PERFORMING VIDEO GAMES: APPROACHING GAMES AS MUSICAL INSTRUMENTS

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PREFACE

One of the things that I realized during my studies is the necessity to define what Electronic and Time-Based Art is to people, who are not familiar with the subject. Thus, I will begin by trying to provide a definition of the subject. In fact, there are multiple words or terms that more or less define the same field of study. Steve Dixon lists electronic art, [1] digital art, [2] computer art[3] and new media art[4] as terms used for the same or similar type of works. At this point, I will not try to discuss which term should be used but rather I will try to explain the subject defined by these terms. For this thesis, I will use the term, new media, to describe the field.

A significant effort for defining new media comes from Lev Manovich. In *Language of New Media*, he defines certain principles to separate new media and old media even though he accepts that there are and will be exceptions. He proposes five principles that are introduced in an accumulated sense such that the last principle builds upon the previous principles. These principles are: 1) Numerical Representation, 2)

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[1] Steve Dixon, *Digital Performance: A History of New Media in Theater, Dance, Performance Art, and Installation* (Cambridge: MIT Press, 2007), 30.

[2] Ibid, 215.

[3] Ibid, 88.

[4] Ibid, 9.

Modularity, 3) Automation, 4) Variability and 5) Transcoding.[5] In short, new media can be formulated mathematically and is subject to algorithms and mathematical calculations. New media objects can be combined and/or assembled to construct novel new-media objects. New media objects can be automated, procedurally created. A new media object can exist in different forms, different versions and might have multiple faces coming from the same source. Lastly, new media can be translated into another format.

Following the path of Manovich's principles, here is how I relate to them:

- **Numerical Representation:** In addition to my artistic view, I can use my engineering background to create and modify information.
- **Modularity:** Modularity allows me to overcome the limitations of a single software or a single tool. It presents me the choice of procedural/step-by-step creation.
- **Automation:** My works include algorithms that interact with the audience or the input creating the final output.
- **Variability:** My works require audience input or interaction, which in the end shapes the experience creating a meaning that is different for each person.
- **Transcoding:** Transcoding allows me to link different events, actions and ideas through data mapping.

Building on these, it can be summarized that my works include programming, automated generation, interaction and architecture. In addition, I use navigation and

[5] Lev Manovich, *the Language of New Media* (Cambridge: MIT Press, 2002), 49.

virtual environments. Computers play an important role: I do not employ computers only in the creation process but the work itself exists with and within the computer. This means the computer is an active agent during the creation process and during the finalized (exhibition) form as opposed to having a final form that exists outside the computer (like print). In addition, the computer is not just a passive container (displaying digital data linearly) but actively participating in the experience/exhibition/performance.

My artistic practice and research are located at the intersection of gaming, interaction, sound, music and architecture. Video games are an integral part of new media: They incorporate Manovich's five principles and in addition to being fun, they provide opportunities for experimentation, education, narration, performance or shortly self-expression. Furthermore, the field of video games is driven by a young and growing commercial industry, and it is becoming a more common form of media; and as artists, I believe it is our responsibility to look at games from a more critical and creative angle.

Drawing on my interdisciplinary education and perspective, my projects often combine artistic strategies with engineering expertise. To me, the computer is an integral part of my practice, an active entity with a creative role. Conceptually, I try to reflect on my personal experiences and observations to create installations and works that pose critical questions. Through technological experimentation and knowledge, I push the boundaries of common technology usage and human perception in order to achieve poetic interaction, multi-sensorial aesthetics or novel narration methods. In

short, my works can be described as sound-based critical[6] experiences in a virtual world with unique interaction methods in the form of game-based installations.

Yet, in the end, I see sound as my main medium, which means if I had to simplify my projects to their basics, the output format would remain audio. Even though, we are living in a visual culture, where visual information and aesthetics are more valued;[7] I believe sound is underused and underappreciated and has much more potential for creative expression and critical design. Sound is processed and received differently by the brain with respect to vision. Thus, we cannot shutdown our ears in the way we close our eyes. We cannot really turn away from sound. The ear is connected to the brain in such a way that it uses both the processed and the unprocessed information. Sound can work on a very primal level affecting people's emotions or with the aid of icons, symbols and indices; it can be employed to discuss any complicated topic. Artistically, my goal is to employ sound and other media such as gaming in a way that is different from their widespread usage to create pieces that trigger critical thinking, in which the audience is encouraged to think about the topic that the work conceptualizes.

[6] Here, I use the word critical as defined by Dunne and Raby. The critical design FAQ can be found at http://www.dunneandraby.co.uk/content/bydandr/13/0.

[7] Nicholas Mirzoeff, *The Visual Culture Reader* (London: Routledge, 2002), 3-12.

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ABSTRACT

Mungan, Remzi Yagiz. M.F.A., Purdue University, August 2013. Performing Video Games: Approaching Games as Musical Instruments. Major Professor: Fabian Winkler.

In this thesis, I argue that approaching video games as musical instruments can create unique sonic experiences through the application of game engines and game ideas to musical performance, creation and instrumentation. I show that many artists' and musicians' experimentations in sound arts can be categorized as narration, timbre, generative systems, space and interaction. These elements can all be found in games and game-as-a-musical-instrument enhances music in these areas. This also increases the immersion and the possibility of flow of the performance as well as the accessibility of music creation, especially for a younger audience. On the other hand, games benefit from the more creative approaches of artists and musicians as they can create meaningful experiences using game technologies.

The number of games that feature sound and music as the most important element is very small compared to the overwhelming majority. In addition, the sound-focused games that do exist lack in certain areas when they are considered as "games-as-musical-instruments". Due to the lack of studies about the topic, a design model for creating games-as-musical-instruments is also proposed. The model is composed of

ideas from new media theory, systems theory and game sound. Such an interdisciplinary approach is necessary since games-as-musical-instruments are interdisciplinary objects.

Finally, I have developed *Causality* with these ideas in mind. The first iteration was deployed as an installation in East Patti and Rusty Rueff Gallery at Purdue University. The feedback from the installation has shown the possibilities as well as problems and potential pitfalls that can be improved and avoided. Even though the design model proved helpful, the most important challenge has been identified as the balance between the visual stimuli and the sonic stimuli.

CHAPTER 1. MOTIVATION

1.1 Motivation

The motivation for this study is to apply video game[8] technologies and ideas to sound and music[9] in order to create new genres of games, music and performances which will provoke discussion and new possibilities for creating meaningful works using games and sound. This is achieved through the power of game engines and applications of game ideas such as technological sonic capabilities including digital signal processing, synthesis and generative systems, interaction, narrative capabilities, immersion, flow and virtual space. These elements have been applied to sound practices individually. However, using a game approach makes all of them applicable at the same time. In addition, a quick search among the proceedings of The International Conference on New Interfaces for Musical Expression (NIME[10]) returns only nine[11] papers that look at games, thus this is an area that is not well researched within the emergent field of using technologies for musical expression and instrumentation. Such an instrument-game can

[8] From now on, the word "games" will be used for "video games".

[9] From now on, the word "sound" will be used for "sound and games".

[10] See http://www.nime.org for more information. NIME is the primary conference that focuses on the research in musical instruments and expression.

[11] The amount includes papers that only include partials of game/game engine.

be defined as a generative or non-generative system that is focused on musical creation and performance through gaming technologies and ideas.

Even though all games that have sound can be approached and even enjoyed as musical instruments, a game that is designed and developed to be a game-as-a-musical-instrument can create a *meaningful*[12] sonic experience. Such a game should be imagined as an instrument from the inception. Thus, this thesis offers approaches in designing such systems.

As an artist and gamer, I have observed that video games can be richer and more meaningful than the limited approaches of the game industry. Creating games capable of methods of novel expression is a way to improve that condition. Finally, with this work, I also criticize the importance of visuals in the mass media as well as in games. Thus, the test case, *Causality,* attempts to create a novel experience that utilizes hearing. Through this thesis, I aim to contribute to the fields of new media, games, sound and music as well as performance art and performing arts.

The performances of games are recorded and studied daily by professional gamers of various levels. As a part of eSports[13], many players watch game replays in order to improve. However, for this thesis, with the word performance one should think of performing arts, performance art and musical performance. Yet, for practical

[12] With meaningful, I mean culturally and/or socially significant.

[13] eSports is the field of playing games professionally

purposes, I will mostly refer to musical performance with the word performance: A musician playing an instrument with the audience listening and watching him/her.

Looking at the performance of games as performance art and especially sonic-based performance art has yet received much discussion and is mostly practiced through custom-made games by artists and designers experimenting with either sound or games. In *The Fantasy Role-Playing Game: A New Performing* Art, Daniel Mackay[14] also mentions computer games, but his approach is mainly based on tabletop gaming. Tacit Group[15], a group of artists from Korea, has been active in musical performances of games. Their approach includes hacking or redeveloping classical games like *Tetris* as an instrument that you perform by playing the game. Even though they create interesting audiovisual and game performances, the games that they use focus on gameplay and are devoid of narrative. I believe that by performing games we can create performances that employ imagery, sound and story that are controlled by the performer while taking advantage of the possibilities that are available through new media technologies. With these games or instruments, we can create novel tools for artistic expression and present gamers with a way to create and perform music. This will broaden the field of musical performance as well as providing new tools of expression for artists, composers and game developers to create meaningful artifacts.

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[14] Daniel Mackay, *The Fantasy Role-Playing Game: A New Performing Art*, (Jefferson: McFarland & Company, 2001), 1-10.

[15] Kyuhee Baik, "Turning Video Games into Live Music: Meet Tacit Group," *The Creators Project | Technology and the Brightest Young Minds in Music, Art, Film, and Design*, last modified November 20, 2012, http://thecreatorsproject.vice.com/blog/turning-video-games-into-live-music-meet-tacit-group.

One might argue that musical performances have long been audiovisual by providing examples such as Paganini and Liszt from the 19th century. In addition, projections and light shows have been part of concerts for some time. However, in most cases, the musician does not play the added visuals; instead they are synchronized to the music. Experimental or new audiovisual instruments attempt to combine both performances. Yet, they are not designed with the aim of storytelling.

Another problematic area in sound is storytelling. Sound is intrinsically abstract and does not carry any meaning. In order to communicate successfully with sound, humans have added cultural meanings to abstract sounds to create languages, icons and indexes (semiotics). With program music, composers such as Hector Berlioz and Franz Liszt in the 19th century tried to tell stories and ideas with instrumental music, which is a collection of abstract sounds. However, they had to provide programs, written descriptions of what the music is trying to express, in order to tell the story successfully. Opera has been combining narrative and storytelling with music while still keeping the product a dominantly sonic one. However, it is less of a personal and more of a group performance based on a predefined story. Even Wagner needed the actors and musicians to perform his music dramas in addition to the whole production crew. By employing games for music, the idea is to create a concept similar to opera, where sound can be the main medium in a multimedia work.

In the field of sonic arts[16], my interests lie in pushing the boundaries of aesthetic qualities of the sound, narration capabilities of abstract sound and using sound as the basis of multi-sensory experience. Music and musical instruments have been in a state of continuous evolution. This evolution has increased with the development of technology and globalization with conferences such as NIME. Video games represent one of the most dominant usages of advanced computational power and new media; I believe using game technologies for sound and music will provide interesting and meaningful results.

In most of mainstream multimedia, audio is of secondary nature. Games are primarily regarded as visual and technological interactive artifacts with narrative capabilities. Audio in games has been mostly overlooked in game studies[17] and the technology is the topic that is investigated mostly. However many topics such as relating between sound with the player, relating sound with narrative and sonic creation are left mostly unexplored by the researchers in game studies. Games with custom-created mechanics and interaction methods can be used to create unique sonic experiences and this study can provide insightful information about using sound and games together. My personal interest lies in the condition wherein the sound becomes the main element of the game. This thesis, however, excludes sound games, which are sound only computer/console games that are designed for the blind. The games that I investigate

[16] Here, I use the term for all the artistic and creative practices that uses sound as their dominant medium.

[17] Mark Grimshaw and Gareth Schott, "Situating Gaming as a Sonic Experience: The Acoustic Ecology of First-Person Shooters," *Situated Play, Proceedings of DiGRA 2007 Conference* (2007): 474, 10.1.1.190.1352.

are complete audiovisual games with sound as their seed and core of the idea, such that sound is affected directly by the actions of the player. The rules of the game are based on sound. The player's aim is to create a certain state of sound and the player is rewarded with sound. For this reason, I will look at games through sound starting with more mainstream designs and then move to more experimental ideas that feature sound in a more creative way.

CHAPTER 2. INTRODUCTION

2.1 Introduction

In this chapter, I will provide background information in order to approach video games as musical instruments. For that reason, I will start with looking at music from the early 20th century and progressing through various composers and artists who challenged the definition of music and sonic arts. These new musical practices will be tied to games with the way they incorporate technologies and ideas. Second, I will provide a concise introduction to games in order to familiarize the readers with the different game genres and encourage them to look beyond the more common genres. The aim of presenting these two landscapes is to show the capabilities and possible interactions between the fields of games and music. I claim that various approaches of the presented artists can be united to a degree[18].

2.2 Music and Sonic Arts

While this thesis does not try to cover the history of music, I believe it is necessary to mention the developments in music that have influenced this work and *Causality,* which is the first iteration of the implementation of ideas presented here.. This is necessary to understand the roots of *Causality* (discussed in detail in Chapter 5)

[18] It is to a degree because the presented works of art are the result of the ideas and creativity of the respective artists and in no way I am trying to reduce their artwork and practice to a tool.

since the practices of the artists and musicians discussed can be reflected to approaching games as musical objects and vice versa. In that sense, digital games can be seen as another technology to use for sound and music pieces.

Music before the 20th century has been predominantly tonal and mostly played with traditional instruments or instruments with traditional timbres. In 1908, Arnold Schoenberg abandoned tonal music completely and started composing in what would be called atonal music. Schoenberg believed that with the evolution of music, tonality was losing its importance. Thus, he thought it necessary to free the dissonance through 12-tone music. In 12-tone, the music would be composed by developing variations, the integration of harmony and melody and chromatic saturation.[19] This was a groundbreaking new idea in music.

However, there were also other developments, which were only possible due to emergent technologies and their effects on the society. Of course, classical Western music did not cease to exist. The definition of music expanded not only due to technology but also due to avant-garde artists and musicians such as Luigi Russolo, Erik Satie and Arnold Schoenberg and interactions with other styles of music such as jazz and blues, which were new at those times and presenting new music to the masses.

At this point, I will start talking about practices in sound, incorporating elements that can be related to games. These works can be put under the umbrella term sound art. Sound art is a term that is used loosely for defining works that wander away from

[19] Jay Peter Burkholder, Donald Jay Grout and Claude V. Palisca, *A History of Western Music* (New York City: W. W. Norton & Company, 2010), 810-23.

the regular boundaries of music. Before going into examples, I will look at different definitions in order to have a common understanding in what the term encompasses.

