From Sound Art to Virtual/Augmented/Mixed Reality: the expansion of immersion and agency through 3D and interactive sound in digital media.

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Abstract

This paper is intended to explore the overlapping concepts of sound art with virtual reality, focusing especially on immersion and agency. Contemporary art in the 60s, and particularly sound artists, engaged in a reconfiguration about traditional understanding about art, its exhibition spaces, and the relationship between artist and audience. Through this questioning, it explored changes in space through sound translocation and spatialization, as well as with interaction. This interactive, two-way communicative relation between artist and audience enabled people to shift from a passive absorbing state to a more creative active one. The artist and the audience are co-creators; they are in a same level position.

Virtual Reality, with the use of 3D audio and interaction, also immerse people in environments that break dichotomies between artists and audience, art and person, and place the people within the piece of art. The feeling of immersion in VR is strengthen with interaction, which enables people to alter the content of the virtual world, hence creating a solider feeling of immersion through a convincing sense of agency. Digital technology offers new possibilities to engage humans in creative endeavors that no longer depend on location or moment. The mobility and computing power of new technologies have taken one more step to the front, the ideas that were once conceived within contemporary art.
The development of this work is based on a background research on sound art and VR and a synthesis and analysis of concepts. These concepts are then evidenced in case studies of recent virtual reality projects.

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Abbreviations

VR- Virtual reality

AR- Augmented Reality

MR-Mixed reality

AI- Artificial Intelligence

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Chapter 1

This first chapter is intended to explain the context of the research area, what this project consists of, and why it is important. It will also define the scope of this research, its motivations, goals, and the general structure of the paper. It will point out the present rise of Virtual (VR), Augmented (AR) and Mixed Reality (MR) technology, and how, through an analytical description and comparison of sound art and VR, a parallel can be created to merge both fields, exploring new creative possibilities.

1.1 Context and project description

There is an inevitable rise in present days of virtual, augmented and mixed reality technology. After decades of research and development, the technology that was once available only on special research facilities is now being offered massively for the general public. Oculus Rift, HTC Vive, Gear VR, Google Cardboard, Microsoft Hololens and many other devices, are now available for consumers. According to Digi-capital (2017), the AR/VR market in 2016 was $3.9 billion dollars. Even though the hype around this technology created before 2016 has stumbled with reality, generating less revenue than expected and shifting the focus more on AR than on VR (Digi-capital 2017), the fact is that this technology has finally arrived and this is the reason why it is necessary to discuss and research the possibilities that this new medium offers in diverse fields like arts, entertainment, enterprise, and education.

For this paper, the area of research will center on space and interaction in sound art and VR, and the particular role of 3D audio and interactive sound in new media. The first section of this project will introduce basic concepts of sound art focusing on space and interaction. It will then explain the role of sound in linear and nonlinear media and through this, compare concepts and techniques used in sound art in relation to VR, finding similarities and differences between both mediums, and showing how the concepts of both worlds overlap, thus providing an interesting new area of experimentation and development.

1.2 Motivation and Goals

There are three main motivations for this research. The first one is to compensate the traditional lack of importance given to sound as an area of research and as a main creative tool in media. As Franinovic and Serafin (2013. p.1) state, "sound has been a neglected medium, with designers rarely aware of the extent to which sound can change the overall user experience". Michel Chion (1994) also claims this situation stating that traditional theories around cinema have eluded or sub estimated the role of sound and its importance, even though film and television, as well as other types of media, provide not only visual but also aural information. A second reason for the research is the expansion of this new technology in recent times, as it can be seen in the financial earnings stated in the previous section. Even though there have been previous attempts to commercialize, for example, virtual reality technologies like the Virtual boy of Nintendo, these technologies never had enough commercial success, technological evolution or financial investment to expand as they do today. On the other hand, two years ago, as Solomon (2014) informed in Forbes magazine, Facebook decided to buy Oculus, a major VR developing company, giving the sector a massive financial boost. This absorption of Oculus by Facebook combined with the impressive expansion of smartphones is also very important for the rise of this new medium since AR and VR content can be developed for this hardware. According to The Economist (2015) half of the population on the planet has a smartphone in their pockets, and it will probably grow to 80% of the population by 2020, amplifying massively the possibilities of offering AR, VR and maybe even MR experiences to huge amounts of people. This present context makes it inevitable to focus on this technology and its potential uses. A third motivation for doing this research is related to art and the conceptual changes promoted in the 60´s by contemporary artists, especially focused on sound art, who changed the institutionalized traditions around art. It is interesting to explore how these ideas are applicable in the new digital era. As Claudia Tittel (2009) explains, since the 1960´s, a shift in the way that artists perceived audiences and art itself created a subversion of traditional conventions regarding participation, space, and immersion. The ideas that motivated the expansion of subversive artists included the rupture of the division between artists and audience, the co-creation of an artwork, and the alteration of space among many others (Licht, 2009). It is interesting then to see how these ideas are overlapped on current

social and technological contexts to see how they are still applicable and how they can be expanded in ways that previous artists never imagined possible.

One goal of this paper is to, first, make an overview of sound in media and see its applications in current interactive technologies focusing on immersion and agency in VR. A second one is to draw a parallel between sound art and VR to establish common points and explore interactive sound as a key element for immersion and agency. The paper aims also, in general, to provide evidence about the usefulness of sound as a tool for interactive media capable of enhancing immersion and interaction.

1.3 Research and Contribution

The digital world has evolved exponentially to the point of offering to consumers VR, AR, and MR devices. How can artists and audiences interact in these mediums? What sense of agency is given to a person within VR? What difference exists between the immersive experiences created in the 60´s and the sonic worlds created with 3D Audio? The aim of this paper is to describe immersion and agency in sound art and see its translation into virtual reality to understand how through interactive sound in VR, these two elements are further enhanced and explored. The analysis of sound and its interactive applications will contribute also to the expansion of previous sound installation scenarios that were created before the development of digital media. After researching about sound interactivity and sound art, there is a gap involving the possible merging of these two fields and a general need to develop interactive audio and its potential benefits in an ever growing digital world that needs exploration and expansion in the way humans relate to digital content: HCI (human computer interaction) using sound.

1.4 Paper Structure

This paper consists of four sections. Chapter One is the introduction to the subject, which includes the motivation for this research, as well as the goals of the paper. The second chapter analyses sound art and specifically points out the ideas of agency and immersion promoted from this discipline. Another subsection of this chapter gives a general distinction between sound for linear and non-linear media and introduces specific technical

characteristics of Virtual Reality Audio, and it includes a discussion section, which explores possible developments present only in the digital world. The third chapter of the paper analyses different VR projects that evidence interaction, immersion, and agency making comparisons with sound art projects. Chapter four provides conclusions around this comparison between sound art and VR projects.

Chapter 2

2.1 Introduction

This chapter will introduce sound art, explain its concepts and origins and define two main elements that will be analyzed in detail. These two elements are Space and Interactivity.

2.2 Sound Art

Finding an absolutely precise definition for sound art is very difficult. As Licht (2009) states, different authors have tried to define it as sound sculptures, sound with visual art concepts, or just art where sound is a primary material. In his article, he states that this type of art is not constrained to a specific time period, a specific group of artists or a unique location. This ambiguity supports the vagueness and inconsistency of the term but Licht (2009) still sustains that the term 'sound art' is useful when defining "site or object-specific" sound works that are not music. For understanding sound art, is useful then to see some characteristics that define the art form but since it comprises a wide range of elements, this paper will focus only on space reconfiguration and interaction.

Since the beginning of the 20th century and with particular cases starting during the 60s, sonic and visual artists who wanted to change the traditional dichotomy between artists and audience promoted a huge change in the way art was created and absorbed.

