cleansed.”

Elsewhere, Xenakis reminds us that:

[O]pera is a whole dramatic complex, with hypotheses, arguments and a whole paraphernalia of old-fashioned and now obsolete traditions. You cannot ask, for example, a guy to go out and buy a pack of cigarettes while singing (opera). However, if we remove singing and also remove the action, then opera no longer exists. That would simply be called ballet... [O]pera is a dead art, a false musical expression (today). (George, 1974)

Furthermore, it is true that Xenakis always struggled with human presence on stage, other than for traditionally performing musicians, of course. In the same interview, Xenakis states:

[T]he human body is loaded with so many meanings, it is so likely to fall into the spectacular, the pseudo-tragic or the comic... the human body remains limited... the repertoire of the body’s possibilities is very limited. It’s as though you want to play symphonic music on a guitar.

His proposed solution was to dominate the technology of the time; not simply exploit what it can easily offer, but to dominate it with one’s own artistic vision that will transcend the limitations of our physical bodies. We will return to this point later.

For now, let’s return to “opera” as we have come to understand it and to recognize that Xenakis was not the only composer of his generation who considered that opera needed to kick the dust, once and for all.

2 Several versions, either complete or as trailers, can be viewed on Youtube.

From an historical perspective, let's remember a few facts:

- The first specifically constructed opera house was opened in 1637, in Venice, the Teatro San Cassiano.
- By the end of the 17th century, ten other opera houses had been opened in Venice, thanks to which La Serenissima was for a long time considered the capital of the medium.
- Around the same time (1669) Louis the XIVth founded the Académie de l'opéra in France putting Jean-Baptiste Lully (1632-1687) in charge, and the ensuing struggle for power - operatic dominance - between Lully and Rameau is legendary.
- It wasn't until Mozart (1756-1792) that German-speaking opera began to have any real significance.
- Over the following 150 years or so, opera morphed only in accordance to stylistic changes, from Baroque to Classical to Romantic... basically up to and including Alban Berg, with his *Wozzeck* from 1925 and *Lulu* from 1937.
- From an architectural point of view too, opera houses barely evolved from the two standards - "shoebox" or "horseshoe" - floor plans. Even Wagner's own "revolutionary" design for the Bayreuth Festspielhaus barely changed the confines and constraints of narrative opera's origins. (Pecqueur, 2015)

Post-WW II: the dawn of a new era

Then came the 1950s and the *tabula rasa* the World War II imposed on the Western world at large and on culture in particular. This marks several turning points: on the one hand, the beginning of a period of irreverence of the operatic canon; and on the other hand, the advent of new technologies that captured the imagination not only of scientists, but also of artists. New architectures for music began to be built as well, but that rich topic would make us stray too far from our subject here. (Pecqueur, 2015)

Musically speaking, we began to witness such revolutions with the pioneers of *musique concrète*, Pierre Henry and Pierre Schaeffer's *Orphée 53*, from 1953. From its conception - as a radiophonic and electronic opera - it deliberately turned its back on opera as it was known until then and sought to create an entirely new experience. Forget the opera house! Bring opera into the comfort of your own living room, via the radio! The opening minutes, with its Prologue and Orpheus's first "aria" can be heard here: https://youtu.be/9L6dfKm_qoY.

We must not forget what Pierre Boulez, who never wrote an opera himself yet who conducted landmark performances of Wagner's *Ring* and Berg's operas, said in an interview for Opera Magazine (UK) in 1967:

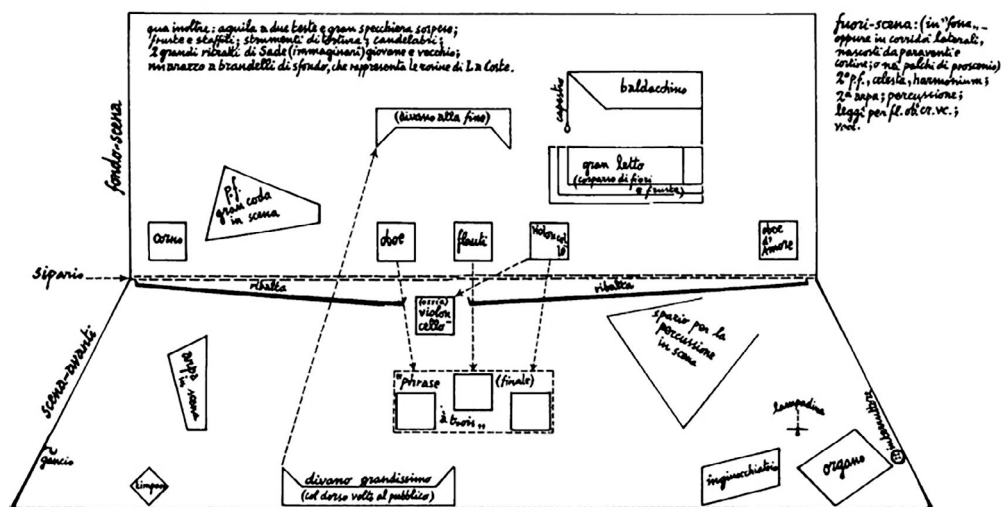
Before all others, opera is the area where things have stood still. Only with the greatest difficulty can one present modern opera in a theatre in which, predominantly, repertoire pieces are played. It is really unthinkable. The most expensive solution would be to blow the opera houses up. But don't you think that would be the most elegant? [...] Or one can play the usual repertoire in the existing opera houses, Mozart, Verdi, Wagner, up to about Berg. For new operas, experimental stages absolutely need to be incorporated.