Christoph Cox introduces the term sound art as follows:

> Sound art is an uncertain category and practice. The label itself–in circulation since the mid-1980s but only widespread during the past decade–is dismissed by some prominent practitioners and used sloppily by critics and curators. Visual artists predominantly wonder whether sound art is not really just music, and many musicians either reject the arty whiff of the term or latch onto it in hopes of gaining art-world credibility. Those for whom the term describes a genuine category of artistic practice distinct from visual art and music tend to disagree about its contents and their provenance, about the very nature of the field and its history. Perhaps this tenuousness is due to the absence of a rigorous critical and historical assessment of sound installation, sound sculpture, and allied practices. Such an analysis has certainly not come from art-historical scholarship, which manifests a peculiar allergy to the sonic, unless it is attached to video or performance.[20]

Matthew Mullen, a scholar in art history, explains the term in these words:

> Sound art, as an independent term, is a young one; its origin by name dates to the 1980s, but was not fully realized in practice until the 1990s and not committed to the typical institutional exhibition strategy until the first years of the new millennium. Due in part to the confused curation of these millennial exhibitions and to the scattershot PR programming of progressive or "out" music publishers, sound art has become erroneously synonymous with mediocre contemporary experimental and electronic music forms.[21]

In *Sound Art: Beyond Music, Between Categories,* Alan Licht defines sound art with the following statements:

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[20] Christoph Cox, "About Time: Christoph Cox on Sound Art," *In Print,* (2007), accessed April 18, 2011, http://www.artforum.com/inprint/issue=200709&id=18807.

[21] Matthew Mullane, "The Aesthetic Ear: Sound Art, Jacques Ranciere and the Politics of Listening," *Journal of Aesthetics & Culture*, vol. 2 (2010), accessed March, 2011, http://www.aestheticsandculture.net/index.php/jac/article/view/4895/5625.

Sound art belongs in an exhibition situation rather than a performance situation.[22]

Sound art rarely attempts to create a portrait or capture the soul of a human being or express something about the interaction of human beings.[23]

Sound art, then, rejects music's potential to compete with other time–based and narrative–driven art forms and addresses a basic human craving for sound.[24]

Sound art, like its godfather experimental music, is indeed between categories, perhaps because its effect on the listener is between categories. It's not emotional nor is it necessarily intellectual. [25]

In *Noise/Music: A History*, Paul Hegarty defines sound art with the following words: "Something porous and very hard to describe but … it is too self–contained, and sets up the listener as self–contained."[26]

The beginning of the history of sound art can be marked with the invention of the phonograph in 1877 as Kahn suggests, which enables recording and playing back, thus converting sound from waves into a more permanent medium.[27] In addition to Kahn, the editors of *Audio Culture: Readings in Modern Music* start their chronology with the invention of the phonograph.[28]

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[22] Alan Licht, *Sound Art: Beyond Music, Between Categories* (New York: Rizzoli International Publications, 2007), 14.

[23] Ibid, 14.

[24] Ibid, 16.

[25] Ibid, 218.

[26] Paul Hegarty, *Noise/Music: A History* (New York: The Continuum International Publishing Group Inc., 2007), 170.

[27] Douglas Kahn, *Noise, Water, Meat* (Cambridge: The MIT Press, 1999), 5.

[28] Christoph Cox and Daniel Warner, *Audio Culture: Readings in Modern Music* (New York: The Continuum International Publishing Group Inc., 2006), 399.

The founder of the UbuWeb[29], Kenneth Goldsmith, starts the history from 1902 with the performance of Erik Satie[30], wherein Satie wanted the audience not to pay attention to the performance and failed. It is followed by the futurist movement in the 1910's. Goldsmith's next main stop is after World War II. The advancing technology inspired some artists such as Karlheinz Stockhausen and Pierre Schaeffer to create electronic instruments with new sounds. The history continued to the Fluxus movement around the 1960's with John Cage and such works as Indeterminacy. In the 1970's, process becomes a significant idea. For example, in Alvin Lucier's *I Am Sitting in a Room,* Lucier dictated, recorded, and re-recorded his actions. The 1980's presented people who used samples like *Plunderphonics*. Goldsmith concludes his history by saying that in sound art, no single style will ever dominate, but it will always change.[31]

At this point, I will now investigate works and artists by categorizing them with respect to their relation to approaching games. A more detailed description of the works can be found in Appendix A. The categories below do not represent an official or absolute classification and there will be places where overlapping might occur. Nevertheless, the categories have provided me with examples and insight in using individual elements from games. The categories are as follows:

- Narrative works

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[29] UbuWeb is a database of avant-garde works. It can be found at http://ubu.com/.

[30] Kenneth Goldsmith, "Flabby Preludes For a Dog: an Erik Satie Primer," k*enny g's home page,* last modified Fall 1997, http://www.wfmu.org/~kennyg/popular/articles/satie.html.

[31] Kenneth Goldsmith, "Bring Da Noise: A Brief Survey of Sound Art," *NewMusicBox: The Web Magazine from the American Music Center*, last modified March 1, 2004, http://www.newmusicbox.org/articles/Bring-Da-Noise-A-Brief-Survey-of-Sound-Art/.

- New sounds and timbre
- Algorithmic or generative systems
- Space-related works
- Interactive works

2.2.1 Narrative Works

In this section, I will investigate the works that use novel methods to add meaning and narrative to sound. The importance of these works is located in their power to convey a certain message and narrative using non-symbolic sounds dominantly. One of the problems with storytelling using sound is the abstractness of the sound. Due to that abstractness, it is hard to say something unless you are using semiotics. However, artists and musicians are able to propose a question or express a message using elements related to timbre, the process of creating sound and volume. Even though their works are often accompanied with an artist's statement, their practices can be applied to games to create stories driven by sound.

For example, in John Cage's *4'33"*, we are presented with a silent song wherein musicians have no notes to play.[32] The act of not making music gives rise to other sounds and, in the end, we are presented with a music composed of by the noises of the people. Another example is Christian Marclay's *Guitar Drag.*[33] Without knowing the process behind *Guitar Drag*, one can say that it is a recording of a person randomly

[32] Refer to Appendix A for details about 4'33".

[33] Refer to Appendix A for details about Guitar Drag.

hitting an electric guitar. However, by being aware of the actions that produce the sounds, the piece becomes meaningful.

It can be argued that these works employ a contextual understanding instead of semiotics to provide a narrative and without that context, the works lose their meanings. Here, it must be noted that the required context is directly related to the sound itself, since it is the process that creates the sound, not an external element. With a game that is played to create music, the context can always be established through the process in the game world. This sound creation process, which is established by the game mechanics, can be designed in any way to support the sound with a narrative. In one game-as-a-musical-instrument, the player may need to read a book to make a certain sound; yet in another, the player may need to shoot to make the same sound[34]. In these cases, the perceived meanings of the sounds will be different. Moreover, those meanings will also be different from the case, where the same sound is isolated from the process or the context.

2.2.2 New Sounds and Timbre

With the industrial revolution and improvements in technology, the soundscape of the populated environment changed. This also inspired musicians to search for new timbres that represented their time. Noise as art historically appeared with Luigi Russolo as a futurist ideology and now, it is a part of pop culture through simple distortion pedals. Noise art generally focuses on the liberation of sound from the tonal scale and

[34] It must be noted that in these hypothetical situations, the player's aim is to make sound. It is not to read or to shoot, they are the action required to create the sound in these hypothetical virtual worlds.

the timbre of classical western instruments, often associating itself with experimental music. The noise art movement provides an extreme example regarding the timbre of the instruments used for music. By doing so, it opens up possibilities for different types of sounds and provides artists, musicians, and composers with a broader vocabulary for creating music.

The relation between noise art and technology is obvious and is based on the industrial revolution. With *Intonarumori*, Russolo created a set of machines that were a precursor to today's digital synthesizers.[35] Similar to Russolo, Pierre Schaeffer was inspired by the noises of daily life and used recordings of daily life objects such as trains or machines to compose *musique concrète.* [36] Karlheinz Stockhausen aimed to control all the aspects of an instrument's sound when he created *Kontakte*.[37] In an excerpt from the unreleased Oxford Handbook of Interactive Audio, Damian Kastbauer extrapolates the state of digital audio synthesis based on the current research in the field. In Kastbauer's article, the present soundscapes of the world are generated within a computer simulation in the future. Looking at current research, he argues that it will be possible to synthesize realistic sounds for the most complex events in real time.[38] Even though sound synthesis is not that advanced today, games still offer the infinite world of software synthesizers, where each parameter can be controlled within the game.

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[35] Refer to Appendix A for details about Intonarumori.

[36] Refer to Appendix A for details about musique concrète.

[37] Refer to Appendix A for details about Kontakte.

[38] Damian Kastbauer, "Our Interactive Audio Future: Modeling the Future of Game Audio," *Game Developer Magazine* 20, no. 6 (2013): 50-53.

2.2.3 Algorithmic or Generative Systems

The computer is not only a playback device; it can also create music using algorithms, rules and artificial intelligence. These systems not only allow for experimentation in composition but also allow the mapping of various types of inputs to music. *Illiac Suite,* by Lejaren Hiller and Leonard Isaacson, was the first algorithmic composition to employ computers. [39] Before that, musicians used analog methods as a decision-making process for algorithmic compositions. [40] Mozart used dice and John Cage used chess play to define the parameters for the composition. Iannis Xenakis is one of the pioneers of computer music, who experimented with different ideas such as stochastic systems and translational systems. [41] Brian Eno created multiple mobile applications that create evolving never-ending music[42].

Games not only inherently bring the computational power for algorithmic composition but they are also already applying the same idea in many different ways. First, games can be thought as generative systems since they are interactive, non-linear and each walk-through of a game is unique. Moreover, some games employ algorithmic generation processes in addition to non-linear mixing to create levels, visuals, characters, stories and music. Musicians can take advantage of games to create generative music systems that also create virtual spaces, stories and interaction methods algorithmically.

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[39] John Maurer, "A Brief History of Algorithmic Composition," *CCRMA alumnus John Maurer,* last modified March, 1997, https://ccrma.stanford.edu/~blackrse/algorithm.html.

[40] Ibid.

[41] Ibid.

[42] The applications can be found at http://www.generativemusic.com/.

2.2.4 Space-Related Works

In this section, I discuss works that map sound to a space that is different from the traditional understanding of a performance space. In these instances, location is an important element as it affects the perceived meaning of the sound. The simple idea of acoustic ecology is that all the sounds that we hear around us and in fact, the universe itself is music composed by the factors that act upon the environment.

R. Murray Schafer introduced the term acoustic ecology; his studies of sound environments show that everything has a special place in the frequency spectrum.[43] Schafer recorded various soundscapes to preserve them. With *music concrète,* Schaeffer not only introduced daily sounds to music but also introduced the transportation of one space to another through sound. Similarly, Teri Rueb explored the idea of drifting through GPS-based interactive sounds.[44] The common theme here is the idea of experiencing sound within the context of a space that is navigable physically, virtually or sonically.

Games also exist in a space: the levels or the virtual environments make up the space of a game. These spaces are tailored by the designers and can be used to create space-related sound works in the way desired without the limits of physical laws[45]. For example, Schafer's acoustic ecologies can be simulated in games with virtual animals to

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[43] Kendall Wrightson, "An Introduction to Acoustic Ecology," *Soundscape: The Journal of Acoustic Ecology* 1, vol. 1 (2000): 10-13.

[44] Refer to Appendix A for more information about Teri Rueb's work.

[45] However, the technology is still a limit.

understand the dynamics between living things that share the same acoustic environment. This also helps people experience the environment in different ways.

2.2.5 Interactive Works

As we have seen, artists and musicians have always taken advantage of technological improvements in order to create new works. Another set of alternative artistic practices can be labeled as interactive sound or music installations. These systems are designed to react to various types of inputs and they shape these inputs to create a sonic output.

With *Very Nervous System,* David Rokeby created an interactive sound installation that is played through body movements as the system watches the performer.[46] The translation from body movements to sound creates new dynamics and modes of expression for the artist. Through the dynamics between the instrument and the player, Rokeby experimented with the interaction and performance. For *Very Nervous System*, Rokeby developed a complex system that includes cameras, computers and synthesizers. Today's gaming technologies offer such a system as a package. The mainstream game interfaces start from the keyboard and the mouse but do not end there. They also include gestural, motion-based, touch-based, sound-based controls and virtual-reality headsets. These interfaces can be used to create novel translations from action to sound to achieve new styles and aesthetics of music. With the developments in technology, all these interfaces are now widely available for artists and musicians to use.

[46] Refer to Appendix A for details about Very Nervous System.

2.3 Introduction to Games

At this point, I will talk about games in order to introduce different types of games that can be seen as interactive musical objects. The background information will include definitions from different sources and the significance of games in today's culture.

2.3.1 Definition of Video Games

Before discussing video games, it is necessary to provide definitions to select or develop one that will be used throughout the thesis. This is important in understanding the capabilities of games as a medium. Jesse Schell, in *The Art of Game Design: A Book of Lenses*, describes games[47] as "a problem solving activity, approached with a playful attitude".[48] Grant Tavinor studies the definitions of video games and introduces his definition as follows: "X is a videogame if it is an artifact in a visual digital medium, is intended as an object of entertainment, and is intended to provide such entertainment through the employment of one or both of the following modes of engagement: rule and objective gameplay or interactive fiction." [49] In *Video Game Explosion: A History from PONG to Playstation and Beyond*, Mark Wolf approaches the definition of game through screen technology and in the end avoids a description in order to include all the

[47] The definition is not limited to digital or computer games.

[48] Jesse Schell, *The Art of Game Design: A Book of Lenses* (Burlington: Morgan Kaufmann Publishers, 2008), 37.

[49] Grant Tavinor, *The Art of Videogames* (Malden: Wiley-Blackwell, 2009), 26.

possible types.[50] Another detailed discussion exists in *Videogames and Art*, the writers approach games from the point of fine art and look at the borders of interactive art, art game and mainstream games. Even though, they do not offer a formal definition, the discussion revolves around using games as a medium.[51] This is similar to how I define games; my approach is also based on the medium and independent of the content and the aim. This definition, even though it cannot cover all the exceptions, is aimed at avoiding limitations of stricter definitions and it embracing the creative potential of all games and genres of games[52] that are created by different parties for different aims. Here is how I define games:

Digital video games are a creative, interactive and audiovisual medium that–by employing ideas of play–is used in, but is not limited to, entertainment, art, storytelling, education, experimentation, creation and well-being.

2.3.2 Brief History of Video Games

I believe it is relevant to talk about the history of video games because their evolution is dominantly determined by technological capabilities. The same technological changes will also determine the musical capabilities of games.

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[50] Mark Wolf, *Video Game Explosion: A History from PONG to Playstation and Beyond* (Westport: Greenwood Press, 2008), 3-7.

[51] Andy Clarke and Grethe Mitchell, "Introduction," in *Videogames and Art,* ed. Andy Clarke and Grethe Mitchell (Chicago: University of Chicago Press, 2007), 7-22.

[52] For those, who are not familiar with games other than the mainstream games, a quick look at different types of games can be found in Appendix B.

The video game world is a relatively young world. The first examples are Willy Higinbotham's[53] oscilloscope-based table-tennis like game in 1958, Steve Russell's[54] *Spacewar* in 1961 and Al Alcorn's[55] *Pong*. [56] The first videogames needed specific hardware to operate and were works of pure engineering compared to today's interdisciplinary teams. There were strict limitations on what could be done due to the hardware. Their ancestors, housed in huge arcade machines, were coin-operated electro mechanical games. In 1976, Fairchild Camera & Instruments released *Channel F*, the first programmable home game that used cartridges.[57] In 1979, *Microvision* was released as the first handheld programmable game platform.[58] Moreover, during the 1980's, the ancestors of modern computers, handheld devices and consoles were created. With time technological limitations such as display screens, memory size and computational power were improved and by 1993, *Doom* was released and the US Senate held hearings on video game violence.[59] Today, video games are everywhere in handheld devices, phones and web browsers. They are designed by engineers, artists and writers

[53] Willy Higinbotham is a physicist in Brookhaven National Laboratories in New York.