> "Since the nineteenth century, for instance, the modern concert hall has developed a physical and conceptual segregation between a "performing space and a listening space"(Blesser and Salter 2007,130)… listeners sit in silence, thoroughly immersed and emotionally engaged in the music, **yet unable to affect the flow of sound**. The

> concert auditorium´s design, Christopher Small (1998,26-7) argues, not only "discourages communication among members of the audience", it is also planned " on the assumption that a musical performance is **a one-way communication**, from composer to listener through the medium of the performers. "(Rogers, 2014 p. 17)"

Artists like John Cage, Max Neuhaus, and La Monte Young, among others, conscious of the rigidity of these physical and cultural structures, started to change this traditional conception of communication and shifted to ideas where the concepts of music, sound, space and audience role were altered. As Licht (2009) states, John Cage´s *4´33*[1], for example, breaks the traditional hierarchical relation between composer and audience and instead creates a "listener to listener" connection between them. Another interesting aspect of sound art relates to the strong criticism to restraining and institutionalized spaces related to art exhibitions, museums, and auditoriums. In her article, Tittel (2009 p. 59) says that "artist were leaving the institutional framework of museums and galleries…as a protest against conventional art practices", and she uses Max Neuhaus´ *'Drive in Music'* (1967) sound installation as an example where the public space becomes the new "gallery" to "make music for all". Sound art relates sound with architecture, environments, interaction, space, design and ecology among other areas. (Licht 2009, Tittel 2009). Since sound art has many different elements, the two main ones that are exposed with more detail in this paper are space and interactivity. These elements are the ones that can clearly be transposed into virtual reality and to understand them better the following section will use sound art projects as a way of explanation and understanding of these ideas.

2.2.1 Space and Immersion.

Oldenburg (2013) says that sound art explorations include experiments arranging sounds in space, the effects of sound on the body and sonification. To see some of the rearrangements of space within sound arts we can start by using an example shown by Licht (2009); a work of Maryanne Amacher called *City Links*. Here sounds are taken from urban environments and are translocated to other spaces. In *City Links # 6*, for example,

[1] 4'33 is a work consisting of three movements where the musician doesn´t play a single note. All that is heard is the environmental sound of the moment. (Hermes, 2000)

Maryanne captures the ambience from a Boston harbor and sends it modified to a gallery space.

> "City-Links is a piece in which sounding resources of 2 or more remote locations are fed back to each other to allow for interaction between men and sound at distant locations."(Amacher in Ludlow, 2010)

In this project, there is a transformation of a space based on transformations of the perceived environments. These sonic variations of the environment suggest transformations not only of a perceived sound but also of a perceived reality.

In another example of sound installations, Hans Peters Kuhn reconstructed the sounds of a steelwork that was not longer functioning as well as Ron Kiuvila did with the recreation of the sounds of a factory that once existed in a specific location (Licht, 2009). Sound installations reestablish a location, a space and therefore a reality (or at least part of it) with the use of sound.

> "Sound can help to structure rooms and differentiate between functions and purposes… may build the illusion of certain countries or locations."(Herzer, 2014)

The transformation of locations can be either in internal or external public places. As Franinovic and Salter (2013) wrote, the project *Recycled Soundscapes* (2004) was made in a public space where an artifact captured distant sounds and reproduced them back through speakers built in other artifacts on that space (see Figure 1).

Fig. 1 Recycled Soundscapes (Source: Zero-Th. 2004)

After being captured, the sound being played back could then be altered by any passer-by that felt interested to interact with the object. With urban-public projects, the idea, according to Franinovic and Salter (2013 p. 54), is to challenge "legitimized identities and social codes", expanding, even more, the disruption of contemporary art not only against traditional art spaces but also against conventional social structures and beliefs. In sound art, then, the treatments of space relate to transformations of 1) public areas, 2) interior spaces based on relocations or mutations of external environments, as seen in *City-Links,* and it also sometimes draws its inspiration from 3) internal structures (Licht, 2009), as exposed next. The architecture of certain locations affects the way sound is transmitted and thus, the way it is perceived. The project called *Sound Field IV* (1995), by Bernhard Leitner, uses covered loudspeakers placed on the floor (see Figure 2).

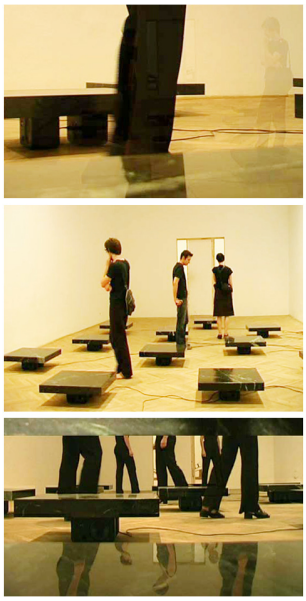

Fig. 2 Sound Field IV (Source: Bernard Leitner 1995)

The low sounds are kept on the ground level and, when people move within the space, these create a sensation of movement through "aural waves" (Licht, 2009). In another example, we can see the use of the building structure itself becoming part of the sonic creation with David Byrne´s *Playing the Building* (2005). Here we find a work using plumbing, beams, and pipes that are connected to the building as well as with an organ which can be played by the visitors. The room itself becomes a resonating box, an instrument (see Figure 3). Here the use of the structure is more direct. Klein (2014) explains that sound artists use the acoustic

characteristics of a space, its architecture and its visual traits to transform it or reinterpret it through the use of sound.

Fig. 3 Play the Building (Source: Byrne 2005)

One final idea related to space is immersion.

> "Immersive environments that remap spectatorial habits from one-way communication to two-way activity help to bind spectator to spectacle by removing the barriers of passivity and the physical space between viewer and art exhibition; listener and music recital." (Rogers, 2014, p.20)

The idea of breaking the separation between audience and artwork brings the person into the world of the art piece. Max Neuhaus (1993) says that when he creates spaces, the listener that enters into them slowly changes its perception of it when it starts focusing on the sound; the scales of the sonic elements change from an almost imperceptible state to a very conscious perception of the aural environment. His works imply a bodily immersion of the participants. Rogers (2014, p.21) also talks about this idea with Bill Viola´s works like *Five Angels of the Millennium* (2001) and *Ocean without a Shore* (2007) where an audiovisual immersion is created to detach the person from the real world and " the result is akin to jumping into a painting or into the diegesis of a film".

When talking about immersion in contemporary art, it is pertinent also to talk about sound spatialization. The rupture of the division of the stage and the audience was explored by moving the sounding source from the central stage into the surroundings of the audience.

Licht (2009, p.4) states that during the seventeenth and nineteenth centuries, the halls were developed to propagate sound coming specifically from the stage. Works like *Antiphony I* (1953), where five orchestras were placed around an auditorium, or *Gesang der Jünglinge* (1956), from Stockhausen, which used five speakers around a hall to playback sounds, changed the centralized sources of sound and moved them to occupy the space and immerse the audiences in the sonic environment. In following sections regarding film sound and the perception of sound, we´ll see how immersion through sound spatialization was created for film and how it evolved to 3D audio in Virtual Reality.

In conclusion, we can see three characteristics about space in sound art. One involves the use of external environments or synthetic ones that can be modified and translocated to change another place´s ambience, either a public open space or an interior one. The second characteristic takes into account the structure of an internal space, its architecture, textures, and general organization, using them to alter the way sound is propagated and thus modify how it is perceived. The third element is related to immersion, and how the expansion of the sonic ambience and the incorporation of the participant into the art project, dissolves the division between reality and the created world and also breaks the traditional division between artists and audience. The next section will now talk about interaction in sound arts.

2.2.2 Interaction.

As seen in previous segments, sound art is strongly involved with spatial reconfigurations but also with interaction. It supported the idea of breaking the wall that divided the artists from the audience, disrupting its passive position and shifting it to an active one. It is interesting to note, though, that the immersive environments described before could involve participants that were passive and/or active. The fact that the audience is immersed in an artwork doesn´t necessarily mean that it can change the " structure, content or flow of a work (Rogers, 2014, p.21)." The difference between immersion and interaction lies in this part: the possibility of action of the spectator.

To evidence interaction in sound art, we can start with an example shown by Claudia Tittel (2009) where she explains how Christina Kubisch´s *Electrical Walk* (2004-2015) promotes

a sonification of urban environments where electromagnetic fields are present. Participants of this project move freely around the cities wearing headphones that perceive these varying electromagnetic fields and create sound depending on these variations. Tittel (2009) says, "participants are thus free to create their own electro-acoustical pieces." This project clearly shows a characteristic present in sound art where the actions of the audience are taken into account and affect the piece of art. Actually, the word audience in this context needs to change completely since it is not only listening to the work but it is also creating it; the word participant or co-creator could be more appropriate. *Drive in Music* (1967), by Neuhaus, is another good example of a work where the input of the participants changes the content of the art piece. In this project, a group of transmitters were set on trees along a road to generate different sounds that varied according to weather conditions. The transmitters included antennas that were positioned to occupy a specific area where cars, tuning the same frequency of the transmitters, would capture the signal. The final sonic result of the project here would change depending on the weather but also on the speed and direction of the cars (Tittel, 2009, p. 59). A third example of the participation of people in art projects is shown by Licht (2009) with the project called D.A.M.A.G.E. which, even though it falls more into the category of experimental music, it has elements of interaction that apply to this case. D.A.M.A.G.E incorporates a plastic beach ball as a controller that generates electronic music as the ball is bounced and translated around the participants. In this case, the aural result is only present if the audience directly acts in the piece of art. The project in this case is co-created by the artist and the participants and breaks the hierarchical separation between them. One final example useful to show interaction within sound arts is *Vicissitudes* (1998) by Camille Utterback (see Figure 4).