This apparently senseless demand has already been widely realised in other branches of the theatre³.

3 Boulez interview from Opera Magazine (UK), 1967 cited in a music blog in The Guardian: <https://www.theguardian.com/music/musicblog/2015/mar/26/boulez-in-his-own-words> (consulted March 24, 2018)

Soon after Henry's and Schaeffer's *Orphée 53*, Bernd Alois Zimmermann composed (and revised) his opera *Die Soldaten*, between 1957 and 1964, based on a play by the 18th century visionary Jakob Lenz (1751-1792). Zimmermann composed the libretto as well and his score is very specific about the logistics and apparatus of the stage direction. Originally, the composer wanted to present it on twelve stages surrounding the audience seated on swiveling chairs, but the Cologne Opera authorities who commissioned the work nixed that idea, although Zimmermann presented a successful concert version of some of the music in such a setting before the opera's completion. Despite the means required (an orchestra of more than a hundred musicians, some seventy percussion instruments, a jazz combo, truckloads of electronics (including three film projectors and screens), 16 singers, 10 narrators, etc...) the opera is presented much more frequently than most post-1950 operas. Although Zimmermann was generally devoted to the 12-tone technique, here, he composed a web of musical allusions, including Renaissance fanfares, Bach chorales, Wagnerian harmonies, electric jazz, and futuristic tape sounds, creating, in the composer's words, a "pluralist opera":

Following such a deterministic approach to the medium, just one year later, in 1966, the Italian composer Sylvano Bussotti (1931) produced his *Passion selon Sade*, which is sub-titled a “chamber mystery with living tableaux,” but that he often referred to as an “installation,” or later, as a “happening.” Whatever one calls it, Bussotti very specifically detailed the costumes, scenery and movement, and his score also details the stage layout, lighting, and movement for all involved.



N.B. il "motet" e gli "elementi" scensici dovranno appartenere al "repertorio" d'Opera - per es., divano della Trinità, letto di Otello, ingiunghiastio di Don Carlos, strumenti di tortura della Turandot, legacci e sgabelli di Nixon; ecc. ecc. - non dovrebber essere in scena, alcun elemento di modernità; tutt'antiquariato.

Fig.1 Sylvano Bussotti, *Passion selon Sade*, stage layout, excerpted from score⁴⁾

4 Sylvano Bussotti's full score for *Passion selon Sade* was freely accessed here: <https://fr.scribd.com/document/201538734/Bussotti-Sylvano-La-Passion-Selon-Sade>

The lead role, playing three female characters, [two from Sade's eponymous novels (*Justine* and *Juliette*) and O, from the famous erotic novel, *l'Histoire d'O* by Pauline Réage], was written for and premiered and toured by Cathy Berberian. As we can see from the printed score excerpt below, Bussotti nevertheless, through his (gorgeous) graphic notation, leaves a fair amount of freedom for interpretation.

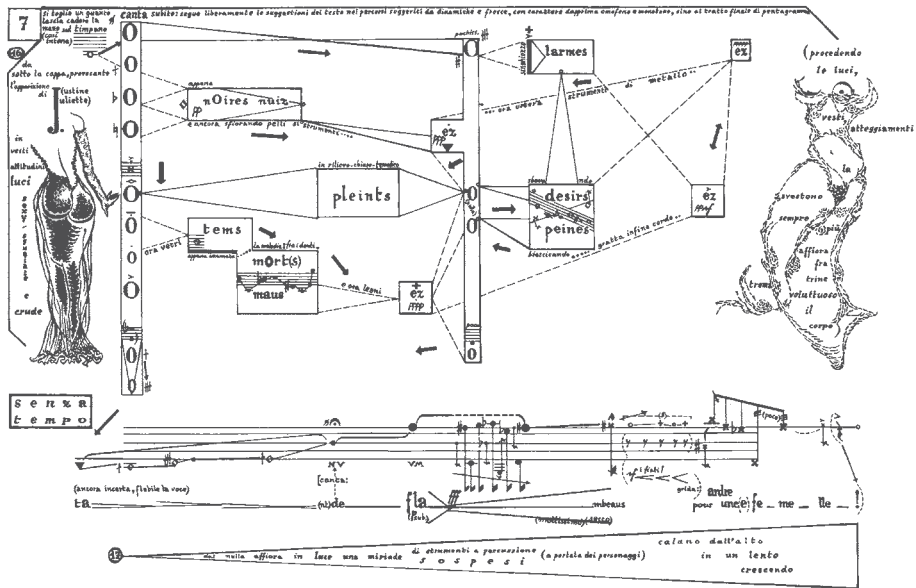


Fig. 2 Sylvano Bussotti, *Passion selon Sade*, excerpt from score⁵

The following year, 1967, Nam June Paik (1932-2006), created quite a scandal – actually the performance was interrupted by the New York City Police! – when premiering his *Sextronic Opera* for nude cellist, the incredible Charlotte Moorman⁶, taking the provocation one level higher than the subtly overt sexuality in Bussotti's *Passion de Sade*. However, from our perspective, Paik's most important contribution came about two years later, in 1969, with his *Electronic Opera N° 1*, a 17-minute work commissioned and composed specifically for television, using *that* medium to its fullest, with the composer sometimes instructing the viewers during the broadcast to close their eyes, open them, etc. A short clip from that can be seen here: <https://youtu.be/lASEJXN0mtg>.