[54] Steve Russell is a student studying computer science at MIT.

[55] Al Alcorn is an engineer working for Atari.

[56] Steven L. Kent, *The Ultimate History Of Video Games: From Pong To Pokemon And Beyond…The Story Behind The Craze That Touched Our Lives And Changed The World*, (Roseville: RandomHouse, 2001), 18.

[57] Ibid, xii.

[58] Ibid xiii.

[59] Ibid xv.

and are used for fun, art, entertainment, training and education. I will further discuss the current landscape of games, but now I will provide a glimpse about the position of games in the society.

2.3.3 Significance of Video Games

Earlier games resided in dedicated hardware; thus, they could not be distributed as easily. Today games can be bought and downloaded from the comfort of one's home through services like Steam[60], GameFly[61], Xbox Games Store[62], PlayStation Store[63] and various application markets for mobile devices. A study from 2003 shows that in the U.S. a 21-year-old person invested in total an average of 10.000 hours in video games[64] and any basic internet search will show the immense size of the industry, which is still growing. For example, during 2009, 1099 games were released for only PS3, XBOX 360, and Wii platforms. It must be noted that this number did not include games released for computers, web, phones and tablet. [65] The worth of the game market was measured to

[60] Steam can be accessed at http://www steampowered.com.

[61] GameFly can be accessed at http://www.gamefly.com/download-games/.

[62] Xbox Marketplace can be accessed at http://marketplace.xbox.com/.

[63] PlayStation Store can be accessed at http://us.playstation.com/psn/playstation-store/.

[64] Marc Prensky, "Digital Game-Based Learning," *ACM Computers in Entertainment* 1, vol. 1 (2*003*): 2.

[65] Leigh Alexander, "Gamasutra – News - Report: 1,099 Games Released In 2009, Up Slightly From 2008," *Gamasutra – The Art and Business of Making Games* ,last modified December 24, 2009, http:// www.gamasutra.com/view/news/26635/Report_1099_Games_Released_In_2009_Up_Slightly_From_2008.php.

be around $80 billion in 2012.[66] *Grand Theft Auto IV* had a first week sale of $500 million.[67] Even though, these numbers are not the focus of this work, it certainly shows that videogames are a part of today's culture. Many people show interest and use the medium either as a creator or as a consumer.

Games have already become a part of education and social studies. Serious games are being developed with the sole functionality of teaching, while regular videogames are used as a material and method for teaching. Games are used for understanding human psychology and rehabilitation. Artists use the technology to create a wide range of works from public performances with political implications to experiments with visuals. I argue games can also be used to create sound and sound-based performances and it will allow sound creation practices to reach the masses that play games.

2.4 Conclusions

Today's games are much more complicated than their earlier counterparts are; moreover, they are widely accessible and are one of the most dominant forms of media especially among young people. Games as a medium are capable of many things not limited to entertainment and they can employ unique interaction methods to support the act of play or the main theme. They have the potential to be used for sound that still takes advantage of the technologies and the ideas of games.

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[66] "Video games: Battle of Boxes," *The Economist*, last modified May 25 2013, http://www.economist.com/news/business/21578427-microsofts-newest-games-console-has-entire-living-room-its-sights-battle-boxes.

[67] Tavinor, *the Art of Videogames*, 7.

On the other hand, artists have experimented with sound to widen the expressive nature of the medium. As the examples in Section 2.2 have shown, each work, even though primarily a work of sound, also includes different aspects such as performance, programming, experimentation, space, interaction or narration and expands the idea of traditional sound and musical pieces. Games as a medium inherently include the elements that artists and musicians experimented with and combine them into a single package. That is why I believe it makes sense to use gaming technologies and ideas for sound and music to create an evolutionary path[68] of the practices above. With this in mind, the earlier works provide valuable insight for venturing into new areas. This also expands the definition of games and helps trigger new ideas to create games that are more meaningful as well as media objects that employ *sound* (as opposed to visuals) dominantly.

[68] This does not mean that game sound replaces traditional music or traditional music is obsolete.

CHAPTER 3. USING GAMES FOR SOUND

3.1 Introduction

In the previous chapter, I proposed that using game engines and gaming ideas will improve the expressive capabilities of sound because games already contain the elements that artists have integrated with sound. In this section, I will isolate these elements and discuss the ways they can enhance sound art. I will also compare them with traditional musical instruments when possible.

The elements I already discussed were identified as narrative capabilities, variety in timbres, algorithmic and generative processes, space-related ideas and interactivity. Here, I will approach the elements from the perspective of gaming. Thus, I will reorganize these items and add two more: technical sonic capabilities, interaction, narrative, immersion, flow and virtual spaces. Here technological sonic capabilities reflect the possibilities in sound provided by technologies and include variety in timbres, algorithmic composition and generative processes. In games, those two are connected because they are directly affected by the capabilities of the sound engine. Immersion and flow are added since they play a crucial role in media performance, consumption

and creation. Immersion directly affects the perception of the media, while flow directly affects the performer in both games and sound affects the performer in both games and sound[69].

3.2 Technological Sonic Capabilities

In Section 4.3, I will introduce games where sound is an important part of the design. In this section, I will focus on the technical capabilities of game engines[70] in the field of sound by giving examples of games that use sound uniquely from a technical perspective. I argue that by employing a game engine for creating a musical instrument, one can benefit from a number of technical capabilities.

Game engines are not only capable of playing back recorded sound; they can also generate it. The common usage of sound engines in today's games can be explained as follows: listening to the variables in the game in order to cue the correct music part in the correct beat since video games are a non-linear medium and the composed music and sound need to respond to all the possible changes in real time. Let us think, for example, about a generic scene that represents the above-mentioned situation:

> The hero is exploring the environment. There are no enemies around and 'peaceful' music is playing with ambient sound effects. Once the enemies appear, combat music kicks in; however, the passage from the 'peaceful' music to 'combat' music needs to be seamless. The simplest action would be crossfading the prerecorded music pieces. However, now games can afford to do more due to increased memory and processing power: the game detects the beat of the 'peaceful' music and plays 'peaceful-to-combat transition' music and then plays

[69] The performer and the observer can be the same person. At least the performer is also observes during the act of play, while there can be a dedicated observer.

[70] Part of the game engine that deals with audio is called audio engine. However, I will continue my approach and look at the whole game engine.

the 'combat' music in the correct beat. While this transformation takes place, we also hear the ambient sound effects getting a lower mix with the combat sounds being mixed up.

The above example is the basic usage of sound in most popular games today. In a recent talk about *Assassin's Creed III*[71] during Game Developers Conference 2013, the same scenario was presented. [72] Even though the mainstream usage might present audio engines as glorified playback engines that are aware of what is going on and can respond to that through improved mixing and cuing capabilities, there are also games that employ the technologies in ways that are more creative. Here are some examples that fully display the sonic capabilities of game engines:

Rocksmith[73] is a guitar playing game. The player can connect a real electric guitar or bass guitar and play the game while practicing. The game's main aim is to provide a practicing environment with virtual copies of musical equipment, synced notation and visuals. The translation from the game controller, which is the guitar, to what it does in the game is one-to-one and does not add or remove anything other than translating it to digital. In the end, *Rocksmith* mimics reality and provides an educational experience with added visuals.

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[71] Ubisoft Montreal, *Assassin's Creed III* (Montreuil: Ubisoft, 2012).

[72] Jerome Angelot and Benedicte Ouimet, "*Assassin's Creed III Music Score: Redefining Musical Standards for the AC Brand*" (presentation, Game Developers Conference, San Francisco, CA, March 25-29, 2013).

[73] Ubisoft San Francisco, *Rocksmith* (Montreuil: Ubisoft, 2011).

Fract OSC[74] is defined as a "first-person puzzle adventure game inspired by electronic music".[75] The game has not been released but the earlier demos and prototypes have won various awards. The game world can be defined as a synthesizer and the player repairs and activates these synthesizers to create their music. Technically, the game uses *Pure Data* as the sound engine, and this allows *Fract* to synthesize sounds on the fly as well as inheriting all of *Pure Data's* capabilities.

The latest *SSX*[76] game features some interesting musical ideas and capabilities. *SSX* can be described as a skateboarding game wherein the gameplay shapes the game music. This still follows the standard idea of gameplay event triggering sonic action; however, the sound responses are not short audio clips. Instead–depending on the action–the game applies various sound effects to the music playing. Even though the game does not allow music creation from scratch, the developed sound engine (RUMR) turns the game into a mixing table that is controlled by playing the game. In addition, the game also allows the users to put their own songs into the games, making it a more versatile tool. Still, it should not be forgotten that the game is primarily about skateboarding.

In the end, games residing in a computer technically have access to all the computational power that the computer has. As described in the preface, new media works are modular, and as software, they can be enhanced with additional parts and

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[74] Phosfiend Systems Inc., *Fract OSC* (2013).

[75] Phosfiend Systems Inc., "FRACT | An Indie Adventure Game by Phosfiend Systems," *FRACT | An Indie Adventure Game by Phosfiend Systems,* last modified 2013, http://fractgame.com/.

[76] EA Canada, *SSX* (Redwood City: EA Sports, 2012).

functionality. The available computational power can be used to enhance any element of music in a dynamic way in order to create unique sonic experiences:

- Dynamic sound synthesis
- Dynamic algorithmic composition
- Real time digital signal processing
- Dynamic Difficulty Adjustment
- Procedural generation
- Multiplayer
- Integration with social media

The main problem that limits the capabilities of audio engines–compared to a standalone virtual instrument–is that sound is not the only product that a game engine creates. In addition to the sound, a game engine is responsible for the interface, numerous calculation and graphics or in short, the rest of the game. However, this is a purely technological limit, and it is changing with advancements in software technology, hardware technology and cloud computing.

3.3 Interaction

The interaction methods in traditional musical instruments can be defined as follows based on their categorization of strings, percussion and wind: bowing strings, plucking strings, hitting with various items, breath and pushing keys. These interaction methods have successfully supported musicians in expressing themselves in many different styles. However, it is also helpful to investigate new interfaces that will allow new expression methods. NIME, as introduced in Chapter 1, is aimed at furthering this study. NIME proceedings feature many instruments that take advantage of the new control schemes made available by new technologies including game interfaces. Within

a game engine, all of these digital or computer-based interfaces are embedded with audio, visual and programming capabilities as a system.

On the other hand, game-based control schemes are a part of our society. In our daily lives, we use multiple digital devices that are also used for controlling games. Thus, through game interfaces, musical creation can tap into a community who is already familiar with game interfaces. Finally, there are many ways to design the interface for a game-as-a-musical-instrument. The actual interaction method can add new meanings to the performance through meaningful translation of action to sound.

3.4 Narrative

As mentioned before narrative is an inherent problem with instrumental music and abstract sound. For *Symphonie Fantastique*, Berlioz printed a description of the stories told by the music. The 1845 version starts as follows:

> The composer's intention has been to develop various episodes in the life of an artist, in so far as they lend themselves to musical treatment. As the work cannot rely on the assistance of speech, the plan of the instrumental drama needs to be set out in advance. The following programme* must therefore be considered as the spoken text of an opera, which serves to introduce musical movements and to motivate their character and expression.
>
> *This programme should be distributed to the audience at concerts where this symphony is included, as it is indispensable for a complete understanding of the dramatic plan of the work. [HB] [77]

Here opera is presented as the reference for music with narration, and the narrative in opera is driven by voice. However, opera also draws its narrative power

[77] Michel Austin, "Berlioz Symphonie Fantastique," *The Hector Berlioz Website - Devoted to Berlioz's life and works,* last modified 2013, http://www.hberlioz.com/Scores/fantas.htm.

from being a 'multimedia' medium. In that perspective, games[78] as an integration of multiple media offer more capabilities. There are multiple ways to implement narrative in games. For this thesis, I am interested in narratives driven by sound in games. Here remembering the game perspective is important since games are different from other audiovisual media such as film. Sound in games is not only something that is listened to but also that is created. That is why the method of interaction and the creation process is part of the sound, granted that the game allows sound creation or is designed for sound creation.

An interesting example is *Bastion*[79]; a game that brings a refreshing twist to the idea of voice-over narration. Even though the aesthetics, the production, or the content of the voice-over is nothing new, the way it is presented is interesting as the voice-over–a linear storytelling tool–responds to what the player does dynamically and in a seamless way. In the end, this creates the feeling of a unique linear story rather than an interactive one.

3.5 Immersion

One aim of games is to provide immersion[80] and to put the player into a *flow*[81]. Immersion is the state when one is engulfed by the virtual reality, game, book, movie or

[78] Here, it is critical to use the whole game engine not just the sound engine.

[79] Supergiant Games, *Bastion* (Burbank: Warner Bros. Interactive Entertainment, 2011).

[80] Laura Ermi and Frans Mäyrä, "Fundamental Components of the Gameplay: Analyzing Immersion," *Proceedings of DiGRA 2005 Conference: Changing Views – Worlds in Play,* (2005), accessed January 15, 2013, http://www.digra.org/dl/db/06276.41516.pdf.

[81] Flow is a term that will be explained in detail in the next section.

music among others. When immersed, a person feels like they exist spatially in the created environment[82]. I argue that games-as-musical-instruments can offer more immersive experiences than more traditional experiences, which will provide new methods of expression using sound. In their well-known paper, Laura Ermi and Frans Mäyrä propose a gameplay experience model based on three types of immersion.[83] The model is named the SCI-model:

- Sensory Immersion: Sensory immersion is mainly defined by the audiovisual component of the games. Larger screens and surround sound systems make the experience more immersive. Elements of game working in synchronization with each other such as the relation between a player's input and the game's reaction as action, sound and vision add to immersion.
- Challenge-based Immersion: This type of immersion is felt most when there is a satisfying balance with the skills of the player and the challenge of the game. Games provide an option to adjust the difficulty setting; in addition, there are games that have dedicated artificial intelligence systems that work to provide the optimum difficulty for the player's skill set.
- Imaginative Immersion: Stories and characters of the virtual world trigger imaginative immersion as the player thinks about the game realm. This directly resonates with a game's narrative capabilities.

Even though the SCI-model is applicable to traditional music, it is limited. Here is the SCI-model from the perspective of a regular musical performance.

- Sensory Immersion: Sensory immersion in a musical performance has two sides. From the audience point of view, the performance is an audiovisual one, as there is at least the musician playing the instrument as the visual stimuli. However, for the musician, it is mostly a sonic experience. Even though the musician can

[82] Bartholomäus Wissmath, David Weibel, Rudolf Groner, "Dubbing or Subtitling? Effects on Spatial Presence, Transportation, Flow, and Enjoyment," *Journal of Media Psychology* 21, (2009): 114-125.

[83] Ermi and Mäyrä, *Fundamental Components of the Gameplay*., 1-14.

observe the visual extras while performing, they will pay less attention to them since the visuals are external and are not a part of the feedback cycle between the music and the performer.