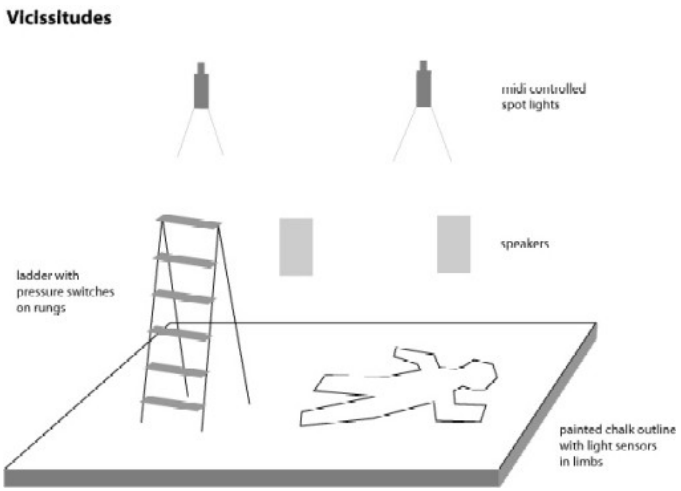

Fig 4. Vicissitudes by Camille Utterback. (Source: Electronic Book Review)

In this project, there are two soundtracks: one has interviews with people talking about positive aspects of life or moments where they felt 'up' and another one with interviews about negative moments, or when people felt 'down'. When people go up the ladder, the volume of the positive interviews goes up, and when a person situates itself inside the outline on the floor, the negative interview starts to become audible. In this sound work, the person involves its complete body to be part of the piece and to generate content showing the "embodiedness of language itself." (Utterback, 2004)

2.2.3 Conclusion

Interactivity within sound arts relates to the capability of the user or participant to affect the piece of art. Contrasting with traditional divisions between audience and artist, the destruction of the barrier between these two entities promoted by contemporary art invites the audience not only to be immersed into the art piece but also to affect it or sometimes even to create it. The audience stops being a passive body and transforms itself into an active entity flattening the previous hierarchical status of the artists. The relationship becomes more one of a 'listener' to 'listener or 'player' to 'player' one, as Licht (2009) describes, than a one-way traditional communicative system.

Space and Interaction are the two main characteristics present in sound art that can be translated into the virtual world. Sound art in the 60s used multi-speaker systems and analog transducers to create immersion and interaction, but the technological digital evolution of recent times have expanded the possibilities of exploring these two ideas even further. The next section will now introduce virtual reality audio by starting with sound in linear media and the switching to nonlinear. The study of sound elements in traditional media will help to define what aural components are present in media in general, what role they play and the evolution of surround sound. The description and understanding of them will then give enough background to analyze VR projects and overlap sound arts concepts with VR worlds.

2.3 Sound Design and Interactive audio.

This section will give a description of sound both on linear and non-linear media. It will specifically focus on film/TV sound and on video games and VR sound. This section, combined with the previous concepts of sound art, will give the basic concepts to analyze the case studies of section three, thus enabling the connection of both fields.

2.3.1 Linear media sound

To make a distinction between linear and non-linear media, it is useful to take Karen Collins´ metaphor when explaining music compositions for both mediums.
According to Collins (2007), when composing music for linear media, musicians now how something will sound from the start point to the end. There is a sequential set of events that follow a specific track: "Like being locked to a train track, it has been composed to start on one point and progress to another " (Collins 2007). On the contrary, in non-linear media, there are no predictions about what is going to happen. What we encounter are options, which instead of being like a fixed train track, work more like a metro where any person can hop on and off from any station and change direction in any way desired (Collins 2007). Within linear media, then, we can situate film and television. In these mediums, the content, both visual and aural, is predefined and can´t be altered by the spectator. It is useful to first explore sound on film since most of its main elements are also used in interactive media and the evolution of immersive surround sound is connected both to sound art and virtual reality. The specific differences with VR regarding technology, implementation, reproduction and other aspects, will be explained in the non-linear section.

Sound on film has existed for approximately 90 years. Since the introduction of live pre-recorded sound played back on disk in 1926 with *Don Juan* and the following introduction of sound within the film itself in 1927 in *The Jazz Singer* (Bordwell, Thompson 2012), films have been transformed into audiovisual creations where sound has become a major element in the construction of this art form. Even though music was being played live in synchronization with films before *The Jazz Singer*, it wasn´t until sonic elements were recorded on the film itself that the use of sound as an individual, malleable, and separate process opened a world of creativity and possibilities that were not achievable in live

situations. According to Bordwell and Thompson (2012), sounds can be divided into three groups: speech (dialogue), music and sound effects. At the same time, we can divide the sound from a film into two source groups: diegetic, which means that the source of the sound is part of the world of the film, and non-diegetic, which are elements that are not in the characters' reality. The link of sound and images has evolved into a complex mixture that combines music, dialogue, and sound effects to create an illusion, an "audiovisual contract" as stated by Michel Chion (1994). What is interesting to see is that these sound sources and types, which have been categorized and analyzed in traditional media, are completely transposable to nonlinear media. Speech, sound effects, and music are present in video games and VR worlds and these are elements that are used to engage in an interactive way with a user within a virtual world. Since one of the aims of this paper is to evidence the usefulness of sound in media, the following section describes the current uses of sound in traditional linear media, which are in general also applicable to VR. A second reason supporting the inclusion of the following section is that interaction, as a key element that unites sound art and VR, is strongly achieved through sonic interaction, as it will be described in the VR section and as it has been evidence in the previous section. The possibilities of interacting with the environment, virtual objects and even musical objects within VR give enough support to understand with more detail the functions of sound and what they can create for spectators and players.

Depending on the intentions of the designers of the worlds, the different combinations of sound types will create different results. To have a general idea about the creative possibilities offered by the different groups of sounds, we´ll see the functions of music, dialogue and sound effects in linear media. Sonnenschein (2001 p. 155) gives four main functions for **music**:

1) Emotional signifier: which relates to the supporting role of music with "spirituality" and emotions of the characters and story of the film.
2) Continuity: music works as a "fill" that compensates lack of continuity either on sound dialogue, ambience or on visual material.
3) Narrative cueing: the music helps to establish a particular "point of view" or predefine or anticipate "a threat or a setup for a joke", establishing story driven events.

4) Narrative unity: music can give a formal unity by the use of repetition or variation of melodies, instrumentation or harmonic structure. The idea of leitmotiv could be included here, where a specific musical theme is attached to a particular character or event.

Sonnenschein (2009, p. 56) cites Michel Chion when defining three types of **dialogue** in film:

1) Theatrical speech: This refers to the in-story text made by characters.
2) Textual speech: it refers to voiceovers, which are non-diegetic and are usually for special characters or narrators.
3) Emanation speech: This text can´t be clearly defined and is used more to convey a character's presence than to understand the meaning of the sounds.

For **sound effects**, Sonnenschein (2009) points out the use of ambiences sounds, for example, as elements that establish continuity between film edits and sets the location of a scene. Foley and sound effects help to give " a realistic sonic presence of the action" (Sonnenschein, 2009, p. 40).

Besides having the three major groups of sonic elements that are present in film sound we also need to think about how they are combined to work as a unity for the film and how they are played back to the audience. The process of combining sound is called mixing and the way it is played back in theaters sets one common area with sound arts and VR: immersion through sound. Surround sound has a long story starting in the 1940s with the use of quadraphonic sound, which revolutionized the use of space in theaters, but it was only until the 70s that surround sound developed by Dolby started to be used massively. The expansion from stereo sound to 5.1, 7.1 and beyond gave the audiences a better feeling of immersion than previous settings but they were limited on providing vertical (above and under the body) sonic information. Dolby Atmos as well as Auro 3D are recent evolutions of cinema audio that compensate this and create a more complete 3D sonic experience. (Schoenherr 2005; Dolby 2017; Auro3D 2017).