Stepping back to 1967 again, the year of Paik's *Sextronic Opera*, what was Xenakis up to? That same year, he began teaching at the University of Indiana at Bloomington, hoping to create a computer music studio there, that, even after five years of patience and politics, never fully came to fruition. 1967 was also the year of the World's Fair in Montreal, and originally, Xenakis received a commission to write music to accompany an exhibition of crystal within the French Pavilion. But when he saw the scale model of the structure, designed by architect Jean Fauteron,

5 The entire score is accessible from <https://fr.scribd.com/document/201538734/Bussotti-Sylvano-La-Passion-Selon-Sade> (accessed Dec. 4, 2018)

6 For more information on this extraordinary musician, see: Rothfuss, Joan, *Topless Cellist: The Improbable Life of Charlotte Moorman*, Cambridge, The MIT Press, 2014.

7 Polytope, according to Xenakis, is a generic term involving several (*poly*) spaces (*topos*), or means or media

and especially its central “void” around which five floors of exhibition space evolved, his imagination was triggered and he made a counter-proposition for creating his first “Polytope⁷.” No complete footage exists, alas, of this automated performance that lasted 6 minutes and was played every hour, unbeknownst to the visitors of the pavilion. Actually, very little documentation is available of the actual performance(s) of *Polytope de Montréal*, (as well as of his four other Polytopes), despite their epic success at each occasion. Therefore, we have taken the liberty to assemble a montage of existing, small snippets of material, that can be viewed and heard here: <https://youtu.be/Q0OAiaAVS2Y>.

Originally, Xenakis proposed writing music for 17 acoustic instruments, but due to budgetary reasons, that needed to be scaled down to 11. So, he counter-proposed superposing the 11 instruments four times, creating – in effect - a piece for orchestra of 44 musicians. This overdubbing was recorded in a studio and played back within the French Pavilion through four separate sets of speakers astutely placed around the central void on the different levels. To our knowledge, the music alone has not yet been premiered in a straightforward concert situation, although the score is published and readily available⁸!

Xenakis composed a “score” and a “scenario” for the visual spectacle as well, nearly as precise as the music score. As he stated at the time (1967):

The music is independent from the light spectacle. I wanted to create a contrast. The lights in my spectacle create a multitude of points that stop and go. The music creates a continuity, thanks to the glissandi. The sound changes but never stops. It is instrumental music with instruments from the classical orchestra, there are no electronic transformations. (cited in Xenakis, 2008, 214)



Fig. 3 Excerpt a copy of Xenakis's “score” for *Polytope de Montréal* light spectacle (author's archives)

As can be seen in the *Polytope de Montréal* montage-film referenced above, Xenakis erected a “virtual architecture” in the large void in the belly of the building, composed of 5 “webs” of minutely calculated hyperbolic paraboloids from some 200+ steel cables ranging from 20 to 31 meters in length on which equally minutely calculated 1200 light flashes were attached (800 white xenon tubes plus 400 colored lights (yellow, green red, blue).

8 Perhaps due to the word “Polytope” in the title people automatically believe any performance entails multi-media means? Yet, Xenakis was adamant about maintaining the autonomy of each artistic component of all of his Polytopes. (Xenakis, 2008)

Everything was fully automated, both the light show and synchronized with the music. In 1967, computer technology was not what it is today, or even a few years later, and automating the light score was a major obstacle. Over 9000 punch card type frames needed to be created by hand to run the fully automated light show from a command film (the black frames with white dots that appear in our film). But the effort was certainly worth it. Expo '67 was reputedly the “most successful” World’s Fair in the XXth century, and after 6 months of non-stop hourly performances (between April and October 1967) this first Polytope was seen and experienced by hundreds of thousands... which, according to Xenakis, represents “an encounter between 2 different musics, one to be seen and one to be heard.”

Later, in an interview with François Delalande, Xenakis further stated:

I was able to work with real light, not with light reflected off a screen. The electronic flashes produce white light, similar to the sun, in a continuous spectrum with increasingly intense blue and green beams, creating a relatively cold and penetrating light. And that was the first step for *music in space*, with visuals and with real light.
(cited in Xenakis, 2008, 206)

And this gives us the telling clue of where Xenakis found his inspiration for such an adventure...

The Philips Pavilion

Literature on the Philips Pavilion from the Brussels World’s Fair of 1958, and Xenakis’s role in that historic project and realization while working for the architect Le Corbusier is abundant⁹. It is undoubtedly then and there that the seed for his future polytopes was planted.

In his seminal article from the same time, “Notes towards an electronic gesture¹⁰,” Xenakis was indirectly very critical of Le Corbusier and the figurative and narrative aspects of his visual “Poème électronique.” There, he states:

[...]I will attempt to highlight some of the current tendencies within artistic creation that are converging towards *an integration of the visual and audible arts*.
The intentions behind painting and sculpture have already adopted the most recent stages of physical, mathematical and philosophical thought. These are steps towards Abstraction. Abstraction, here, is meant in the sense of conscious manipulation of laws and pure ideas, and not of concrete objects[...] Xenakis, 2008, 131

The rather banal images chosen by Le Corbusier to illustrate his visual spectacle were projected onto screens espousing the interior curves of the Philips Pavilion. Xenakis concludes this article by stating:

[...] In this respect, the Philips Pavilion at the Brussels World’s Fair represents a first experiment in this artistic synthesis of sound, light, and architecture, an initial step towards an “Electronic Gesture.”
I will conclude by saying that a new conceptual consciousness – abstraction – and a technical infrastructure – electronics – are currently stirring human civilization at this very hour.
(cited in Xenakis, 2008, 134)

Henceforth, we may consider Xenakis’s *Polytope de Montreal* from 1967 his first experiment following the Philips Pavilion in creating his own “artistic synthesis.” He used the then-state-of-the-art technology available, surpassing its possibilities, and actually anticipating by some decades what was to become “new technological standards.”