- Challenge-based Immersion: Each musical piece requires a different skill level and one can choose what to play or listen to depending on their skills. However, a written musical piece lacks the adaptability of a game where the difficulty can change depending on the performance.
- Imaginative Immersion: A musical piece can have a background, lyrics or a program, however, the amount of information or lore they can convey is much less, compared to a video game. In addition, except for lyrics, the narrative is not an integrated part of the music but an external one.

This comparison shows that games can provide more immersive experiences and, by using games appropriately, one creates novel sonic experiences that can go beyond the offerings of more traditional instruments.

3.6 Flow

Mihály Csíkszentmihályi defines flow as the psychological condition in which a person is totally immersed in an activity she is doing, resulting in a much better performance of the activity. In a state of flow, a person has a heightened sense and understanding of the action; she can perform, create and learn better and she will be in a positive and joyful emotional space.[84] This state is achieved when the perceived skills of the person match the challenges of the action.[85] Figure 1, seen below, summarizes the state of flow:

[84] Mihály Csíkszentmihályi, *Flow: The Psychology of Optimal Experience* (New York: Harper Perennial Modern Classics, 2008).

[85] Ermi and Mäyrä, *Fundamental Components of the Gameplay.*, 1-14.

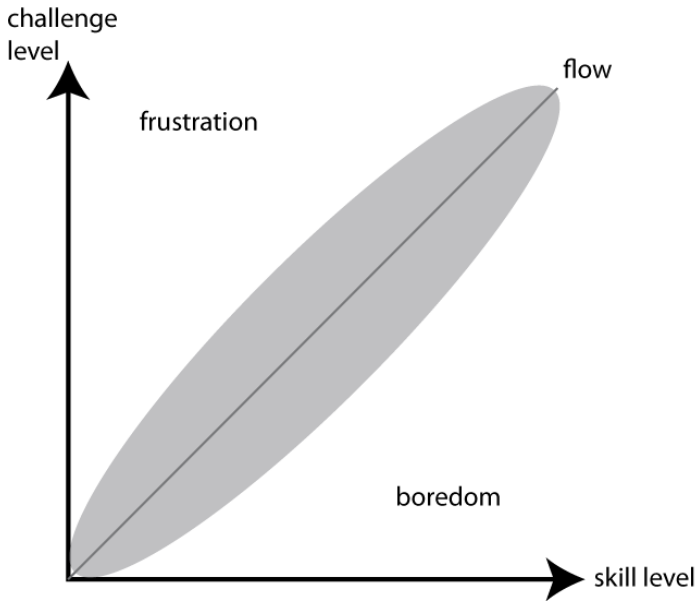

Figure 1: Flow diagram showing the relationship between challenge and skill levels

Jenova Chen offers an interpretation of the elements that need to exist in a game to evoke flow:[86]

- The game needs to be rewarding in order to increase player's desire to play the game
- The game needs to offer a challenge level matched to the player's ability in order to further player's attention and interest toward the game
- The player needs to have control over the game activity

Csíkszentmihályi argues that listening to music can help increase the chance of experiencing flow as it tidies up the mind. However, experiencing flow only through music is not an easy task, as it requires heightened levels of listening where one analyzes the sounds while enjoying them.[87] With that said, it is easier to get into *flow*

[86] Jenova Chen, "Flow in Games (and Everything Else)," *Communications of the ACM Magazine*, April 2007, 31-33.

[87] Csíkszentmihályi, *Flow*.

through a game. Thus using a game-as-a-musical-instrument will help the performer perform better in a more creative and involved way. Even though in the above cases that Chen offers, music might not be a focal point; those cases and relations can still be established through sound-dominant feedback between the game and the player. In addition, the act of creation will be an important part of the reward.

3.7 Virtual Space

Games employ virtual worlds in which the games take place. These worlds are handcrafted custom worlds and designed to serve and support the game. The design of spaces in games is called level design. Even though depending on the game the main aims of level design can change, generally they are leading the player, supporting the narrative and shaping the emotional value thus adding to the immersion and flow of the game.

In the case of game-as-a-musical-instrument, virtual spaces can open the door for new expression ideas. The virtual space becomes a musical tool that adds to the spatiality and narrative in a unique way similar to what Terry Rueb does. In addition, it also allows ideas of acoustic ecology and soundscape become controllable or designed elements of a musical performance.

From another perspective, in most games the experience and the production occur in the virtual space. The virtual space is limited by computational power and can be far larger than the physical space it contains and it can act much different from what

physics suggest. This simply helps games achieve their goals; in the same sense, it also enhances sound by literally expanding the production space[88] of a performance.

Looking at virtual spaces from the perspective of music and sound, the performance space takes an interesting turn. In physical reality, sound is shaped by the space; however, in virtual spaces, this is optional and the way that space shapes sound can be in any way.[89] This allows us to create conflicting information for the eye and the ear. For example, we can see the violinist playing the instrument on the left but can hear the sound coming from behind. This easily allows us to create two different spaces that are superimposed onto each other and to expand the space or create new musical venues that were not possible before. However, it must be noted that inconsistent conflicting information can result in frustration.[90]

On the other hand, Lefebvre defines three types of spaces: mental, physical and social. [91] The natural or the physical space is what exists inherently. The mental space is formed of logical abstractions. The social space is a social product that belongs to a society and/or to a mode of production. From the perspective of games, the three types take different meanings. The "physical" space of games is the virtual world. The mental

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[88] The term, production space, needs to be understood from Henri Lefebvre's point of view.

[89] Barry Blesser and Linda-Ruth Salter, *Spaces Speak, Are You Listening?: Experiencing Aural Architecture* (Cambridge: The MIT Press, 2007), 164-214.

[90] Florian Schmidt, "Use Your Illusion: Immersion in Parallel Worlds," in *Space, Time, Play: Computer Games in Architecture and Urbanism: The Next Level,* ed. Friedrich von Borries, Steffan P. Walz and Matthias Bottger (Basel: Birkhäuser Verlag AG, 2007), 146.

[91] Henri Lefebvre, *the Production of Space* (Cambridge: Basil Blackwell, 1991), 1-67.

space of a game is the perception of the virtual world in the physical world. These two combine and make the social space of games, which is by design limited to the virtual world or physical world within the context of the game. Games aim to create a production space that is defined by the events and interactions going on in the game. This supports immersion and escapism by providing a standalone space that a person can exist without being bothered by the events happening outside the game world.[92] However, these two spaces need not to be separate. With virtual spaces, games not only simply present spatial possibilities but they also provide new ideas and meanings through the expansion of the physical space with the virtual space.

3.8 Conclusions

In this chapter, I investigated the individual elements benefiting sound in games. Even though technology is the main driving factor behind the possibilities, ideas that are present in non-digital games such as playing, rewarding and active participation also play a part in the enhancement. In addition, all these elements provide possibilities for higher immersion in the media and an easier access to the state of flow.

[92] This can be both physical and/or virtual.

CHAPTER 4. GAMES AS-MUSICAL-INSTRUMENTS

4.1 Introduction

In the two previous chapters, I presented the experimentation and research going on in sound art as well as the current state and significance of games. I have concluded that their combining the elements of each can benefit both sides. This does not mean that sound does not exist in games; of course, games feature sound. However, in most cases, the relationship between sound and game is not designed for creating a game-as-a-musical-instrument as described in the motivation part of the thesis. Yet it is still beneficial to investigate the current relationship between sound and games as it provides a starting point for future works and studies by providing understanding about the evolution of game sound. Thus, I will start this chapter with a brief history of game audio in order to show the current practice that brings sound and games together. In addition, I will investigate games that have a sound-focused approach. These games will be analyzed within the light of this work in order to understand the current approaches in sound games, their successes and their shortcomings.

After this, I will propose a model for designing games-as-musical-instruments. This model is based on three ideas: Gesamtkunstwerk, the composition-instrument model and the acoustic ecology of first person shooter games. Gesamtkunstwerk

provides a general approach to the design of an interdisciplinary new media object. The composition-instrument model offers a system approach to an interactive generative system and provides a bigger-picture understanding. The acoustic ecology of first person shooter games provides the detailed relationship between sound and the player.

4.2 Brief History of Game Audio

Karen Collins divides the history of game audio into three categories: the 8-bit era, the 16-bit in-between and the CD era. I will also use the categories that Collins proposes, as they signal to major technological limitations and capabilities. [93]

The earliest games, *Spacewar* and Willy Higinbotham's table-tennis game–introduced in the previous section–had no sound. Thus, the history of game audio starts with *Pong.* For *Pong*, Nolan Bushnell was tasked with creating loud cheers and boos of the crowd; however, due to limits of available hardware, he had to tap into the sounds that the hardware was able to generate, which were the chip sounds that dominated the early games.[94]

In the 8-bit era, the audio output was defined by the sound chips and the actual sound would change depending on the exact hardware. Storing the audio as waveforms was not an option due to the size of the memory of the host as well as the temporary digital media such as game cartridges. The first personal computers from IBM featured speakers only to convey error messages. The computer was able to create square waves

[93] Karen Collins, "From Bits to Hits: Video Games Music Changes its Tune," *Film International* 12, January, (2005): 4-19.

[94] Kent, *The Ultimate History of Video Games.*, 1-26.

with different pitch but the same loudness; this was later enhanced to produce three different sound waves simultaneously. The 8-bit machines used programmable sound generators to create sound through machine language. The Commodore 64, which was released as a game computer featured the capability of using four different sound waves and the ability to apply filters and envelopes. The Nintendo Entertainment System had five channels with a range of eight octaves and featured the music of *Super Mario Brothers*, composed by Koji Kondo. MIDI was introduced in 1982 and had a positive effect on game audio even though it was not standardized until 1991. *Interactive Music and Sound Effect* (*iMUSE*) engine was developed by LucasArts and enabled developers to create interactive audio with great capabilities. *Space Invaders* from Midway/Taito was the first arcade game to feature background music that was looped. Even though it was the first video game with music, *Space Invaders* featured interactive music as the tempo of the music changed with respect to the game state. With the catchy tune of *Pacman*, game music was able to enter popular culture. [95]

The 8-bit era was followed by the 16-bit era, where improvements in the number of instruments as well as quantization levels were able to reproduce audio with a higher quality level. As CD-ROMs became the norm, recorded sound with CD quality became common; however, due to the limit of the space in CD-ROMs, sounds were mostly compressed with different algorithms. Some games were shipped with multiple CDs to provide space for the soundtrack and the vidoes or with a separate soundtrack. Today, most games are sold through online retailers where they do not need to fit into a

[95] Collins, *From Bits to Hits.*, 4-19.

physical format. However, since they are also sold as physical DVDs, they still suffer from the limits of the memory. As the memory limitations were surpassed, game audio has become dominantly prerecorded or composed. In mainstream commercial games, the music is similar to the scores of Hollywood movies.

As one can see from the brief history, game sound has been directly related to technology and has evolved significantly since *Spacewar*. Today's sound engines such as Wwise[96] or FMOD[97] come with many features that the earlier systems lacked. However, in most games, sound is underutilized: It functions to play back recorded or synthesized samples. Appendix C lists the 100 most frequently played games in Steam and none focuses on sound. In most games, sound plays only a supporting role. I believe game sound can be used more creatively by taking the advantage of computer technology as well as the audiovisual capabilities of games. [98]

4.3 Examples of Video Games Featuring Unique Audio

In this section, I will introduce and investigate select games that feature unique usage of audio. In some of these games, sound is the most important part and in some, it is not, but all provide a variety of ideas that go beyond the standard usage of sound. Of the game below, *Rez*[99] and Electroplankton[100] can be defined as musical instruments.

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[96] Audiokinetic, *Wwise*.

[97] Firelight Technologies, *FMOD*.

[98] Tim van Geelen, "Realizing Groundbreaking Adaptive Music," in *From Pac-Man to Pop Music,* ed. Karen Collins (Hampshire: Ashgate Publishing Limited, 2008), 93-102.

[99] United Game Artists, *Rez* (Tokyo: Sony Computer Entertainment: 2001).

In games like *Guitar Hero*[101], *Beat Hazard*[102] and *Auditorium*[103], sound is an important part; however, they all lack certain aspects to be seen as a creative, musical performance tool with narrative capabilities. Detailed information about the games, discussed below, can be found in Appendix D.

In *Rez*, the actions of the player are tied to musical sounds and the rhythmic layer of the music reflects the pace of the game. The levels act as the score and through gameplay, the player plays a musical instrument. *Rez* is designed as an audiovisual object with a focus on synesthesia and because of that, the visuals and the sound have similar importance. This undermines considering *Rez* as a musical instrument because sound is often a byproduct of the player's reaction to visuals and it does not employ sound to progress the narration. *Electroplankton* is a musical game, where the player interacts with various types of planktons to create music. *Electroplankton* is a musical instrument in the sense that the main aim of the player is to create music; however, it does not try to pursue a narrative or employ gaming challenges. Games like *Guitar Hero* aim to recreate and gamify the actual musical performances. Even though these work as games, they do not offer much in terms opening up new possibilities other than providing the players with a feeling of performing music and basic understanding of the instruments and tools. *Beat Hazard* is an interesting "music" game, where music, as a

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[100] Indieszero, *Electroplankton* (Tokyo: Nintendo, 2005).

[101] Harmonix, *Guitar Hero* (Mountain View: RedOctane, 2005).

[102] Steve Hunt, *Beat Hazard* (2010).

[103] Cipher Prime, *Auditorium* (2008).

recorded file, is the input to the system. Then, the song is used for creating the level and the visuals that may cause photosensitive seizures. Thus, it should not be regarded as a music game. In *Auditorium,* the aim of the game is presented as music, however all the game mechanics are in visual domain. Thus, sound becomes a byproduct that is not essential to the game. There are also games that feature interesting usages of sound even though they are not music games. For example, an open world game such as *Fallout: New Vegas*[104] presents an acoustic environment similar to a natural soundscape. *Silent Hill 2*[105] establishes certain aesthetics of audio that allows the non-diegetic music and the diegetic sounds mash together. In *LIMBO*[106], the *musique concrète* of the virtual world makes up the soundtrack of the game. In the end, these examples provide ideas and partial examples for game-as-a-musical-instrument. However, since most are not designed as a game-as-a-musical-instrument, they lack in certain elements.

4.4 Model for Games-as- Musical-Instruments

The previous section shows that video games in the initial stages lacked sound and are regarded as visual objects, hence their name. However, there are now more games designed with primarily sound in mind than the early years of games, their numbers are limited[107] and most do not embrace a complete focus on sound. Thus, with

[104] Obsidian Entertainment, *Fallout New Vegas*, (Rockville: Bethesda Softworks, 2010).

[105] Konami Computer Entertainment Tokyo, *Silent Hill 2*, (Tokyo: Konami, 2001).

[106] Playdead, *LIMBO*, (Redmond: Microsoft Game Studios, 2010).

[107] More information can be found in Appendix E.

this section, I will introduce ideas, works, design guidelines and a framework that will help in the understanding and creation of a game-as-a-musical-instrument[108].

4.4.1 Gesamtkunstwerk

Even though all games that have sound can be approached and even enjoyed as musical instruments, a game that is designed and developed to fulfill that purpose can create meaningful sonic experiences. The game that satisfies the earlier definitions should be imagined as an instrument from the inception. In that sense, the process of creating such a system should begin with sound. The other elements need to be created purposefully around the core or the grand idea of musical creation and performance.