Sound in film helps to create the illusion of a world with sound effects and a surround environment. The immersion of the audience into new realities is present both on film and sound art but interactivity is not present on films. It can be said that because of this, sound art immerses the participants into unreal scenarios in a more profound way precisely because it gives them the possibility of action, hence bringing nearer the virtual world with the real one. Interaction is a key element for immersion so the next section will now introduce sound in interactive media focusing on games and VR.

2.3.2 Non-linear media sound

Sonnenschein (2001, p. 218) says that " the most profound difference between film and the new media is interactivity… the user has both the discovery and decision to repeat or go forward along a varied of paths." Similar to Collins´ (2007) metaphor of the metro, Sonnenschein shows how options and variety of paths define interaction.
For this project, the focus of nonlinear media will be on video games and VR sound.

2.3.2.1 Games Sound

According to Collins (2007) sound in video games can be interactive when it is responding to direct actions of a player, and it is adaptive when it reacts to events of the gameplay or game environment itself. The term dynamic audio is used by Collins to describe audio that is either interactive or adaptive depending on what happens in the game. Collins (2007) also states that game sounds, as in film, can also be classified in diegetic and non-diegetic sounds but these concepts also should include other divisions like dynamic and non-dynamic sounds as well as the level of "dynamic activity" regarding the world of the game and the player.

As we can see, the level of complexity regarding the understanding and conceptualization of sound increases as the position of previous passive audiences present in film are transformed into creative, active users/players in interactive media. This element is very important as it draws a connection between sound art and interactive digital media. The link can be established by comparing Collins´(2007) explanation about communication, as seen in the following graphic, and the descriptions made by Tittel around sound art.

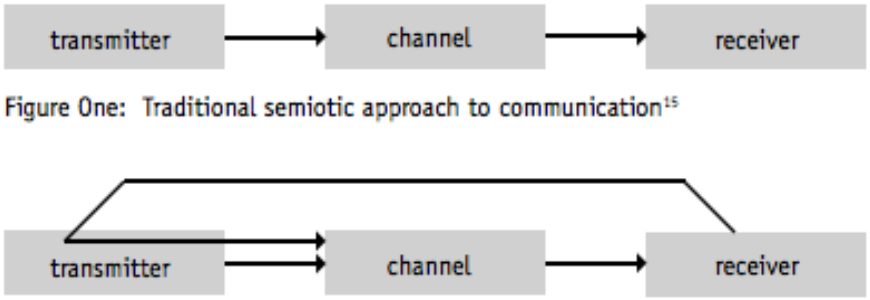

Fig. 5. Traditional approach vs. participative and non-linear approach to communication. (Source: Collins. Essays on sound and vision. 2007)

This change of passive spectators to participatory users is the same seen in Kubisch´s *Electrical Walks* sound art project described by Tittel (2009) where she states "participants are thus free to create their own electro-acoustical pieces." As well as all the examples presented in the interactive section of sound art, the players in video games are actively participating and affecting the content, they have a sense of agency. Atau Tanaka (2006) says that agency is "an ability to take actions, to have initiative." A sense of agency is given to the participants in games, giving them the power to determine what and how things happen within a predefined virtual world. Similar to sound art, the artist serves as a creator of a platform from which the user creates its own experience, its own world and therefore becomes a co-creator of the piece of art. Traditional desktop-based games immerse players in virtual worlds through surround sound (some games use only stereo sound but major consoles incorporate 5.1 and 7.1 sound) and interaction but keep the visual aspect separate from the player through the use of a monitor. In film, a similar situation happens with the use of surround sound but monitor based visual information.

The following section will introduce virtual reality to see how interactivity and space are understood in this environment and how immersion changes within this realm that include a 3D visual field.

2.3.2.2 Virtual Reality

When thinking about video games and films it is interesting to see that both mediums suggest an existence of a "virtual world" where players are immersed, even though one is interactive and the other is linear. As Sonnenschein (2001, p. 159) states, films, with the use of sound, can "induce the sense of space, volume and texture…with the addition of visual information we can be immersed in a more complete **virtual reality**." Strictly speaking, it could also be suggested that even paintings and books are also examples of "virtual reality" since they create synthetic environments into which viewers and readers are transported. Since the concept of VR seems to apply to many varied mediums, it is necessary to try to define a specific use of the term for this paper.

As Mazuryk and Gervautz (1996, p.5) state, in different types of media we can find three modes of immersion:

1. Desktop VR: which uses a traditional monitor for the image (only one image: monoscopic).
2. Fish Tank VR: which uses also a monitor but includes head tracking and a stereo image of a 3d space.
3. Immersive systems: these systems use stereoscopic images and head mounted devices in addition to possible added enhancements for sensory response like 3d audio or haptic feedback.

If we consider videogames like PONG (1972) or Uncharted 4 (2016), the differences between them regarding graphic and sonic quality, and general gameplay complexity are huge, and it could be said that, because of the realism of the graphics and physical modeling of Uncharted 4, a more immersive experience is created for the players than with the older game. The problem here is that there is still a common element in both games and it is that they both remain inside a monitor and do not immerse the player in a complete 3D virtual-visual environment: they are both examples of desktop VR. A similar description could be applied to film since, although it creates an immersive sonic environment through the use of 5.1 or 7.1 mixing; the visual experience is still limited to a monitor. These varied levels of immersion of virtual worlds on different media might generate ambiguity when trying to

define what VR really is. For this paper, VR is referred to the "Immersive systems" available, for example, with current technologies like HTC Vive or Oculus Rift. The participant uses a headset that tracks movement and it provides a 3d visual and sonic environment that transports the user into a completely virtual world. We could use this definition to clarify more what VR is:

> "The illusion of participation in a synthetic environment rather than external observation of such an environment. VR relies on a three-dimensional, stereoscopic head-tracker displays, hand/body tracking and binaural sound. VR is an immersive, multi-sensory experience." (Gigante, 1993, p.3)

To better understand VR it is useful also to see how this concept relates to augmented and mixed reality, which are important technologies also being developed in this moment. According to Milgram, Takemura, Utsumi and Kishino (1995), all of these varied realities lie within a virtual reality continuum. This continuum is a concept where on one side we have total reality and on the other we have total virtuality. The middle region of these two sides is called the mixed reality where a variety of combinations of virtual and real elements are used in different degrees.

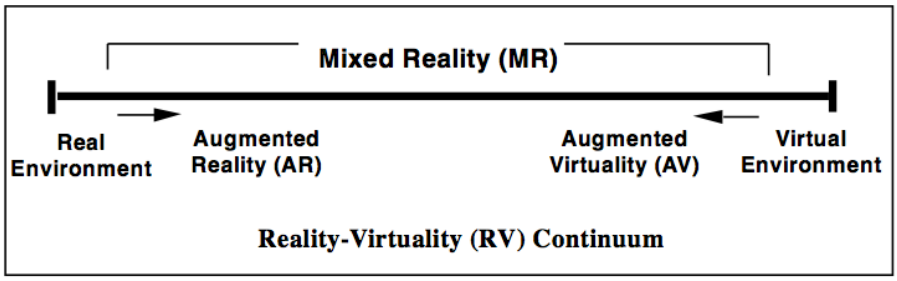

Fig. 6 RV Continuum. (Source: Augmented Reality: A class of displays on the reality-virtuality continuum 1994)

Virtual Reality environments created by the HTC Vive and Oculus lie on the right side of the continuum. The world where the user is immersed is completely synthetic covering an entire 3D space. To understand with more detail how this effect is achieved, we will make a general overview of the history of VR and the technology currently being used by the main VR developers, focusing mainly on sound technology. The understanding of the following

section will clarify how space is understood in VR, therefore creating a background useful to compare to sound art concepts.

The beginnings of VR can be traced back to Morton Heilig in 1962 when his invention the Sensorama was patented. This multi-sensory machine included a stereo colored film, binaural sound, wind, scent and vibrations. (Gigante, 1993)

Fig. 7 Sensorama (Source: Morton Heilig)

After this development, Ivan Sutherland conceptualized “The Ultimate Display” and then developed the first head mounted AR/VR display, which included head tracking and visual content that followed the head´s movement.