⁹ Also, amongst many references, see (Xenakis, 2008, Part 1).

¹⁰ Ibid. 131-134.

Musical Land-Art

Between this *Polytope de Montréal* and his *Polytope de Cluny* (the documentary referenced and recommended as a prerequisite to reading this article), Xenakis embarked on a very large scale, outdoor Polytope in Persepolis, in Iran, in 1971, simply named *Persépolis*. The famous Shiraz Arts Festival commemorated the 2500th anniversary of the founding of the Persian Empire that year. For the occasion, Xenakis composed a unique open-air event for the inauguration of the festival, including a new 56-minute electro-acoustic composition, played through 48 speakers distributed over 6 listening stations (8 speakers per station), complete with 2 lasers and sweeping searchlights, plus 130 torch-bearing children. In his accompanying program note, Xenakis had this to say:

Persépolis is neither a theatrical spectacle, nor a ballet, nor a happening. It is visual symbolism, parallel to and dominated by sound. The sound, the music, must absolutely prevail. This music corresponds to a rock tablet on which hieroglyphic or cuneiform messages are engraved in a compact, hermetic way, delivering their secrets only to those who want and know how to read them. The history of Iran, fragment of the world's history, is thus elliptically and abstractly represented by means of clashes, explosions, continuities and underground currents of sound. The listener must pay for his penetration into the knowledge of the signs with great effort, pain and the suffering of his own birth. (cited in Xenakis, 2008, 221)

In the words of the renowned music critic, Maurice Fleuret, who reviewed this one-time event, Xenakis's *Polytope de Persépolis* marked the first occurrence of "musical land art."

A second large-scale, outdoor Polytope was organized and performed in Mycenae Greece, in 1978, to celebrate the return of Xenakis to Greece after some 30 years of political exile, following his political activities during WWII and the Greek Civil war. Again, means unimaginable today were put at his disposal: torch-bearing children, laser beams, a huge bonfire, electronic music alone and intermingled with live, acoustic performance, plus goats with lights between their horns and custom-made bells hung from their necks. In addition, he used twelve searchlight projectors plus others positioned 10 km away, all generously furnished by the Greek Ministry of Defense, those who earlier had condemned him to death in *abstentia* due to his political activism as a student! In all, an unequalled communal 'performance' to create this hour and a half spectacle. The event took on a hugely popular aspect: farmers allowed their surrounding land to be used as parking lots, local villagers lent a helping hand setting up the bleachers, the Greek army sent troops to help manage the crowds (6-10,000 spectators per each of the 4 performances), local craftsmen produced the special bells for the 'performing livestock,' etc. As Xenakis called it, through this "feast in light, movement, and sound", the composer was triumphantly celebrated as a national hero.

From Polytope to *Diatope*

The same year, 1978, Xenakis was commissioned to create a "moveable feast" to celebrate the inauguration of the Centre Georges-Pompidou (also known as Beaubourg) in Paris. Xenakis first imagined a characteristically utopian, nearly cosmic project: a "World Polytope." Some 40-plus years later, his proposal still rings like a prophecy of things yet to come:

The time has come to bridge the arts across oceans, between continents and among countries. Military alliances and trade agreements touch people indirectly leaving them caught up in monstrous dogma. Why not weave together the population of the earth through the arts, by establishing a new, direct contact that overcomes the

barriers of language, politics, parochialism, racism, chauvinism? Today this is possible, provided the art form is allowed to create sparks of immediate contact. This art form already exists. It has already been tried by the *Polytopes* at the Montreal World's Fair, in Paris (at Cluny), where tens of thousands of persons of all ages attended and plunged in. It expresses the childish side of adults, that which remains of their deep creative purity, the wonder before the play of lights, before a music of sounds and lights. The new technology consists of electronic flashes, powerful lasers, tracking satellites, computers, and the most advanced systems of light and sound composition. This novel art form can be, after more than twenty years of research and application, now established on a worldwide basis in the following manner: Urban areas of the U.S.A., Russia, France, Germany, England, Japan can choose to install *Polytopes*, consisting of actions and effects of light and sound through banks of electronic flashes, lasers and electroacoustic sounds. These processes are directed by small computers or digital tapes produced by computers, according to software especially conceived for that purpose. The receiving center, installed in the open, in public squares or shelters, is the theatre of these presentations. These centers will be linked across the oceans and between the continents to points of transmission installed in various countries, through a system of visible (or invisible) laser beams bouncing over tremendous distances on mobile or geostatic satellites. The transmission points will compute changes in the performance at the receiving centers in accordance with a highly-ordered plan. [...] Within such a project, the most advanced scientific research can be combined with the most prophetic art forms. Yet both can remain powerful abstractions closely related to cosmic phenomena with immediate effect on the imagination of the humblest man and child of all races and religions. These means are now available and one can create a fantastic network of optimistic and pacifistic art throughout the world. Never before has such a thing been feasible. Today it is.