This approach is similar to Richard Wagner's idea of "Gesamtkunstwerk". Karl Friedrich Eusebius Trahndorff first coined the term Gesamtkunstwerk in combining the art of sound of word, music, mimic art and dance to become a single production. In *The Artwork of the Future*, Wagner talks about the term Gesamtkunstwerk, which literally means 'total work of art'. With Gesamtkunstwerk, Wagner meant to unite all the individual practices of opera under a single idea and mostly to support and enhance music.[109]

However, "Gesamtkunstwerk" is not a term or an approach that belongs only to opera; in fact, it has been a term related to all intermedia objects. In the 1950's the idea of Gesamtkunstwerk again came into discussion with the Fluxus artists led by John Cage.

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[108] It must be remembered that this study is not about game design and this chapter is not about providing guidelines for game design.

[109] Burkholder Grout and Palisca, *A History of Western Music*, 658-702.

Fluxus artists created intermedia and multimedia works in which Gesamtkunstwerk was discussed in a contemporary setting outside of the opera house.[110] Today, multiple fields of art are united in the digital space for creating Gesamtkunstwerk, which Roy Ascott defines as the integrated data work "Gesamdatenwerk". In *Is There Love in the Telematic Embrace?*, Ascott argues that the computerized media cannot be just seen as an extension to the traditional media, and needs to be discussed as a complete different entity.[111] This can be translated to the idea of game-as-a-musical-instrument if accepted holistically as a system.

Similarly, I use Gesamtkunstwerk to define a completely consistent, well-thought-out game: a game that has all the elements (visuals, audio, mechanics, story and other elements) and is created the way it is because of shared values that define the game itself. This requires conscious choices about the elements rather than random or default choices. This idea is not about the importance of individual elements but is about establishing meaningful relations between the elements. However, since this thesis studies games as a musical instrument, the meaning of Gesamtkunstwerk refers back to the definition, where all the elements are united and led by sound and music.

Even though this seems to be the logical thing to do, most of the games today have replaceable parts such that you can swap the story of the game with another story and the game would not lose anything. The main examples for such games are shooter

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[110] Barbara John, "The Idea of Gesamtkunstwerk in Historical Development," in *See This Sound Audiovisuology Compendium*, ed. Dieter Daniels and Sandra Naumann (Cologne: Verlag der Buchhandlung Walther König, 2009), 141-150.

[111] Roy Ascott, "Is There Love in the Telematic Embrace?," *Computers and Art: Issues of Content* 49, no. 3 (1990): 241-247, accessed April 23, 2013, http://www.jstor.org/stable/777114.

games, where the hero kills all of the enemies. Even though some games only rely on mechanics and gameplay, some still advertise their story. The recent *Call of Duty* games are an example of this**.** In the game industry, independent companies are more careful in that sense. *Braid* developer Jonathan Blow expresses his dislike for the disconnect between the various elements of the game and expresses an approach similar to "Gesamtkunstwerk"[112].

4.4.2 The Composition-Instrument

In Section 4.2 and 4.3, I tried to look at games as musical instruments from the point of games. However, to analyze and synthesize 'games-as-musical-instruments', it is also beneficial to be able to look from the point of games and music at the same time. Norbert Herber proposes a framework for a similar system through his composition-instrument model.

Herber introduces the idea of composition instrument in a chapter of an editorial collection titled: *From Pac-Man to Pop Music: Interactive Audio in Games and New Media*. Herber starts the chapter by defining the difference between composition and instrument; he continues by saying that composition and instrument become one within contemporary interactive media as the rules and capabilities of the interactive system are the composition and with interaction, it becomes also the instrument. This is also a common aim and result of the game-as-a-musical-instrument. He argues that this

[112] Taylor Clark, "The Most Dangerous Gamer," *The Atlantic*, last modified April 2, 2012, http://www.theatlantic.com/magazine/archive/2012/05/the-most-dangerous-gamer/308928/?single_page=true.

approach liberates interactive music from linear music as it gives the power of composing and playing to the audience, interactor or player of an interactive piece or a game. Looking at contemporary works, interestingly he concludes *Electroplankton* and *Rez* are examples of similar ideas.

With the composition-instrument, Herber aims to define a "conceptual framework that helps facilitate the creation of musical systems for interactive media, art and game systems."[113] He focuses on the generative aspects of media in composition and sound. Later, in his PhD dissertation, Herber, extends the initial framework and explains possibilities of multiple systems and players. [114] However, I will only explain the single user model, as this study investigates single-player games-as-musical-instruments. Still, the multiple systems model can be a good reference point when translating the idea of the thesis to multiplayer games as one of the possible next steps.

Herber's framework, shown in Figure 2 below, is derived from biology and the generative audio system and the listener are defined as two unities or organisms in an environment. This system proposes that the two are coupled such that changes in one affect the other directly or indirectly. When applied to interactive generative music, the framework offers an understanding and a design method for a fluid stream of musical experience.

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[113] Norbert Herber, "The Composition-Instrument: Emergence, Improvisation and Interaction in Games and New Media," in *From Pac-Man to Pop Music,* ed. Karen Collins (Hampshire: Ashgate Publishing Limited, 2008), 104.

[114] Norbert Herber, "Amergent Music: Behavior and Becoming in Technoetic & Media Arts" (PhD diss., University of Plymouth, 2010).

Herber argues that the interaction with the composition-instrument is like an open episteme, where open episteme is defined as a system, in which the interaction mechanics and the behavior of the system can change at the instance of interaction. However, he also believes that it is possible to have a composition-instrument work in a closed system, yet he has not seen any. In addition, in the closing remarks, he defines a game like *Super Mario Bros,* a semi-open system, which means a closed system that is still capable of a variety of outputs if not infinite as in a generative open system and he introduces the possibility of performing the *Super Mario Bros* as an instrument that involves interaction and gameplay.

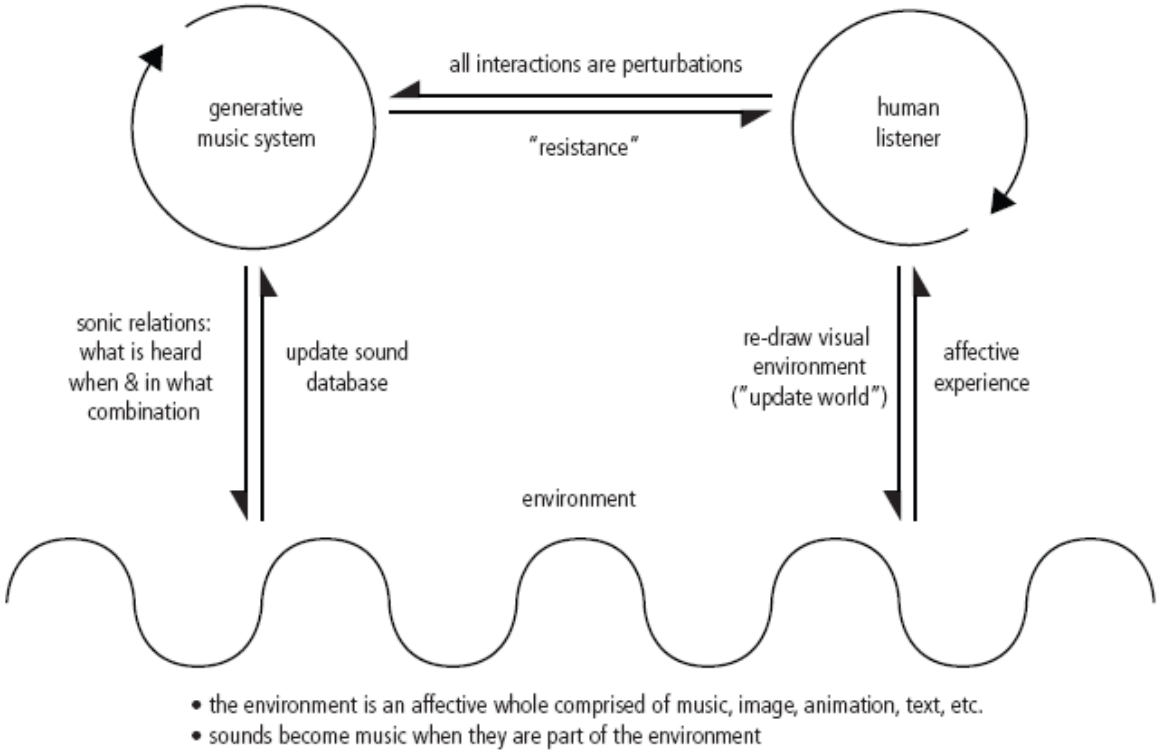

Figure 2: Herber's composition-instrument framework[115]

[115] Herber, *Amergent Music.,* 59.

One of the things that Herber addresses initially is the idea of composition and instrument within the context of interactive and generative media. Like the audience, who has to fill multiple roles such as performer, observer, player, interactor and participant, the musical system also fulfills multiple roles. Some of these roles are being an instrument, a composition and a sound effects library. When a game-as-a-musical-instrument is discussed, a similar set of roles are expected from the instrument and similar relationships can be discussed. However, for my case I argue that all the arrows either should be in sound, originate from sound or affect sound.

A system is defined as a regularly interacting or interdependent group of items forming a unified whole. [116] Herber's approach accepts an instrument as a system that can create, be used as a tool for creation and interact for a unified aim. The instrument-composition model is focused on generative processes in interactive media and games. With my research, I focus only on the possibilities of games as musical instrument/compositional systems as open or semi-closed systems, where even though sound is the ultimate core, it is still embedded in a game. In addition to being an inspiring and educational study, it also provides an overview map of game-as-a-musical-instrument as a system.

4.4.3 The Acoustic Ecology of the First Person Shooter

R. Murray Schafer introduces the term acoustic ecology as mentioned in Section 2.2.4. Acoustic ecology investigates an environment with respect to the sonic properties

[116] "System - Definition and More from the Free Merriam-Webster Dictionary," *Dictionary and Thesaurus - Merriam-Webster Online.* accessed June 25, 2013, http://www.merriam-webster.com/dictionary/system.

of the environment and the things living in that environment. In his PhD dissertation, Mark Grimshaw applies the concept of acoustic ecology to games; he specifically looks at the standard run-and-gun first person shooter games, where the aim is to survive and kill other team members.

Grimshaw investigates the relationship between diegetic sounds and the player as their relation affects the gameplay. His study excludes the non-diegetic music because it is not a part of the virtual environment but rather exists independently. Even though a complete analysis or retelling of Grimshaw's dissertation is not the point of this thesis, his work can be summarized as follows:

Grimshaw argues that the acoustic ecologies of a first-person-shooter emulate those of the real world through the interaction between the player(s) and the space. He argues that sound is one of the most important elements in creating an immersive 3D virtual reality as sound is omnidirectional and processed faster. This creates a rough mapping of the space in the player's mind; however, it requires an initial level of immersion, which is enhanced by the sound later on. Grimshaw starts analyzing the relation between all the diegetic sounds of the game and the player using terms mainly from film studies. However, when these terms are inadequate, he presents new terms for identifying the unique relations that games offer. [117]

Such a term is 'navigational listening', which is an addition to the modes of listening proposed by Micheal Chion and Pierre Schaeffer. Navigational listening involves

[117] Mark Grimshaw, "The Acoustic Ecology of the First-Person Shooter" (PhD diss., the University of Waikato, 2007).

using hearing to locate objects and to perceive space.[118] I argue that navigational listening can enhance the musical performance as it involves the usage of spaces and it requires and encourages a deeper interactive mode of listening that is more immersive in the sense that it stimulates increased brain activity. Grimshaw also argues that the game sound offers unique potential for immersion. In general, Grimshaw offers a detailed analysis of the diegetic sounds as they interact with the players. The vocabulary, he proposes, also helps understanding the roles of each sound and thus helps create games-as-musical-instruments.

The main interaction between Grimshaw's dissertation to my thesis comes through analysis of the relationship between the sounds and the player. If we look back at Figure 2, we see the environment as an entity. In the case of a performance within a game world, the production space is the physical and the virtual environment. The virtual environment is the representation of the instrument. Grimshaw's framework for a first person shooter can be found in Appendix F.

On the other hand, the way he approaches the game sound is limiting because of the genre that is the subject of analysis; the study provides a detailed framework about the player's relation with non-background sounds of a game from the perspective of a game. This set of ideas can be translated to conditions that do not present survival and killing and changes the focus from information to aesthetics of sound. Using games as musical performance allows the musician to utilize the virtual space, and Grimshaw's dissertation provides an insight in understanding the usage of sound in the virtual

[118] Grimshaw and Schott, *Situating Gaming as a Sonic Experience*., 477.

worlds in mainstream-game situations. In the end, the study is still applicable to experimental games such as *Causality* and it presents an understanding of the relationship between audio, immersion and gameplay.

4.4.4 The Design Model

In this section, I will present my model for creating games-as-musical-instruments. The idea of "Gesamtkunstwerk" provides a general understanding for approaching an intermedia system with a focus. Herber's composition-instrument provides a framework to create and understand interactive, creative new media systems that exist in a space that it is aware of. Grimshaw's study in acoustic ecology of first person shooter lays out the multiple ways sound effects communicate with the player in a game. Grimshaw's framework provides the details for understanding and analyzing game-based music creation systems. Synthesizing these approaches gives me a structure for a game-as-a-musical-instrument–which is still a game–that can act as an instrument and composition through generative music while still benefiting from being a game in order create an enhanced musical experience for both the performer and the audience. As described before, the elements that enhance the musical experience are:

- Technological sonic capabilities
- Interaction
- Narrative
- Immersion
- Flow
- Virtual Space

Figure 3 shows the proposed design model:

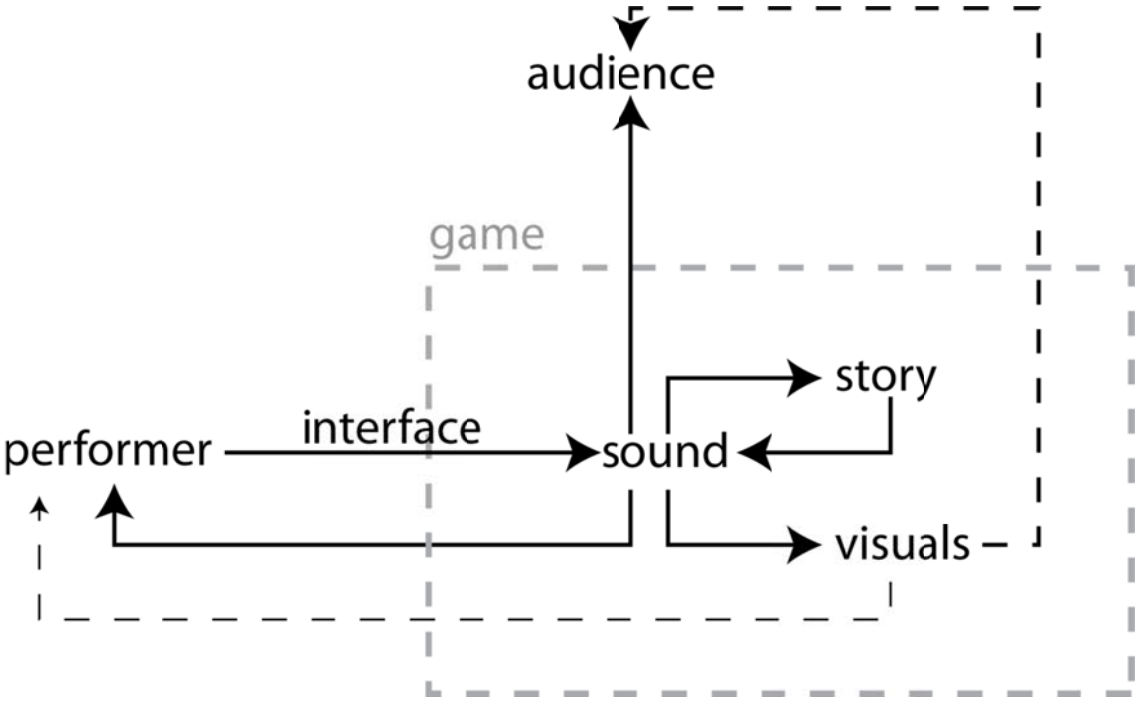

Figure 3: Design model for game-as-a-musical-instrument

The higher-level model aims to define and separate major elements of the performance and the instrument. The most important concept here is that the game is divided into three elements in relation to the aspects of the performance. Through gameplay, the performer directly affects sound and the main form of feedback is from sound either directly hearing the effects of her actions or through the change in game state, which in Figure 3 is shown with the feedback from story to sound. The visuals play a less important role; this is shown with the dashed lines and the line widths. For the performer, the visual is a product of her actions that she can control; yet it does not really convey information because musical performance is the focus. For the audience, visuals have a more important role than the performer, as indicated by a thicker line. By

design, sound is chosen as the main information channel between the system and the observers. However, since a passive observer does not interact with the system, the observer will perceive a translated sonic action that causes a change in the visuals differently. Thus, due to the interaction, the actual experience of the observer and the performer will vary. Depending on the context, it can be argued that the observer may have a diluted experience.