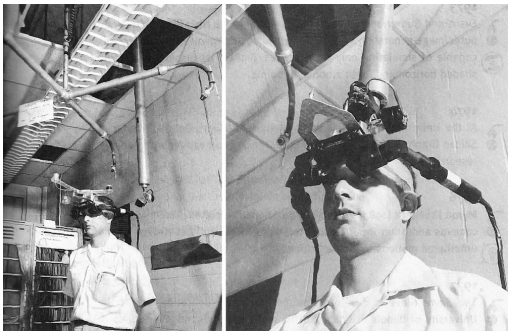

Fig. 8 Head mounted display (aka The Sword of Damocles) (Source: Forensic VR)

After these initial developments, NASA and military institutions made more incursions in VR technology but it was only until 1985 when VPL commercialized the Dataglove followed in 1988 by the Eyephone (Gigante, 1993).

The unsuccessful commercial results of VR had to wait until 2012 when Oculus, a startup company, managed to raise $2.4 million dollars and started developing the new generation

of VR headsets (C.S.W 2013). As stated before, Oculus was bought by Facebook in 2014 and on present times, VR development has increased massively offering commercially VR headsets which include the HTC Vive, Oculus, PlayStation VR, Samsung Gear VR, Google Daydream, Cardboard and mixed reality devices like the Microsoft Hololens (Lamkin, 2017).

Fig. 9 PlayStation VR, Oculus Rift, HTC Vive headsets (Source: Wareable 2017)

To make possible a synthetic 3D world, it is necessary to understand how human beings sense the world. For this paper, we will focus on the way sound is perceived by humans and how VR technology uses this information to recreate a virtual world.

2.3.2.3 VR Sound Technology

Localization refers to the way human beings locate sounds in a 3D environment, while spatialization refers to the positioning of sounds in a 3D space based on the way humans perceive sound (Hook 2014). The way sound is perceived can be summarized with the following list (Oculus 2017; Hook 2014):

1. Lateral Localization: this refers to sound perceived on the sides of the human body. When the sound hits the left side, the sound reaches the left ear first and then the right ear. There is a difference in time and level between the sounds perceived in both ears. For these measurements the ITD (Interaural Time difference) and the ILD (Interaural level difference) are used to calculate the variations. These changes are dependent on frequency as seen on Figure 10.

2. Front/Back: for perceiving information from front and back we need more than level and time differences. As seen in figure 11, sounds could be perceived as coming from the exact same position if they are emitted at the same distance and time from front and back. To fix this, our brain gets information also by the spectral (frequency content) characteristics of the sound that are changed by the shape of our ears, head, and torso.

3. Pinnae: As seen before, the different shapes of the pinnae (external ear) changes the frequency content of the sound and therefore affects the way the brain perceives the sound location. The sound from the front will "resonate" with the shapes of the ear while the back will "shadow" the sounds.

4. Head/shoulder/Torso/Elevation: To cue the sound sources, our brain uses information not only from delays between ear and level differences but it also includes the shoulders, head shape, and torso. The different reflections and changes of sound created by the shape of the body, gives extra clues to the brain to infer where the sound comes from. When trying to perceive sound from above or below, the effect of the body is very important since it interferes with the direct sound, giving clues about the location of the sonic source. The measurements that include body effects are called HTRF (Head Related Transfer Functions).

5. Distance and ambience: The HTRF, ITL, and IDL give enough information to locate a sound in a 3D environment but it is not enough to now the distance to the sonic objects. For achieving this, it is necessary to take into account loudness, initial time delay, the ratio of direct sound and reverb, motion parallax and high frequency attenuation. The first element is the most obvious one, and it shows that the closer an object is, the louder it sounds. The second element refers to the time it takes for the first reflection to reach the person after the direct sound. The third element refers to the mix of direct sound and reverberation: the closer the object is, the more direct sound we perceive and vice versa. Motion parallax refers to the perception of the speed of movement of sound in relation to distance: the faster a sonic element moves, the closer it is. Finally, high frequency attenuation is faster than low frequency, but this characteristic applies only for very long distances. When taking

into account the reflections of sound, what we are talking about in general is the ambience in which the sound exists. It is the combination of HTRFs and reflection details that create the whole information needed to precisely locate sound in a 3D perspective.

Fig. 10 ITD and IDL based on frequency (Source: Hook. YouTube 2014)

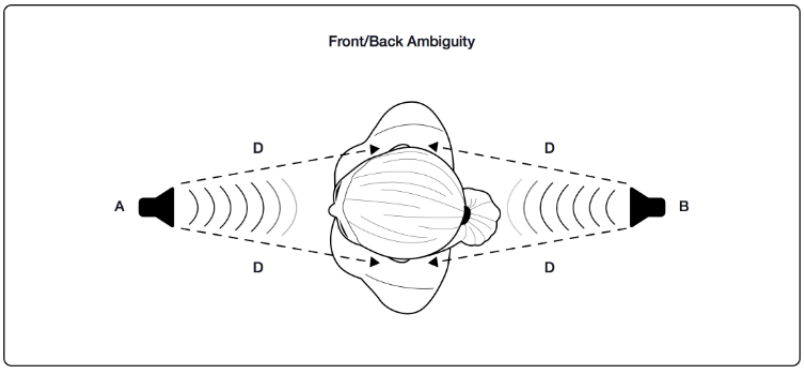

Fig. 11 Front/Back ambiguous perception of sound. (Source: Oculus 2017)

Once we know how humans perceive 3D sound, it is time to actually implement this information to spatialize any sound we want. To do this, the HTRFs are applied to the sounds. Since the aim of this paper is not a deep technical understanding of VR audio beyond of what has been exposed, it is useful to use what Oculus (2107) states on their website, "what matters is the high level concept: we are filtering an audio signal to make it sound like it´s coming from a specific direction."

As it can be seen, the level of complexity in which human beings gather information to interpret the 3D sonic landscape is huge since it involves not only the ears and sound waves but also the whole body, its shape, and its movements that summed with level and time differences, give all the necessary cues for the brain to locate sound. The reason why the previous detailed description is important is because VR took a further step in

understanding what perception and, thus, immersion is and how to create it in a closer way to reality compared to previous attempts in sound art or film. Through the understanding of the body´s influence in the soundscape and on perception, the technology generates a realistic discernment of space.

The evolution of immersive sound is astounding. It can be traced back to the quadraphonic developments in film and its following expansions to 5.1, 7.1 and Atmos technology, ending up to the recent 3D audio developments in VR. As in film and VR, sound art also used spatialization of sound, shifting from the traditional stage-centric sound sources to a more open field use of sonic projections. In these three art fields, there is a disintegration of the division between the audience and the work as the "stage" is expanded and surrounds the listener.

But one thing is to create a surround sonic environment for a user to be in and another thing is interaction: the capacity of humans to change the content of the sonic and/or visual landscape. In VR there is the possibility of having both interactive and linear content as seen in the following diagram by Altman, Krauss, Susal, Tsingo (2016).

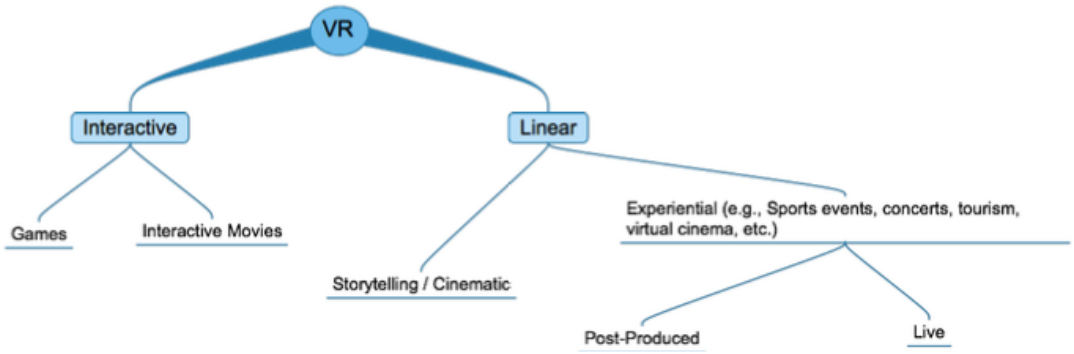

Fig. 12 VR linear and interactive. (Source: AES Immersive Audio for VR 2016)

This means that within a surround visual and aural landscape, it is possible to engage in more contemplative or passive experiences but also to participate in interactions depending on the content being presented. If we were to include sound arts within the graph above, it could be placed on both linear and interactive sections. It is possible to create sonic environments where the user can only change its point of view but not the content presented. A passive VR experience, even though it generates an immersive feeling through 3D environments, lacks a deeper sensation of presence due to the lack of interaction.