Paris, March 1974 (cited in Xenakis, 2008, 254-255)

Xenakis was obliged, little by little, to reduce the scale of his prodigious intentions. Nevertheless, he managed to create in the *Diatope* a truly quadri-dimensional composition uniting architecture, music, texts, and lights, a pluri-sensorial “moving feast” for the eyes the ears, the mind, and, for some, the soul. He designed the self-supporting structure, which resembled a close-cousin of the Philips Pavilion, composed the 46-minute electronic work, *La Légende d'Eer* which accompanied the immersive light spectacle involving 1680 xenon light flashes, 4 lasers, 400 fixed or pivotal mirrors placed on 6 glass columns within the circa 500 meter² space, and devised the program generating the lights and coordinating that with the sound distribution. A single performance entailed over 140 million commands (over 2000 elements – flashes, mirrors, lasers, sound all calculated at 1/25th of a second, times approximately 46 minutes).

In the press release issued for the *Diatope*, Xenakis declared:

[...] Imagine in a distant future that the power of the artist's action be augmented as never before in history (in fact this is the path followed by mankind in its creation and dissipation of ever-increasing quantities of energy). Indeed, there is no reason why art cannot escape, as science has done, into the cosmic immensity, and why it cannot modify, like a cosmic landscape artist, the shape of the galaxies. (cited in Xenakis, 2008, 248)

This, in our opinion, is why Xenakis never wrote an opera, *per se*, and furthermore made the bold declaration that “The only thing contemporary about opera today is the word ‘contemporary.’ There may be creation, but there is no novelty.” (Segalini, 1989)

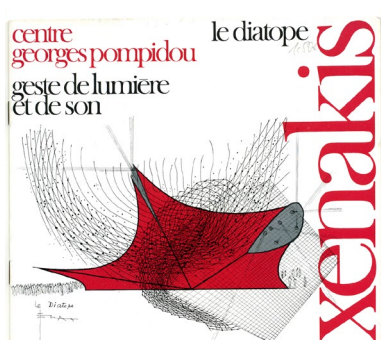


Fig. 5 Photo taken during the *Diatope*
© Bruno Rastoin/Archives CIX



Fig. 4 Pamphlet cover for the *Diatope* (author's archives)

Today the task remains, as in Xenakis's time, to *dominate* technology and spearhead where tomorrow may lead us and not simply showcase what technology can already do, no matter how mind boggling that can be at times. As artists, as creators, it is our responsibility to exert our influence and shape the *future*, not be nostalgic and weep our contemporary tears on our art's relics. In other words, it is not a question of thinking in the box, nor even outside of the box. But daring to think without a box, at all!

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Magdala, on the threshold of sensations

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The contemporary opera renews in the format, for necessity of survival and development of the dramatic thought. Thus, the adaptation of the multimedia and cinematographic formats invade the scenic and sonorous space of the recent operatic production.

The developments of digital manipulation have allowed us to open different paths to the concept of sound story, or tell a story through the senses.

In *Magdala* are applied concepts that are mixed between visual and sound scenography, applying different layers of perception to the effect. The

scenario is supported in the video exploration added to the sonorization of the environment, as a complement to the narrative, simultaneously with the operative discourse. The work is distributed through manipulations of effects, environmental and structural sound creations, in images that involve distinct plans of assimilation by the auditor.

This paper intends to demonstrate how the various elements are essential for the development of the work, as well as the relations between them, as a sensorial context.

Keywords: opera, soundscape, set design, atmospheres, sound scenography

Introduction

As described by the neurologist António Damásio “(...) cultural activity began in feelings and continues to depend on them. If we want to understand the conflicts and contradictions of the human condition, we need to recognize the interaction, both favorable and unfavorable, between feelings and reasoning.” (Damásio, 2017, p. 15)

A synoptic presentation of the opera *Magdala* allows to recognize the fundamental elements of its musical structure, as a formal and technical definition, as well as its sensorial unrolling. Beginning with its conceptual presentation, one begins with its structural and significant construction.

Mary of Magdala, woman, apostle, mystery. Several women in one, beloved and repudiated, symbol of grace and fall, of sin and salvation. Going through the demons of her childhood, the attraction of divinity, the doubts of the woman about humanity and the sacred, until the spiritual and philosophical blossoming in the encounter with the spirit and the soul, so the opera *Magdala* is developed.

Three paths, one destination. Three ways, one arrival. A reflection on the woman and her sacredness, on her humanization, full of doubts, fears and desires. Full of herself, solitary or involved in affection and abandonment, Mary refers to her natal Magdala as the refuge necessary for her understanding of the choices, her and the gods.

Freely based on Margaret George’s book *The Passion of Mary Magdalene* and the apocryphal *Gospel of Mary Magdalene* are there three phases of the life of Mary of Magdala, childhood, encounter with Jesus and his testimony after his death.

All the scenery, shadows of mentioned characters, but always physically absent, appear in the video(s), physical scenery, that is slowly transforming also in the background video.

For structural reference, specific interrelated elements are determined, as shown in the following figure.