Here the relation between the performer and sound can be explained with the composition-instrument model as proposed in Herber's article. By replacing the 'human listener' with the performer and combining 'generative music system' and the 'environment' with game, similar entities can be achieved. However, it is also possible to have a closed or a semi-closed episteme. In such a case, the looping arrow around 'generative sound system' will cease and the new entity will be titled as 'sound system' and mainly operate as a translational and mapping engine. In close or semi-close epistemes, the sound would not be generative but it will be composed of pre-designed and composed pieces, which the performer will use to create music. In fact, this is the case with most regular instruments, where the sounds they can make are limited and defined. The actual relationship between the sound and performer can be explained using Grimshaw's analysis[119] as the basis and modifying the framework to fit the designed game.

[119] It should not be forgotten that Grimshaw's model does not include game music. In addition, the model also represents the multiplayer condition; however, the single player part can easily be extracted from the whole system.

On the other hand, one thing that was apparent in the history of game audio is that the technology has a very important place. Thus, the first choice that needs to be made is choosing the sound engine or the game engine-sound engine bundle; this will determine whether or not the system can support generative sound. This choice will define the actions that the performer can do about sound; thus, it will define the game mechanics, the story and, of course, the type of sound and performance. On the other hand, the choice about the aesthetics of sound is a personal preference that defines the voice of the piece.

Even though Grimshaw discusses the first person shooter, the exact genre of the game can be anything, as his analysis can be applied to even non-spatial games. Following Lefebvre's arguments, we can conceptualize the game space as a mental space and still think about sounds as attractors, retainers and connectors. On the other hand, Grimshaw's analysis can be easily be applicable to third person, platformers, strategy games or any game that features a virtual camera and a virtual listener attached to it.

Similar to the genre, the exact details of the story are design choices that do not affect the model. However, how the story is told and how it is propagated is important. As seen in works from sound arts, the translation of the actions and the process of creation can add to the meaning of the output. For games as an instrument, this can be used to enhance the narrative capabilities of sound. The other elements in that case are supplementary and supportive. Thus, when thinking about the story one needs to think about the sounds.

There is an important challenge working with visuals. It is easily possible to turn the performance into a dominantly visual one by using informative visuals. However, for game-as-a-musical-instrument, sound needs to be the dominant sensory input and output. On the other hand, visuals can still be employed for sound by employing a correct balance.

4.5 Conclusions

The history of game audio shows that sound did not exist in earlier games and hence electronic games were called 'video games'. Today more games focus on sound; although it is still a comparatively small number. Even though games like *Rez* and *Electroplankton* are interesting examples, they still lack in certain areas.

The proposed model provides guidelines for creating games as a musical instrument. While it is not possible to say scientifically at this point, whether the model is successful or not, it does combine approaches from system design, media studies and sound design in games, as the problem is not a problem related with a single part of the game or one discipline but it is a problem that involves the whole game. The proposed model was employed to create *Causality,* a game-as-a-musical-instrument prototype, in the next chapter.

CHAPTER 5. TEST CASE: CAUSALITY

5.1 Introduction

In this chapter, I will look back on the installation: *Causality*[120], which is the first iteration of a game that is a musical instrument and a game at the same time. The installation included the implementation of the first part of a larger design. This chapter will discuss the artistic choices that shaped the design of *Causality*. The postmortem will discuss the working and the non-working ideas as well as future directions for the project.

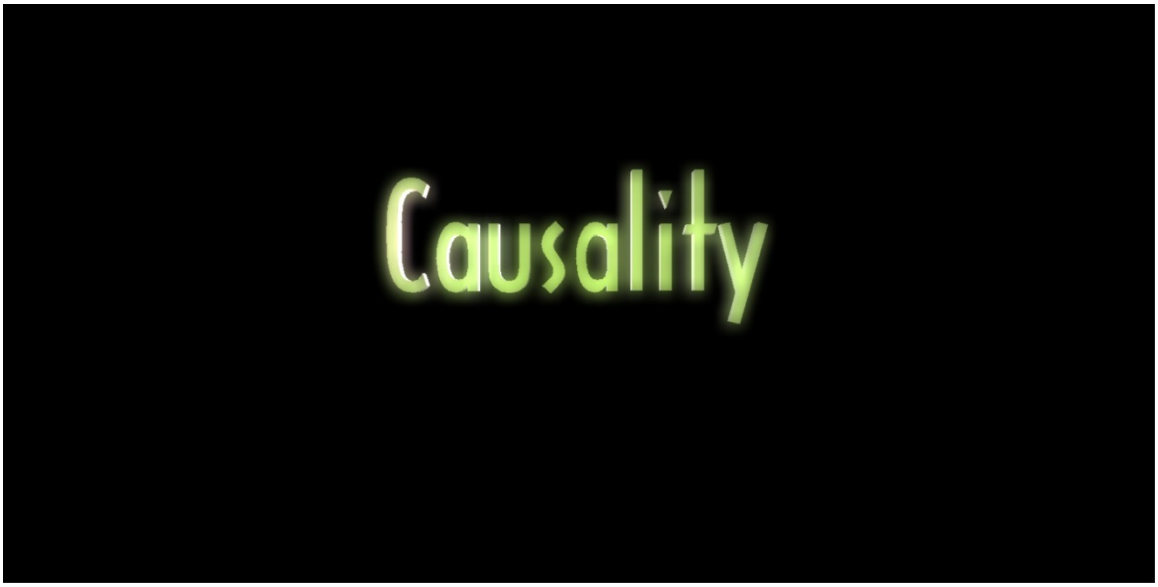

Figure 4: Causality title screen

[120] Audiovisual documentation about the installation can be accessed from http://web.ics.purdue.edu/~rmungan/Causality.html.

5.2 What is Causality?

Causality is a game-based installation that I developed with the ideas mentioned in the previous chapters.

- A game where gameplay creates a sonic artifact.
- A sound-dominant audiovisual interactive installation.
- A game with sound being the most important part of the game mechanics.
- A critical situation proposed via the abstract narrative.
- A navigable virtual environment.
- A semi-closed system: An interactive system with countable options.

If I approach *Causality* as a game only, the core of *Causality* can be described as follows: *Causality* is a game about experiencing sound interactively through an abstract narrative in a specially crafted world through a first-person view.

Then, I can identify the feature set of the game as follows:

- An experience where players mix and create their own music through gameplay.
- A place where players can experience a world of abstract sounds.
- Unique gameplay based on sound.
- A game that allows players to mix and create their own sound story.
- An easy-to-use interface for non-gamers.
- A game that encourages the players to think about what they are experiencing.

5.2.1 The Title

The word causality is defined as "the relation between a cause and its effect or between regularly correlated events or phenomena".[121]

I have titled the installation *Causality* for two main reasons. First, causality is about the effects of our actions and choices. The game refers to an arbitrary slice of life,

[121] "Causality - Definition and More from the Free Merriam-Webster Dictionary," *Dictionary and Thesaurus - Merriam-Webster Online.* accessed June 25, 2013, http://www.merriam-webster.com/dictionary/causality.

where the player has to make a critical choice that will shape the rest of the path. The multiple layers of sounds represent the multiple paths and multiple sources that might affect our decision making process. Second, the title also references the existence of sound. The relation between action and sound can be defined as follows: sound is the effect of mechanical waves in the audible region. Sound is not a cause in production and is not a cause (unless it is perceived by an entity— living or artificial— that can hear and act upon it). In the game, this relation is reversed. The sound is the source of the movement, space and existence just like an audio-only medium; only the things that make sound are visible and collidable in the game. The rest of the game objects do not exist unless they make a sound.

5.2.2 The Story

The story in *Causality* is what can be explained as a framework rather than a well-defined narrative. The aim of the introductory text is to create a starting point and provide a hint about the experience to the audience. Nearly all of the sounds in the game are abstract sounds; thus, they lack a common meaning. The visuals are designed to have the basic form yet free from texture; instead, have pure colors. The visuals are simplified in order to let the sound be the primary storyteller. However, the sounds and the colors of the sound sources are designed to carry certain emotional values. In the game, each sound source is accompanied with a light source. The colors of the lights are chosen in order to trigger similar emotions with the sound source. However, the process of determining the combinations can be described as subjective, which reflects my understanding and taste. Finally, the story is expected to be different for each audience

member as each person's own memories and understanding are reflected by the abstract sounds. An interpretation of one of the arcs of the whole story can be as follows:

> *She woke up in a hospital bed and tried to remember what happened. Not remembering anything, she got up for a stroll. She was nervous. She saw people waiting for the bad news in front of the operating room. Not knowing where to go, she closed her eyes and listened to her surroundings. She heard people cry; she heard people laugh and then she heard people cry again. Behind all these sounds, she heard the wind blowing outdoors through noisy streets and she aimed for that sound. She finally left the hospital. She wandered around the streets aimlessly, sticking with parts of the town that were louder because of either comfort or curiosity. Eventually, she heard the sounds of a train station: people running to catch their trains or say goodbye one last time. She looked around, digested all the sounds and bought a one-way ticket to a place, which she did not know. It was a way out.*

Making choices is an important part of *Causality,* as the installation encourages discussions about how we make choices. Especially how we make choices when the options are unclear and the pros and cons are hidden behind a wall of noises, which is a metaphor for the ideas and information that clouds our decision-making process. By translating navigational choices into subtle sonic options, *Causality* aims to blur the act of making choices and makes it a subtle game mechanic.

The game features no visible characters. The game is experienced through the main character, which is the audience/player. The main character has a blank personality. Thus, the experience is not about playing a certain character but is about being oneself. Other characters appear in the game through sound. These characters are the beacons that the player navigates to or runs away from. They have distinguishable (i.e. baby vs. adult) yet abstract or symbolic sounds.

The levels or the virtual spaces are tied to the story as follows. Depending on the actions and choices of the performer in a level, the next level's sonic content are shaped:

Table 1: Causality level structure

	Level 1[122]	**Level 2**	**Level 3**	
Location	Hospital	Streets	Train Station	House
Speed of Time	Time is slower	Time is normal	Time is faster	Time is faster
Effects on Game State	Determines the pleasantness of the next level	Determines the activation level of the next level	-	-
Variations	One version	Two versions: Sad, happy	Four versions: Sad and low activity Sad and high activity Happy and low activity Happy and high activity	Four versions: Sad and low activity Sad and high activity Happy and low activity Happy and high activity

5.2.3 The Visuals

As mentioned above, the visuals of *Causality* are not realistic. The reason for that choice can be explained by looking at the function of the visuals: in the world of *Causality*, everything exists because it makes a sound; light is not an exception to this rule. Thus, the main function of visuals in *Causality* is to follow and support sound. However, my experiences with my previous works have shown me that the visuals need

[122] Only the first level is implemented for the installation.

to carry a certain amount of information so that the audience should not feel debilitated. *The Castle of Asterion*[123], a previous game of mine that investigates navigation using sound, featured almost no visual information. Most of the players focused on visuals trying to find visual references instead of focusing on sound. After finding a visual reference, they were able to listen to their environments. That is why *Causality* features "visuals," but with limited amounts.

In *Causality*, form is kept only for the buildings. For other objects, basic geometric primitives are used. The buildings, created by the always-present background music, are one of the pillars of the framework in which the user can compose and mix music by navigating inside it. Thus, their shapes are defined, which grants the object a fundamental definition. In real life, buildings are one of the most significant sound sources and effects that change the soundscape of our daily lives. The main aim of color in *Causality* is to reinforce the emotions defined through sounds. Each sound source emits lights with the sound. The color and the intensity of the light are related to the emotional value of the sound. The game world is free of textures. The main reason is to decrease the amount of visual cues and to let the audience's imagination decide how exactly the space looks like and fill in the gaps. Even with the buildings, applying textures would put more information than desired; the additional information then alters the emotional space created with sound. This approach is aimed to make the player be guided by the sound.

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[123] More information about *The Castle of Asterion* can be found at http://web.ics.purdue.edu/~rmungan/vg.html.