Sound interaction involves a sonic reaction created by the input of the user. In games, whether on monitor-based or VR experiences, the audio is usually managed in game engines with audio middleware like WWise or FMOD (or with internal sound tools of game engines like Unity), and the audio is rendered in real time to generate an immediate response to the player´s actions, while for linear content the audio is pre-produced and "encoded, packaged and streamed to the viewer" (Altman, Krauss, Susal, Tsing. 2016, p. 2). Interaction in virtual reality, as well as in some sound art projects, can be expanded beyond the limited actions based on controllers or keyboard inputs triggering reactions, and instead, involve a more corporeal experience. The inclusion of the body as an integral part of the immersive and interactive experience of virtual reality and sound art is what creates a deeper sense of presence and agency.

> "The materiality of sound gains a truly embodied quality through physical interaction- away from equating the medium to the physical support on which it is stored and toward the medium of action-sound relations shaping tangible and corporeal experience." (Franinovic and Slater. 2013. p. 72)

The difference between VR and sound art is that the level of detail used to incorporate the body as a key element in interaction in digital mediums is way more complex and rich, thanks to technological advancements, allowing for greater and more realistic interactions. The fact that 3D audio uses HRTFs for creating the sound spatialization, means that the presence of the body inside a medium is taken into account. Its movements and shape directly affect the sound and its perception. Besides this, natural gestures of the body, that in real life generate a specific effect, can be reproduced in VR with motion sensors or 3D scanners that perceive the body and includes its movements within the virtual reality. A deeper expansion of gesture and interaction will be discussed in the following section.

The next segment will discuss the connections of both, sound art and VR, and see how new concepts and possibilities arise from the merging of both domains.

2.4 General Discussion

This section will take into account the ideas of interaction (agency) and space (immersion) present both in sound art and VR, as it has been shown in previous sections, and explore the connections and creative expansions that could be made within the new digital media world.

Sound art and virtual reality have elements in common. They both immerse users in created worlds through spatial configurations and they both can give the possibility of action; give them a sense of agency through interaction. Sonic artists from the 60s created works that changed the way people perceived art by replacing the locations of exhibitions, the ideas of what an art piece was and also by giving the audience the possibility of shifting from a passive receptive stance to a more active one. The empowerment of the audience determined not only the places where art was being made but also a redefinition of art itself, artists and social concepts. The evolution of digital media, as well, has implied changes that shift from content being created by few entities to content being created by anyone from anywhere. From the expansion of blogs to social media, online videos, digital newspapers, video games, and VR, the digital realm is nurtured constantly by an ever-growing group of **participants** that find in this space an arena where expression is almost limitless. Contemporary artists from the 60s pre-established some ruptures that enabled freedom for content creation expanding the label of "artist" to almost anyone. They allowed an interactive way of communication between people, similar to what we live on with digital media. The strength of their work a lot of times lie more on the conceptual shifts than on actual aural wonders, especially if we think about, for example, John Cage´s 4`33 piece. This work proposes a questioning about what music is: Is music organized sound? Chaotic sonic events can´t be music? What defines music: Rhythm? Melody? Harmony? The piece also invites the listener to gain consciousness about the environment, about everyday sounds. Is there expressive content within urban sounds like traffic? Coughs? Footsteps? Is music made only with instruments? 4´33 also breaks a distinction between artist and audience and sets them both in a same perceptual level. The constant probing about apparently established concepts and ideas around art promoted a rupture that can be traced back to sound art in the 60s and followed into the developments of digital media and the emphasis on user created content. The questioning of concepts established by

contemporary artists didn´t remain constrained to a criticism to institutionalized spaces or ideas. It necessarily directed the center of action to the people. If there are no institutions that define art or social structures then who defines them? The people. Anyone. Everyone. The inclusion of interaction within sound art suggested not only a destruction of previous ideas but also a construction of new worlds. The artists created a platform for users to stand on and become their own creators. The link with virtual reality can be made here, as immersion and interaction are strong elements for this medium. In virtual reality, immersion is not only created by the incorporation of users within the work but also by the interaction in which they engage within these surrounding elements. Since there is a connection between sound art and VR, it is interesting to see what new possibilities this new medium offers to expand sonic art concepts.

As explained in the previous section, the use of the body is very important to enhance the feeling of presence, of strong immersion within the virtual world. The use of the body is strongly related to gesture and even though this is present in sound art projects, it can be taken into a much more deeper level within digital technology. Ainger and Schroeder (2014) write that an interpreter feels, listens and watches the sound he makes. This means that sound is not related only to the sound wave propagating through the air and into the ear but it is also related to more senses: it involves a more complex multisensory cognitive system. Ainger and Schroeder (2014) also state that the use of physical modeling, within the digital realm, divides the qualities of sound in different parameters, and through this, it is possible to assign different characteristics of sound to different types of gestures, as well as assign partial control of them also to computers. Although in traditional sound art projects it was possible to change sonic parameters depending on actions of the participants, these sonic changes were limited because we were dealing with real sounds, not modeled ones: sound is not divided in very specific parameters by physical models or digitized version so these can´t be attached directly to actions made by the participant. The level of detail given by the digital realm is one of the main elements that give VR a new dimension to sonic interaction and immersion.

Virtual reality is a medium where the ideas of sound art can be expanded, as seen previously with interaction (agency). It can also expand the idea of space transformations found within sound arts, with digital modeling of shapes, textures, and organization of

architectural structures, by applying any type of transformation to these various characteristics. If we imagine, for example, the Xenakis and Varese compositions for the *Philips Pavillion* in 1958, the whole construction of the structure was intended to affect the way sound was propagated and perceived by people. This included a spatialization of sound based on loudspeaker placement throughout the building. In virtual reality, buildings can be made without huge amounts of money or time and in any imagined shape. The forms and textures of buildings can be changed to model completely new propagation mediums for sound. The walls could be made of water and the floors of sand or vice versa. The speed of sound can be altered as well as the absorption qualities of materials related to frequency responses. The level of detail into which creators can submerge in within the digital world is almost endless. There is no limitation within the virtual world, compared to the physical limitations of projects created in the 60s, except computing resources, which are year by year exponentially expanding. As Kastbauer (2014) wrote, audio content, in general, will be based more on physical modeling and procedural models. In the digital world, the reality of the world will be reconstructed through very precise algorithms, giving creators and users the possibility of having ultrarealistic experiences but also enabling the opportunity of transforming completely this reality and creating worlds that are non-existent or that would be impossible to find within reality. The physical models let us describe the real world and because of this, it lets us transform it (Ainger and Schroeder 2014). If we take into account not only these internal spatial reconfigurations but also sound placement made through speakers in initial sound art works, sonic objects within virtual worlds can also be placed in any desired position, even breaking physical limitations present in real life. If we want to place a speaker (or any sound source in general) inside a wall created of water, is it easy to do it in real life? Although it might be feasible to find a solution to this, the digital world, based on a numeric characterization of reality, can offer a faster and more efficient way of creating audiovisual experiences that go beyond the physical reality, or that take reality´s characteristics and transforms them in radical ways. As it was seen previously, sound art also was involved in reconfigurations of exterior and public places so it is time to see how new digital technology can develop this area.

Besides thinking about internal spaces being changed, it is also interesting to explore alterations of public spaces, with virtual, augmented and mixed reality tools. As stated before, in the continuum we find different levels of virtuality depending on what place of

the spectrum one situates (see previous Figure 6). Technologies like Oculus Rift and HTC Vive are full virtual worlds but technologies like Microsoft´s Hololens offer mixed reality experiences. The idea here is to blend real world materials with digital synthetic ones (Microsoft 2016). In sound art, we had translocation of environments that created illusions of new spaces for the listeners and also exterior projects like *Recycled Soundscapes* (2004), which altered the public space and changed behaviors and perceptions of citizens. In MR and AR, it is possible to aggregate new sounds to an established real environment with the use of 3D audio. The idea of analyzing our perception and the way sound propagates in space, gives new tools that make easier the blending of two or more sonic soundscapes and make them seem as one. To make a connection between sound art public spaces and VR, AR, and MR, it is useful to think about the previous project describe called *City Links* and modern augmented reality projects like WARA (Wearable augmented reality audio). With this project, special headphones that incorporate microphones were used to blend the real environment and virtual sounds. Through sound spatialization, an illusion could be created to place synthetic sounds next to real world ones and make them seem as one. (Harma, Jakka, Tikander, Karjalainen, Lokki, Nironen, Vesa, 2003). 3D audio is used in VR, AR and MR, and, depending on the technology used, it enables a totally synthetic environment (VR) or a mixed one with reality and digital elements combined. This creates a huge range of possibilities that were not possible in the 60s for sonic artists since it lets an individual to immerse itself in any environment created digitally and it can also incorporate real elements. It is interesting also to note, that these apparatuses are mobile, and this means that a person can recreate its own environment not only in a specific context or place but anywhere and anytime. The mobility enabled by new technology is a huge advancement when it comes to giving the people the possibilities of self-creative exploration through immersion and interaction. The rupture with static art museums, galleries, and exhibition spaces that was once promoted by sound art, is now expanded by digital technologies.