	Acts	Places	Characters	Lights
1.	Demons	Magdala	Maria/ Asera	White/ Red
2.	Disciple	Jerusalem	Maria/ Asera/ Jesus	White/ Red/ Liliac
3.	Gospel	Void	Maria/ Soul	Sepia/ Yellow

Figure 1.Relations between elements

In the creation of interconnected organizations, it is intended to use both the mnemonic functions of a common past in both sonorous, dramatic and visual references, as well as the manipulation of specific artistic techniques and relationships to create a sensorial comprehension independent of the cultural specificities of each auditor. These organizations determine the internal and external dichotomous position that will involve the final receiver of the information transmitted, distinguishing the communicative and expressive signs, their artificial emission (electronic, visual and sound manipulations), or their spontaneous emission (formal and cultural references). As described by Eco (2017): “The former would be codified (there would be rules that establish a correspondence agreed by signifier and meaning), the latter would be comprehensible by intuition, they would escape coding ...”

1. Backgrounds

Magdala relates, in its basis of conception, with three references. Three kinds of opera, different both in staging and in scenic sound conception:

- Steve Reich (b. 1936), *The Cave* (1993);
- Kaija Saariaho (b. 1952), *L'Amour de Loin* (2000);
- Michel van der Aa (b. 1970), *One* (2002)

Among these are common points with *Magdala*, of dramatic, technical and scenic relation.

Thus, the scenic aspects, recurring essentially to video while background, are found in Reich or van der Aa; formal division in Reich and Saariaho; electronics as a scenic element in Saariaho and van der Aa. The theme, although not coincidental in any of the cases, is related to the three operas.

A more focused description of each work will help to better integrate each aspect into the overall context.

1.1. The Cave

Steve Reich's multi-media music theatre work, *The Cave*, was premièred at the Vienna Festival in 1993. Interview material and other images on large video projection with a 17-piece group of musicians and singers, are the performance layout.

The video, created by Beryl Korot, has a main role overall and "(...) involves multi-channel video where the timings between the channels are very highly worked out – four channels where the first and the third and the second and fourth would be interlocked – very musical-type structures." (Smith, 1993)

The global conception, in three acts, changes on subjects, since as Rothstein explains on his review form the first American audition: "The staging is modified only in minor ways from act to act. (...) It is divided into large cubic chambers, in which video screens are inserted and musicians (...), creating a post-modern video-haunted cave." (Rothstein, 1993)

The main concern of the work lies in three diverse cultures, but with common basis. The composer explains in an interview gave to Geoff Smith: "So the piece, on one level, is about three different cultures: the Judaic culture in Israel today, the Arab culture in the West Bank, and the American culture in New York City and Dallas and Austin, Texas" (Smith, 1993)

The final goal of *The Cave* is a preoccupation "with the cultural counterparts of such layers of accumulation and appropriation." (Rothstein, 1993) Where "each act (...) is meant to be a portrait of a group as well as an illumination of the subject." (Rothstein, 1993)

1.2. L'Amour de Loin

Kaija Saariaho's opera *L'Amour de Loin* was premièred at the Salzburg Festival in 2000, "in a period when Europe, especially Austria, was roiled by rising nationalism, movements to protect the sanctity of borders and demonization of the 'other.'" (Tommasini, 2016)

As described by Tommasini (2016) in his critique of the American performance at the Met in New York, "feelings about the 'other' run through *L'Amour de Loin*. In this story, however, the other is not demonized, but idealized. Yet, as this haunting opera suggests, idealized assumptions can also cause harm, however unintended."

In his production, in general, Saariaho uses electronics as a frequent basis of timbre transformation and as a catalyst element of the various functions of musical discourse.

In the specific case of the opera *L'Amour de Loin*, electronics will seek natural elements such as scenic construction, as well as recorded voices that integrate in the dramaturgy and sonorous spatialization creating a scenic space removed from the sonorous musical structure.

To Battier and Nouno (2006), there are five categories of sound sources in Saariaho's opera:

- Resonance models,
- Chord associated to characters;
- Creating resonant filters by using chords and instrumental models;
- Filtering sound samples and interpolating filters;
- Mixing and spatializing models.

The importance of these processes in the creation of a sensorial relation is reflected in the following conclusion:

"Listeners are immersed in a malleable acoustic space in which the sources filtered by the resonance models move gently. Surrounded by loud-speakers, the audience is, in a way, 'inside' the electronic sounds (which themselves come from natural sound sources) and at the same time 'outside' as listeners. This perceptual ambivalence in Kaija Saariaho's writing is like the characters' emotions, their minds turned outwards to the *ultra-mar* (sic), but inwards as well, peering deep into their own intimate feelings."
(Battier, Nouno, 2006, p. 28)

1.3. One

Michel van der Aa's *One* was composed in 2002, and premiered on 12 January 2003 by Barbara Hannigan in the Amsterdam Frascati Theatre.

"The chamber opera *One* represents a new kind of music multimedia drama. Michel van der Aa's poetic production of technological virtuosity fuses libretto, video, live music and soundtrack with the soprano voice and stage presence of Barbara Hannigan into *One*. Projected images and electronic sounds add emphasis to the onstage performance of the protagonist, while the recorded and live voice interact with incredible synchronicity." (Aa, 2018)

Dramatically, the work consists on the overlapping of five existences and elements corresponding to five distinct elderly women. Each of them connects with a younger woman, who gradually relates more with the older one, presenting the image of a woman who completely lost all her identity.