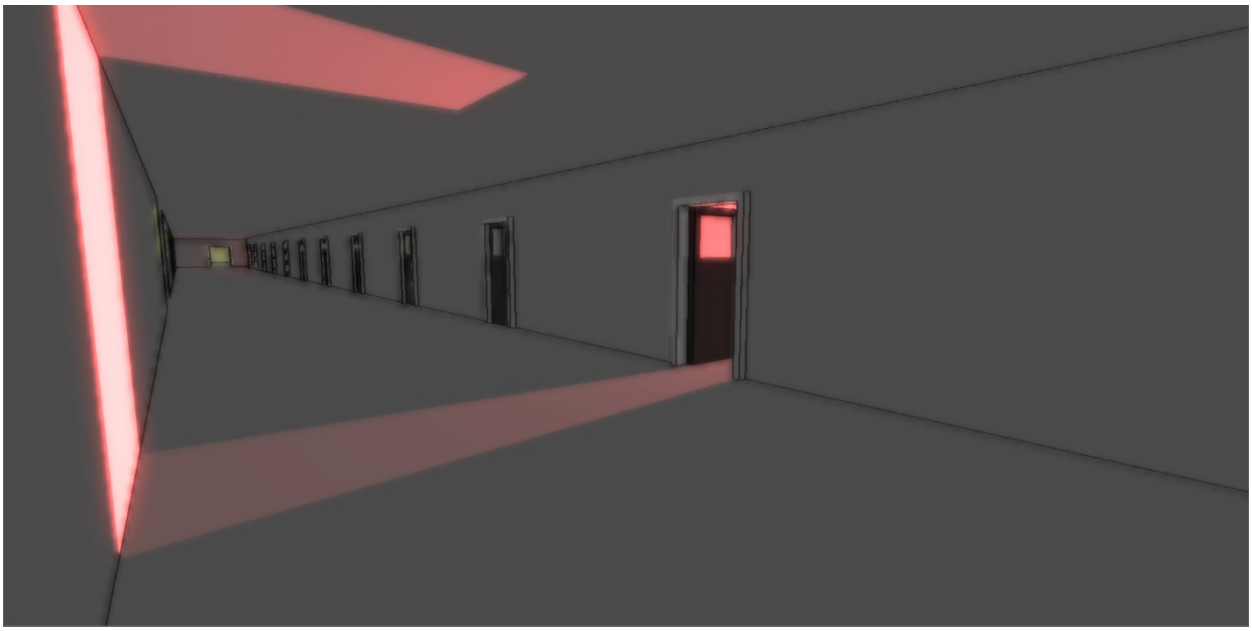

Figure 5: Screenshot from *Causality* showing a corridor

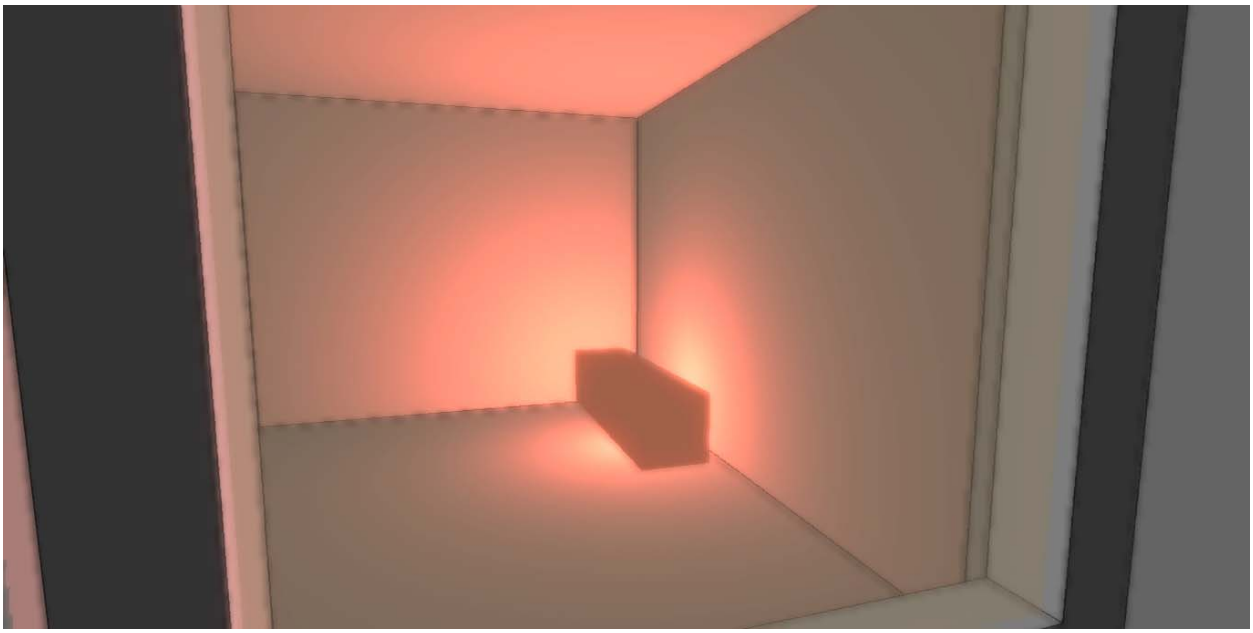

Figure 6: Screenshot from *Causality* showing an object with a primitive shape

Figure 5, above, is a screenshot from *Causality*. As mentioned, the graphics are free of texture and are painted with light source of solid colors. These light sources are the results of sound sources existing at the center of the light sources. The wall, ceiling and roof is gray because of the visual neutrality of the space. Figure 6, above, shows a sound/light source. The light is illuminating the space with a color, that is determined based on the attached sound.

5.2.4 The Space

The space in *Causality* needs to be thought of as both the space of the installation, which is the physical space and the virtual space. First, I will discuss the virtual space. The form of the virtual space is the most realistic part of *Causality*; the underlying reason behind this choice is that it is one of the reference points of the described framework. The sound, which is the source of existence of the architecture in the virtual space, is always heard as the background music from which the audience creates their own sound stories.

If we go back to the discussion of space in Section 3.7 and remember Lefebvre, the space of the game can be seen differently. I want the mental space of the game not to be limited by the game lore or game space; rather I would like it to include the physical world as well as the game world. Even though this might break the immersion in some cases[124], I believe it will allow games that can incorporate out-of-game discussions within the minds of the players and audience. In that sense, having an

[124] The reader can think about phone ringing at a very tense time of a movie or a game. Alternatively, remembering that you have forgotten to pay a bill and now its past due after seeing a bill in the game can break the immersion.

installation rather than a screen and a headphone is important as it reminds the audience of the non-virtual environment constantly. Eventually, the production of ideas should occur as the virtual space and the real space interact. Ideas that are triggered in the game world can have more significant effect through reverberations in the non-game world.

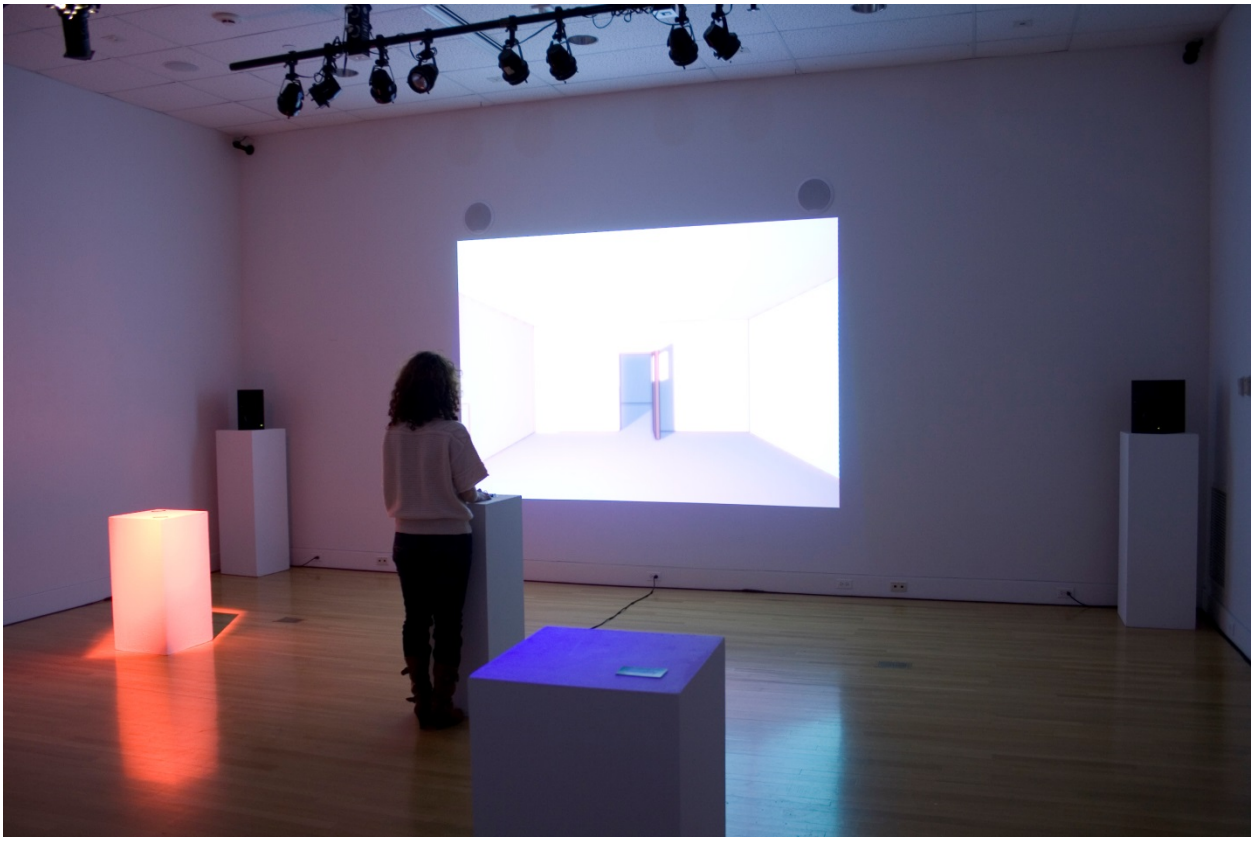

Figure 7: Installation space photograph with extra exposure to show the lines in the corners

Figure 7, above, and Figure 8, below, show the installation space while a performer played *Causality*. Visually, the virtual space is reflected in the physical space through recreation of the black lines of the edge detection in the physical space and through the rectangular prism pedestals that are lighted with colors from the game. The

first, lighter image shows the black lines on the floor of the physical world similar to the black lines in the virtual world. The second, darker image shows a sound source, i.e. a light source in the virtual world and the physical counterpart of it.

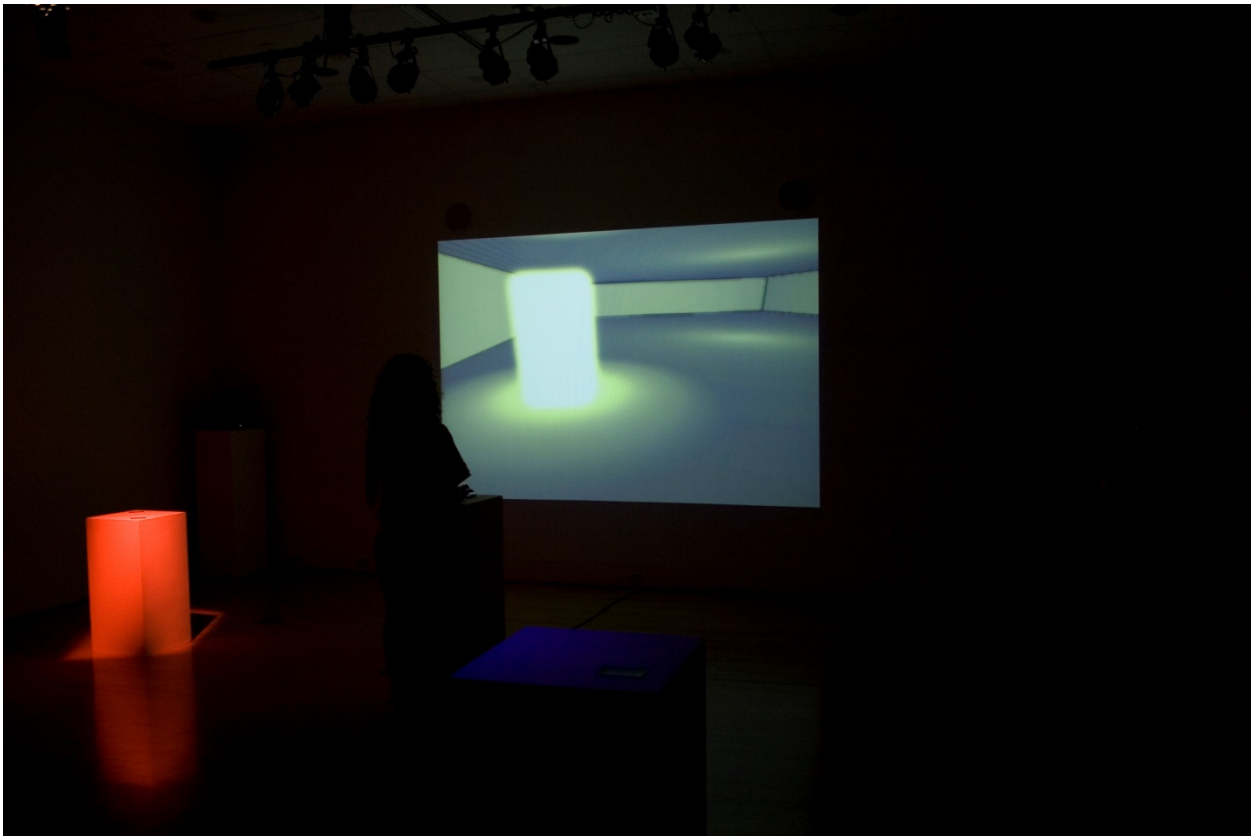

Figure 8: Installation space with short exposure to show the light effect on the cube on the left

5.2.5 The Interface

One of the potential problems that *Causality* faced was the audience. Even though *Causality* is designed as a music creation tool, it supports a game interface since the audience physically interacts with a game while the actions in the virtual world create the musicality. Additionally, *Causality* is an interactive installation that is

exhibited in a gallery. Thus, the interface is designed to provide an ease of use and familiarity for people who will encounter *Causality* in a gallery setting.

I developed a dedicated controlling application—free of unnecessary distractions—and deployed it on a touchscreen tablet computer as a remote control. The image below shows the user interface. The left side of the screen provides the controls for movements and is triggered by pressing the arrows. The right-hand side provides the head movement and it is controlled by a smoother 'touchpad' that the audience needs to touch and drag.

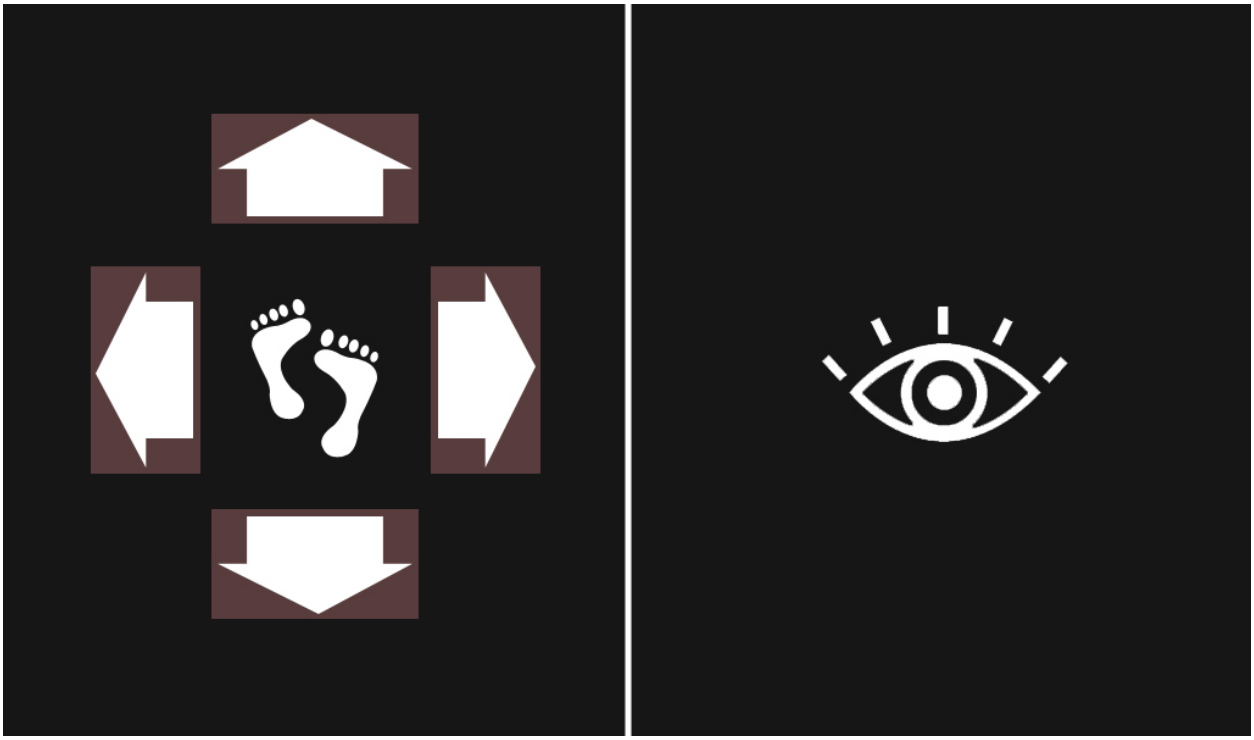

Figure 9: The user interface

Figure 9, below, shows the flow diagram of the interface. The interface constantly checks for user input and, when a touch event is detected, the system checks the connection. If the connection is already established, the action is sent to the game

through by TCP/IP protocol through a pre-determined port; if not a connection is established and the application proceeds by sending the message again. Such a safety net was implemented, since the wireless signal was not stable in the installation space and needed to be checked regularly.