One last important aspect to discuss is the possible interactive uses of sounds used traditionally in film: Dialogue, music and sound effects. There are new creative possibilities with the merging of fields like film and games. Mateas and Stern (2005) developed an interactive drama called Façade. In here, the story is driven by the moment-by-moment interaction of the player and the narrative evolves with dialogue enhanced with AI (artificial intelligence). The user inputs dialogue through a keyboard and, through AI, the story

evolves depending on what the player said. If voice recognition is added to this environment, then a richer interaction can be achieved. The reconstruction of meaning and emotional intention interacting with dialogues and music is an area that is still not strongly developed. This new medium opens possibilities of interaction with filmic elements, which could include sounds, voices, and music. Imagine an interactive film where the participant (in this case the word audience definitely loses validity) is able to change not only the dialogue but also the music that underscores a moment. It can give the person a total creative control about what could happen within a story. It is useful to think about traditional uses of sound to see how they, within interactive contexts, can change the content and open creative possibilities for the players.

2.5 Conclusion

To conclude this chapter is useful to summarize the two main elements that are translated from sound art to VR. These two are immersion (space) and interaction (agency).
When talking about immersion, sound arts explored the use of spatialization of sound through the use of multiple loudspeaker arrangements and reconfigurations of sonic emitters creating a merging of the participant with the piece of art. Sound art also incorporated interaction, giving participants a sense of agency when being involved with art pieces. In VR, spatial aural environments through 3D sound expanded, even more, the idea of immersion as well as the inclusion of interaction within, for example, video games. The possibilities of altering the sonic elements of a soundscape create a higher level of presence and therefore immersion within a virtual world. The following cases of VR will evidence how immersion and agency are present in them and how they relate to sound art.

Chapter 3

3.1 Introduction

Sound art projects have characteristics that can be overlapped and expanded in Virtual Reality. The following four cases contain spatial, and interactive characteristics that have been made in VR projects and with them we´ll see how sound art characteristics are also present, showing the connection between the two fields.

3.2 VR Projects

3.2.1 Ghostbusters The Void

The Void Ghostbusters is a "hyper-reality" project where players are immersed in a physical space, overlaid with digital content through virtual reality. The experience is an immersion expanded by a wireless system that allows players to move freely through a digital world. Throughout the game, the players are affected by sensorial stimuli through 3D sound, stereoscopic visuals, the use of a haptic vest, heat, air, and mist that follow the actions of the virtual world and creates a fully embodied experience for the users (Wired 2017). This project is very interesting because, similar to Camile Utterback´s *Vicissitudes*, the body and its movement becomes essential for the creation of the piece. The immersion is created by the inclusion of more senses besides vision and audition, and the movement of the whole body gives the user a high sense of agency and immersion. The player is not only able to move his head around the world but also to interact directly with physical objects that have a representation in the virtual world. Users can, for example, grab a fire lamp that is a real world artifact and in this way sense it through touch (see figure 13 and 14).

Fig. 13 The Void physical object (Source: Wired. YouTube. 2017)

Fig. 14 The Void virtual object. (Source: Wired. YouTube. 2017)

The reality of the virtual world is strongly enhanced by letting players feel the objects of the virtual world, as stated by Wired (2017). Similar to sound art projects, the player is now inside the piece of art, breaking the barrier separating the work and the audience, and it is interactive since the actions of the player are affecting the content created in the game. Curtis Hickman, co-founder of The Void, states that reality is perceived not only through our vision and that in this project, the creation of a new world is achieved by incorporating more senses to the experience, allowing to create a completely new reality but where "we not only make a regular reality, we make an impossible reality for you to play" (Wired 2017). This is very important if we go back to translocation ideas present in sound art projects like *City Links.* In that project, new sonic environments were created and moved from one place to another, and similar to The Void, a new sense of reality was established by creating new soundscapes. This experience offers also another very interesting aspect that relates to some of the reconceptualization promoted by sound art. As Small (1998) stated, the design of traditional concert auditoriums created a space where the interaction between members of the audiences was discouraged. Contemporary art broke this tradition, for example, with projects like *Drive in Music* or *Lines* (2016), a project created by Anders Lind in which a group of people is able to interact with sonic elements at the same time. Ghostbusters also allows an interactive social experience since three people can play the game at the same time. They are all immersed and acting together within the virtual world.

In general, the environments in these new virtual worlds are becoming more interactive and through this, the players are allowed to immerse themselves even more in the world than with previous technologies. The following project shows some more of these interactive sonic aspects in VR.

3.2.2 PlayStation VR Worlds

This project involves five different scenarios that the player can play.

1. The London Heist: this world set you inside a mafia in London that includes driving and shooting mechanics.

2. Ocean Descent: this game is beneath the sea and it lets you explore the underwater scenery from within a cage. It is a more experiential environment but still has interesting interactive sections.
3. Scavengers Odyssey: this VR world takes you on an extraterrestrial spaceship into a nebula hunting for an old artifact. It is a shooting game fighting aggressive aliens.
4. VR Luge: This game is based on illegal road racing. It is experienced as a person laying on a board and diving downhill while avoiding trucks, cars and many more types of dangerous obstacles.
5. Danger Ball: This is a game similar to Ping-Pong but within a 3D environment where you hit a ball against defined targets.

When it comes to interactivity and immersion it is interesting to see some specific characteristics within these games. The first remarkable characteristic is present in Ocean descent. Even though it is a game that is based more on observation than on heavy action made by the player, interaction and immersion were created by shifting mixing levels of sonic elements based on the point of view of the player and adding subtle sounds to the movements of the avatar. As Simon Gumbleton says in the PlayStation EU (2016) video, one of the essential ideas of VR is to "ground the player in that space". This means to create a feeling of presence within a virtual world. It is very interesting to see that besides the spatialization of sound with 3D sound, the sound designers decided to, first, add sound that was generated with every shift of perspective of the player, creating the sound of the movement of the head in the water, and, second, they created a dynamic aural environment where, after a couple of seconds of the player focusing, for example, in a distant turtle swimming, the level of the sounds of this animal start to raise while other environmental sounds go down (see Figure 15).

Fig. 15 Ocean Descent (Source: PlayStation [online]. 2016)

This means that interaction is based on the player´s head movement and on its perspective. The aural environment is not rigid not only because it is spatialized and the head tracking changes the perception of the sounds depending on the point of view of the player, but also because the focus of the player is taken into account and changes sound levels highlighting or hiding sonic elements: interaction not only gives a sense of agency to the player but it also enhances immersion by making the environment react to its decisions.

Another interesting trait of VR worlds is the use of the built-in microphone of the headset. As Jonas Andres Jensen states in PlayStation EU (2016), the players now are able to interact a lot more with the environment. In traditional games, he also states, the interaction with objects would be made through “fixed animations” while now the player manages in his own time the interaction with the objects. As an example, he describes a section where the player lights a cigar and through the microphone, the user is able to activate inhale and exhale actions of the avatar: the action is made “at your own speed”. Another example of the use of the microphone affecting the virtual world is in the menu where you can scream and this will affect floating rocks that are moving around a planet (see Figure 16). The use of another input sensor besides the hands and head helps the player to increase its possibilities of interacting with the world and creating the feeling that he/she is actually present in that environment.