2. *Magdala*

Many of the basic elements of the three operas portrayed appear in *Magdala* as fundamental elements of their structuring, distributing the same functions in visual and sound scenarios, through four formal references, which allow to integrate the functions of scenic complement, dramatic context and integration of Space and Time using different characters, different states, different places and defining moments of the day.

The actions structured throughout the organizational plan determine the intentionality of the different objects, which in their previous creation determine the decisions of conflicting desires (Searle, 2015, p.88), intentionality resulting from an equally intentional network (Searle, 2015, p. 91)

This intentionality works in the application of significant schemas, which can be described by their functionality in the confrontational presentation of the respective opponents, described here through a semantic axis predicted by Julien Greimas (Eco, 2017)

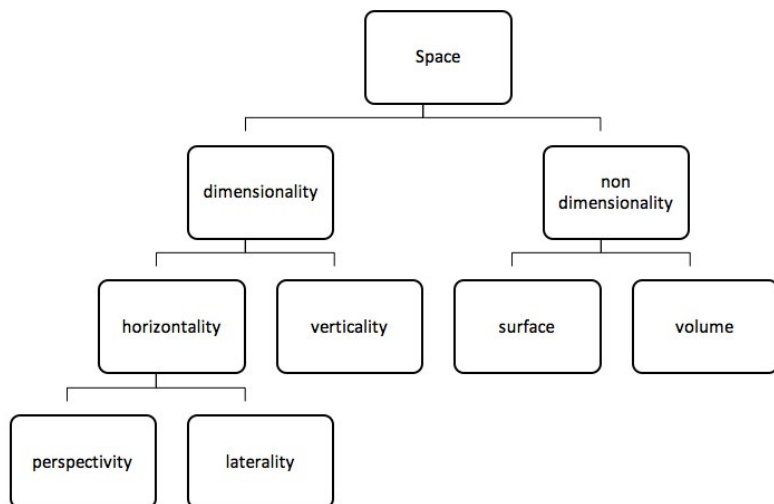


Figure 2. Space organization

This scheme determines the applications of Space in the context of *Magdala* writing, both in the sound and visual aspects and referring to the application of spatialization/ diffusion of the elements.

The creation of the opera relies on a distribution of signs that determine and organize each of its constituent elements in a final process of accumulation and stratification. The cataloging of the elements with source in natural and artificial, that is, originated in nature, or created by Man, allows to infer at each step the location of the object in the specific memory or culture.

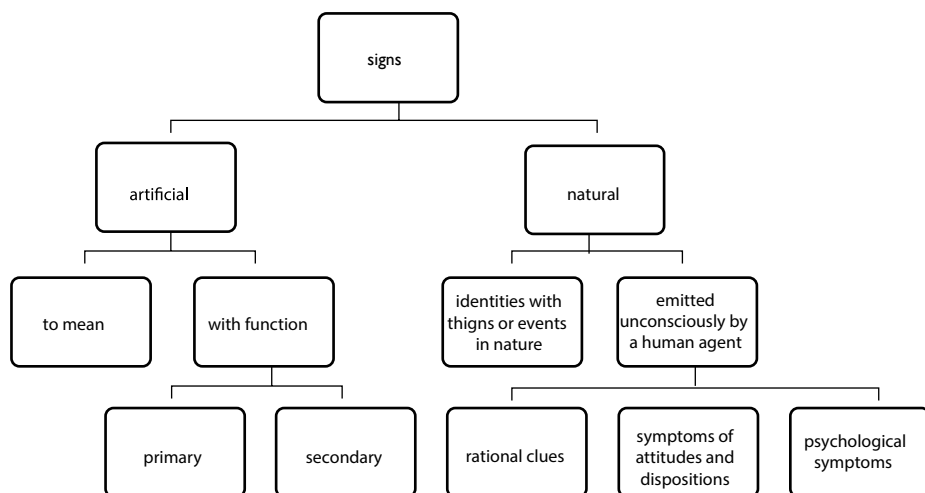


Figure 3. Signs distribution and functions

The overlapping of the different elements, taken from the organization described in the previous figure, into visual and sound elements allows the sense of spatiality to integrate the auditor in a specific localized context. As Augusto (2014, p. 88) describes “... the sound landscape is a key element in the identification of a place, a culture, a task.” It is thus possible that the distributions of different auditory materials in the same image, classify chronological spaces

in the same context described, also creating different types of listening as referred to by Barry Truax¹, sounding, waiting and background. (Augusto, 2014, p.75)

The different processes of listening allow to create a dimensional space in the perception of the listener and in the created references, elements that when being transformed, either by electronic manipulation or by vocal elements creates a new differentiated layer where the disintegration of the recognizable elements allows a sensorial approximation to non-rational elements.

The functionality of the common root elements, sonorous, integrated in different planes, sometimes as a visual complement or as a sound element, create components in the spatial depth, defining the layers of continuous / general or particular structuring. The implicit function of each of these layers, by location in the scenic space supported by the audiovisual references are thus determined structural characteristics.

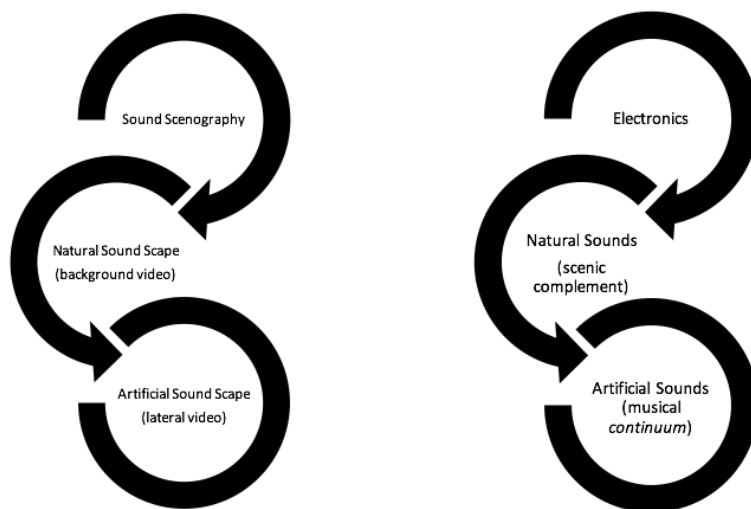


Figure 4. Location of sound functions

All the above elements reflect a single layer² in the structure, the set design, based on transformed or pure elements of image and sound. However, this base corresponds to a dramatic dimension, which is complemented by the theatrical function itself, as an action born of the text and its characters. They are all performed by a single voice, unfolded in the different characteristics by support of live effects, in a process of dimensionality, that removes/ covers the particularities of Mary, central character, in the co-characters. The projection of these is done in real time or by emission of recording, supported by specific light, as described in the introduction, and visual elements in the side video, referring each subject in a light-sound-image complex, falling into a musical characterization, which is not a *Leitmotiv* but unifies every dramatic subject.

1 Canadian composer and soundscape researcher born in 1947. Author of Handbook of Acoustic Ecology and Acoustic Communication.

2 The definition of different layers that become a single refers to the use of fractal structures, as technical elements, which are excluded from the scope of this article

The unification of the dramatic elements allows a greater relationship with the auditor, emphasizing them on the scenographic surroundings, more free of the complexities of the message, without losing the fluency in spiral and channeling function of fixed and determinant points. In the memorial recurrence of certain musical elements throughout the temporal displacement, they are based sensations that are evidenced in the manipulations of the voice grounded on the effects that are added to it.

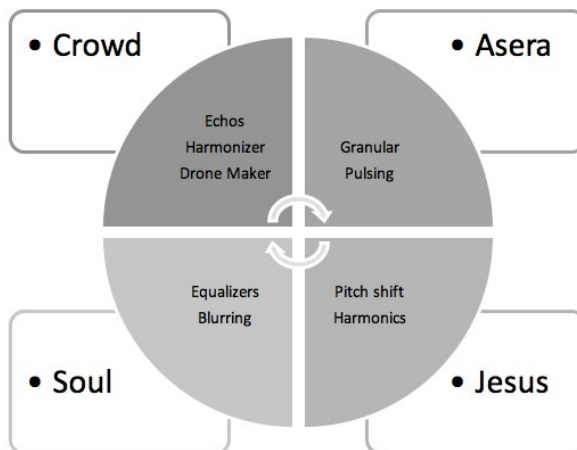


Figure 5.Live Effects for each character

Conclusion

Magdala, as present opera, is inserted in a chain initiated in a wider context, fusion of thought and technology, which will reformulate the idea of theater and its conception, extending to the various references of stage and possible staging.

In this reform, informatics, in the different senses of programming to the diffusion, plays a major role in that it allows an increasing control of the total organization as tool of creation and a greater contiguity of the intervening agents referring them to another concept of location.

“Technology as an art form has to offer more than mere interaction, especially if it is an art as humanized as the theater, which excels by the proximity of the actors and the identification of the performative actions. This question of interaction is related to another notion (...), that of virtual stage.” (Duarte, 2007, pp. 99-100)

A concept of integrated representation is reached, in which the functions of each actor are placed on the threshold of each other, replacing or overlapping. González (2007) states that “the incorporation of informatics leads to a mediated performance where the distinction between means ... fades or disappears.” (p. 42)

Musical models, as a specific case of individual and aesthetically defined writing, emerge as a parallel process, which, together with the technologies involved, allows the creation of a global timber envelope, “technology allows to abstract the model of a timbre, to give it a structuring dimension.” (Dalbavie, 1991, page 327). The deconstruction of the sound constituent function of sound, refers to elements of tension-relaxation mnemonics in the emotionality based on the unfolding of the structure/ form, since “when we use the timbre to create the musical form, it is precisely this that takes the place of harmony as progressive element of music.” (Saariaho, 1991, p. 413)

The audiovisual element shares the timbral component, in the calculations of the light intensity, the color of the image, the distance of focus reaching or distancing granulation/ perception, in its spectral function, microelements of discernment that unite the components in a scenic anamorphosis, supported in psychoacoustic experiences, “Think about the works on ‘auditory images’, flow formations (...), preferential rules of grouping (rhythm), as works that stimulate the imagination and allow to rethink the ‘melody’, the ‘polyphony’, the ‘rhythm’.” (Hurel, 1991, p.265)

As a conclusion, we must understand the total audiovisual fusion, supported in the computation as Vuillemin (2007) describes: “Since before 1980, recourse to the main concepts of computer science had allowed rediscovering the previous theater, analyzing successive dramatic situations, imagining more interactive constructions, being able to simulate dialogues, or even creating total works, unprecedented ‘digital operas.’” Interaction that is extended to individual, emotional and sensorial acculturated relationships, so that the common base overlaps and distinguishes the elements in the intimate connections with phenomena of private memory projecting them into an aggregate of shared memories, global integration.

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