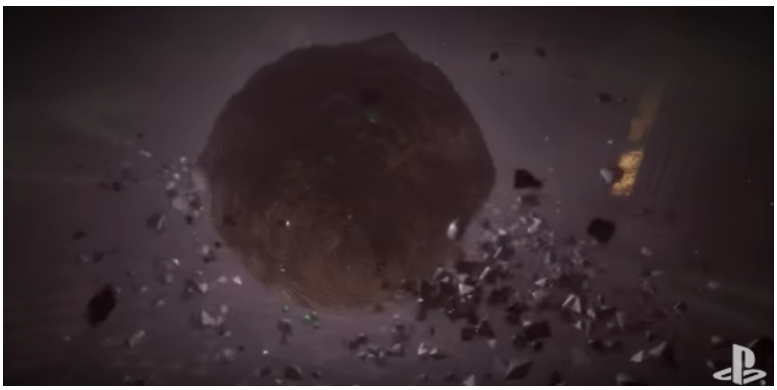

Fig. 16 PlayStation VR Worlds Menu (Source: PlayStation EU. YouTube. 2016)

3.2.3 Playthings: Musical VR Playground

This project was created by Always and Forever. It consists of a virtual world where hamburgers, hot dogs, gummy bears and many other food types are used as musical instruments. Through the headsets and the use of controllers, the players are able to create music by interacting with these objects (see Figure 17).

Fig. 17 Playthings Gameplay (Source: Always and Forever. YouTube. 2016)

It is interesting to see in this project two aspects in relation to sound art. On one hand the idea of enabling any person to be part of this world and affect it "whether or not you are a musician or a gamer" (Always and Forever 2016). This coincides with the ideas of rupture between artists and audiences present in sound art, by giving the power to the people for creating their own experiences. In sound art/experimental music projects, like *Play the Building*, non-musicians were able to make music with a building´s structure as an instrument. If we think about Playthings VR we can see these same elements. First, a non-musical object is transformed into a musical instrument (virtual food and building) and second, the possibility of artistic creation is given to anyone, no matter if they are artists or

not. VR and Sound Art share common concepts and they are evident in this case through interaction: giving people a sense of agency.

3.2.4 Gnomes and Goblins

This piece is still a project under development but it is interesting because it is a mixture of film and game: of interactivity and linear media. The general story is around two scenarios, one with gnomes and one with goblins, and the relationships created by the player with the beings of these two locations (see Figure 18).

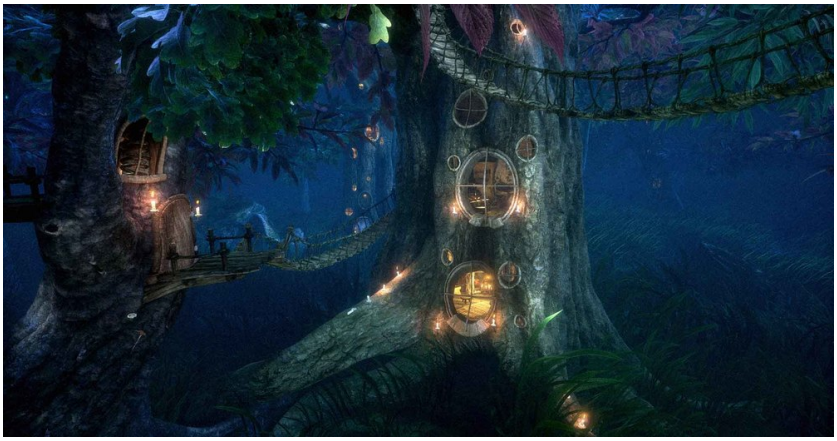

Fig. 18 Gnomes and Goblins (Source: Transport VR. 2016)

As reported by Murphy (2016), the creator Jon Favreau stated that the idea is to make a mix of film and games exploring the idea of immersion. What is interesting to explore here, for Favreau, is to find a balance between giving control to the player to affect the story and environment, and at the same time create a defined plot that guides the player´s focus: the role of the director still exists but with new rules. One of the most important aspects of this project is artificial intelligence (AI) since the relationship created with the gnomes is central to the story. In fact, the way a person decides to interact with the gnome affects how the story is developed. In this project, interaction is present not only by affecting the world´s environmental objects (grabbing fruits, opening doors, ringing bells) but through the interaction with characters. When describing the type of interaction with the goblin shown in the preview of the game, Favreau states, " it´s not a checklist of what you have to accomplish, but the way you approach him, how close you are" (Murphy 2016). If we think about sound art, the idea of co-creation promoted by previous artists is completely

applicable to this project. The director is setting a world where a player can move and act affecting the outcome of the story but still pushing him/she towards a specific goal. Here, the project is created both by a director that plots an open story and a player that moves and redefines this story depending on the actions and behaviors it has. Since it is still a project under development it will be interesting to see if dialogue enhanced with AI or even music interaction is included to immerse the players even more inside the story.

3.3 Conclusion

The VR projects exposed in this section show some of the latest creations made in VR. They evidence the degree of interactivity and immersion that has evolved since the beginnings of this technology. Interactive soundscapes and multisensory systems are pushing the boundaries to create more realistic alternative experiences that give the user a greater sense of agency and therefore immersion. It is through these cases where we see a new perspective on immersion. In previous examples of sound arts, it was stated that one thing was immersion, the feeling of being present in a given space, and another was the ability to change the content within this world, which referred to interaction. Here there is a connection between the two terms not only by coexistence within virtual reality but also by a reinforcement of one by of the other. Interaction in VR, through sonic elements, further enhances the feeling of being part of a new world. Spatial reconfigurations and interactivity, which were strongly developed by sound arts, are taken into new levels of elaboration in VR.

It is interesting to see how new creative developments will grow within VR. The medium could take elements from film and games to innovate. In film, for example, the idea of point of view is very interesting since it is used to show a certain perspective within a story. In this medium, for instance, the equalization and lowering of the level of environmental sounds is a technique often used to suggest an immersion within the mind of a character. This could be incorporated with interactive dramas to make shifts in characters and positions within stories. Since VR suggests almost immediately a first person perspective, the use of variations of sound could change this point of view to shift angles and create possible third person perspectives or changes into different characters. Expanding on the idea of point of view, if we take as an example the film *Being John Malkovich* (1999), we can

think of an immersion within a character where we hear and see everything he does, while still having our own consciousness. Sound in VR, as in film, could offer the chances to shift between internal self directed dialogues and external communications with the world. VR worlds could be enhanced by incorporating self-consciousness and exterior communication with clever uses of speech where, through sound changes with equalization and spatialization, the player can gain an even deeper sense of presence. The avatar within the virtual world is not only a physical being that can be controlled but also a conscious one: it can hear his internal mind voice.

VR could also incorporate ideas from video games to innovate. The idea of competition and reward based on points is a common element in many games. The idea of competition and reward could be used within VR experiences like interactive films where, besides having the freedom to act within a virtual world, and following a predefined story–driven experience, the users can engage in internal competitions depending on specific goals created within the story.

The creative possibilities of VR will continue to grow as the technology becomes more popular and available for everyone to use. On the hands of the creators of contents lies the responsibility of boosting the medium, by offering compelling and new interactive experiences. It is useful to see techniques used in other mediums to explore them within VR, as some of the previous examples showed.

Chapter 4

General Conclusion

This work has made evident a translation of concepts between sound art and VR, focusing especially on immersion and agency. Immersion was promoted in sound art through alterations of space, using sonic reconfigurations with loudspeakers that surround an audience and translocations of aural environments, among many other techniques. Enveloping acoustic creations were also developed within film with the use of surround systems like 5.1, 7.1 and Dolby Atmos and finally, more recent developments involving spatialized aural constructions, which take immersion one step further, are possible with

the use of 3D audio used in VR. The idea of merging the audience and the piece of art, which was promoted from the 60s inside contemporary art, is strongly expressed and heightened in VR with 3D audio but also with interaction. Sound art also encouraged the participation of people within pieces of art, breaking dichotomies between artists and audiences and establishing interactive, two-way communicative systems. Similarly, interactive mediums like video games and interactive dramas/movies in VR involve the participation of players that affect the content of the medium and promote a communicative loop feedback between the digital world and the input of the participants; a two-way communicative structure. Through interaction, a sense of agency is given to participants both in sonic art projects as well as in VR ones. Through this paper, it was created a translation of concepts from sound art to VR, and it was also explored how audio in interactive media is used. Besides this, it gave a general overview of the use of sound in traditional media to see how it could be used within this new digital medium.

Stephen O'Callaghan, head of Sound, Tools, and Technology in *PlayStation VR Worlds*, said "the main challenge for us in working with VR as a medium was that we were on uncharted territory; there was no how-to manual for audio" (PlayStation EU 2016). The field of VR, AR and MR is so new that there are no predefined guides of how audio should be used, and even top-level professionals are in exploratory stages. A lot of research has been done to achieve technical developments but now is time to use the technology in creative ways. Hopefully, this work contributes to promote new ways of thinking about audio taking motivations from previous brilliant sound artists who transcended traditional ideas and empowered transformations in creative works.

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