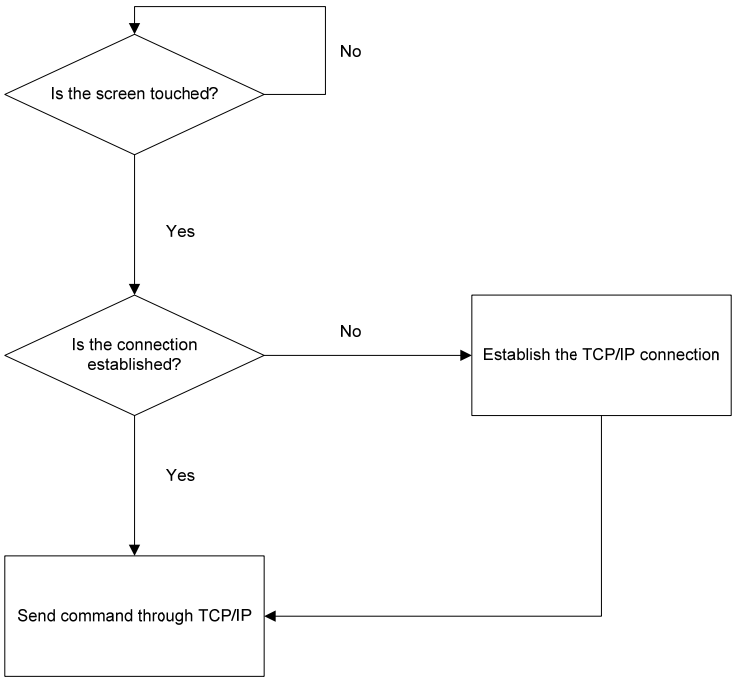

Figure 10: Flow diagram of the interface

5.3 The Sound

The sound is the main element of the installation and the game; thus, it will be described more in depth. As described above, the whole idea starts with the sound. The other elements are thought as they complement and support the sound. The installation space is designed to provide the player with the optimum listening space.

The sounds in *Causality* can be divided into two categories: non-abstract sounds and abstract sounds. The non-abstract sounds are used to establish the setting in proposing definitions for what and where you are. There are only three non-abstract sounds and the rest of the game is defined with abstract sounds.

- Heartbeat Sound: the heartbeat sound is the source of existence of the audience's avatar. Within the bigger picture, it also presents the relativity of time in different conditions.
- Footstep Sound: the footstep sound establishes the interaction between the architecture and the avatar allowing the avatar to move. In addition to realistic footstep sounds, the sounds also have an abstract musical component.
- ECG Sound: the ECG sound can be seen as the heartbeat of the space. It can be heard at the beginning and aims to set the setting. To me it proposes that the experience starts in some kind of hospital however, any other interpretation is also valid.

The aim of the abstract sounds in the installation is to create attractors coupled with various emotions. By following and mixing the sounds, the audience creates an emotional journey, which is also recorded as a linear sound file.

The sounds are designed with respect to the Emotional Response Model (ERM) relation as proposed by Juslin and Västfjäll. [125] The ERM model explains each sound within a two dimensional plane. One dimension of the plane defines the pleasantness of the sound while the other dimension defines the activation level of the sound. Thus, a lullaby is defined as a pleasant sound with low activation, as it evokes the feelings of comfort, love and sleep.

[125] Patrik N. Juslin and Daniel Västfjäll, "Emotional responses to music: The need to consider underlying mechanisms," *Behavioral and Brain Sciences* 31, (2008): 559-621.

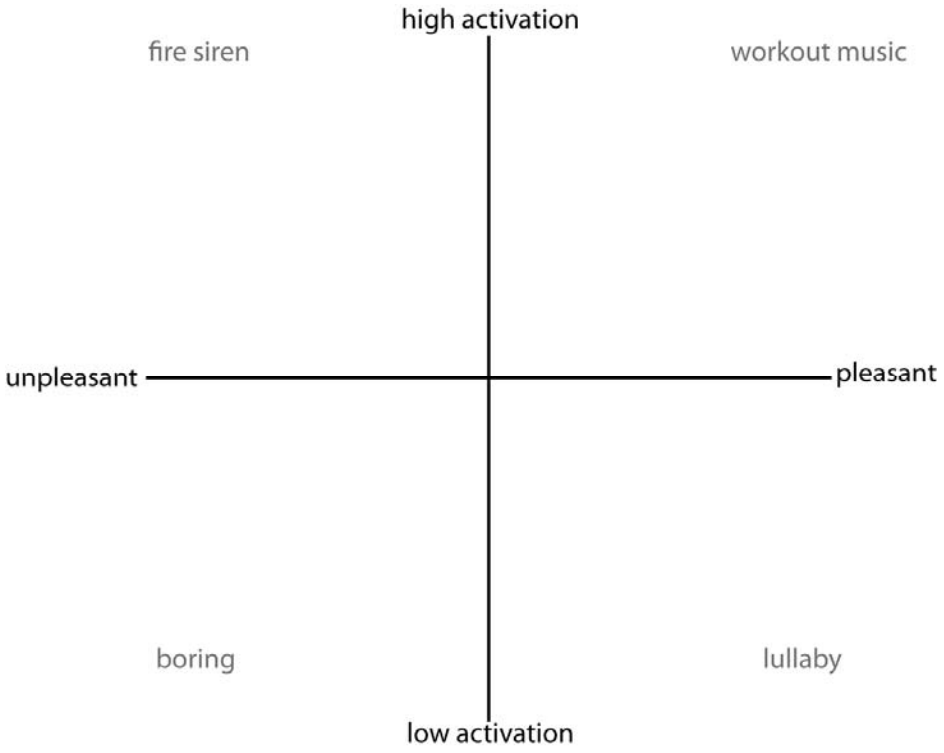

Figure 11: The ERM model with four extreme examples

Within the larger idea of *Causality*, the part that was implemented for the installation would be a psychological profiler: The amount of time that the user spends hearing certain sounds will put the audience at a point in the two dimensional sound-emotion space. This position will define the version of the level that the audience will receive.

As mentioned above, the abstract sounds are linked to the game mechanics through sound puzzles that are subtly placed. The designed sound puzzles[126] and their meanings with respect to the story and game mechanics are as follows:

[126] For the first part of the game, only a selection of the puzzles is used.

- Find sound-source:
    - The player needs to locate the source of a sound that they can hear.
    - While making decisions, sometimes, there is a single goal that we trust with all of our hopes.

- Choose sound and find its source
    - The player needs to identify a sound as the solution and needs to locate the source of that sounds.
    - Most of the time there is more than a single option and there is a need to make a choice.

- Choose music-source and find its source
    - The player needs to identify music, a more complex sonic entity than a sound, and needs to locate the source of the music.
    - Most of the time, it is hard to evaluate the options quickly. One needs to dedicate some time in understanding the individual aspects of the options.
- Darkness lit by sound
    - The player needs to trigger a sequence of sound sources in order to make the sounds permanent and light the environment.
    - Conversing with others or even just talking or listening to others might provide the clarity and the understanding for making a choice.

- Discovering the original sounds
    - The player needs to figure out the source of sound that is changed due to distortion and filtering.
    - There is huge possibility for information to change as it travels.

- Find the source of the echoes and/or reverberations
    - The player needs to find the source of the sound that is echoing and/or reverberating.
    - Choices affect the future; their echoes can be found within one's regrets, memories or happiness.

- Masking and cocktail party effect
    - The player needs to pick out certain sounds or music from a sonic mass. Sometimes these sounds or music are hidden by acoustic masking.

- Flooded with mass information and disinformation, it is not easy to filter out what is related or correct. Confusion is a state that alters one's decision-making process.

Most of the sound and the music of *Causality* are designed not-to-be-layerable. This results in the possibility of different sounds masking each other and provides some of the game mechanics. However, the way sound is implemented in *Causality* can be defined as layered in a different sense, where layering occurs through mixing sounds with different behavior.

The main variable that changes the sound is the location of the avatar. The sound in the virtual environment is mixed with respect to the avatar's proximity to the sound sources. Depending on this interaction, the sounds in *Causality* can be divided into three categories:

- Sounds that are always audible at a constant level: the first category of sounds is always audible throughout the experience. These are the heartbeat and the footstep sounds defining avatar and background music that defines the building.
- Sounds that are always audible but the level depends on proximity: These sounds form the target sounds for finishing the installation. They are synthesized outdoor sounds one with a high energy and one with low energy.
- Sounds that respond to distance: these are the sounds inside the rooms that the audience can trigger or observe.

If we go back to the first chapter and look at *Causality* from the perspective of sound art, I can say the following about *Causality*. *Causality* integrates gaming, interaction, virtual spaces and technology among other things with music in order to enhance it.

The story in *Causality* is described above, and even though it may seem not to be carried with sound, the story is dominantly told with sound directly or indirectly. The narration of the game starts with the initial text and after that, it is handed to sound, visuals and interaction. However, since all the elements are designed and programmed to be based on sound, they are in practice told through either sound or the action of creating sound.

For the game, Unity3D is used as the game engine without any additional plugins. This choice brought stability to the development process with the cost of not being able to add additional functionality. The considered alternative was a Max/MSP/Jitter-Unity3D hybrid that also takes advantage of the capabilities of Max/MSP as a sound engine. Max/MSP would have brought the capability to synthesize and create sounds through gameplay; however, *Causality* still benefits from the world of synthesizers using tonal and non-tonal complex sounds, as the wide range of the timbres increases the vocabulary.

As mentioned before *Causality* is a semi-open episteme. In theory, performing *Causality* yields countable (limited) amount of options. By expanding *Causality* with algorithmic generation capabilities, it is possible to create a system that supports completely unique performances, which in the end makes the system more responsive to the performer and can enhance the narrative possibilities of the system.

The space offers the dynamics of discovery for the performer. Through the virtual space, the performer controls what sounds are heard and how they are mixed and can be seen as walking within an instrument or orchestra. In addition, the virtual

space also brings an organization to the game, to the music and to the performance, which also contributes to the narrative of the work.

Computers provide the ability to map a set of inputs to a seemingly unrelated set of actions. In an act of playing the guitar, what the performer does is to “pluck a string”. However, in *Causality,* the exact action of the performer varies, and at the first sight, it may not be directly related to the performance. For example, the standard actions that a performer does in *Causality* are “moving to a point”, “moving away from a point”, “listening” and “looking around”. Through translation to the output sound, these actions add to the meaning and change the dynamics of the performance.

5.4 How was Causality Perceived?

The feedback for *Causality* is gathered verbally through casual discussions from visitors of the gallery, who have interacted with or observed the piece. Even though the sample size may not be statistically relevant and no specific testing sessions were held, the gathered information is useful as it reflects the gallery visitors’ fresh and free response to *Causality*. The statements below are paraphrased, while keeping the original meaning intact.

- *The installation was immersive*: this statement seems to praise the implementation of the installation rather than the game design. In the installation space, the user stands in the middle of the room in front of a pedestal with the controller. In the four corners, there were four speakers and in the front was projection that provided near actual size graphics. As mentioned in Ermi and Mäyrä’s paper, larger screen sizes and the surround sound systems are some of the elements that provide immersion. In addition, as mentioned earlier, the physical space replicated the style of the virtual space creating a seamless portal between the two spaces.

- *The sound was immersive*: in addition to the above argument about surround sound, the installation featured sounds within a large dynamic range since the gallery was a silent space. This allowed sounds to be loud and engulfing when necessary.
- *The visuals were immersive*: the gallery space was dark except for the two colored spotlights illuminating two rectangular prisms as in the game. Thus, when an audience member was playing the game, they were looking at a screen, which was requiring all their attention because of its size.
- *While playing, I thought about what the sounds were meaning to me*: *Causality* employs abstract sounds for the narrative. This, by default, disables a fixed meaning in the narrative. Instead, the aim of the narrative in *Causality* is to create a framework in which people would put their own meanings into the sounds and create their own stories.
- *I did not understand what the sounds meant*: as mentioned above, nearly all of the sounds were free of a definite meaning. However, this comment shows that the audience member was trying to understand the meaning rather than fill it. I believe this situation could be avoided by providing additional information saying that there is no single meaning and encouraging people to add their own meaning to create their own story.
- *It was a visual game*: this comment shows that the core game mechanics are not working as desired. *Causality* was aimed to be a sound-based game with visuals that provide a certain amount of information that will stay recessive while not making the audience feel debilitated. The main problem introduced with this comment is that the game could be played by using the visuals.
- *Visuals were leading the sounds*: this comment also resonates with the previous one and again requires improvement in the implementation of core mechanics. The problem this comment points to is the relation between the sound and the light in the game. It was designed that the light was to lag and follow the sound, however at places, where the exact sound is not discernible due to masking but the related light source was visible, it was observed that the sound was following light as the avatar got near the sound source and the volume of the sound increased making it recognizable.
- *The sounds were too intense and/or dark*: from the point of loudness, the sounds of *Causality* had a large dynamic range and could become loud depending on the audience's performance. However, this is an issue related to sound design and the style of the game and installation, which is created as a subjective work.

5.5 Conclusions and Future Work for Causality

Even though some aspects of *Causality* were working, some did not work as intended. I believe the most important step going forward is reengineering the idea that sound is the source of existence in the virtual world. This not only allows one to understand the game better but it also encourages one to pay more attention to sound and be more critical in listening thus performing and playing the game.

After improving the fundamental mechanics of the game, the next item that needs to be revisited is the balance between the visual and sonic stimuli. With *Causality*, I aimed to create a balance between the visuals and the audio, such that the visuals will not be debilitating but also not informative, deferring to the audio. Here the main problem comes with the audience: People with different backgrounds pay different amount of attention to the sound and can process different amounts of information from audio. One way to create a more leveled audience is to educate them. Normally, training a game player is done through tutorial levels, where the players are introduced to the game; also the challenge level of the games are gradually increased over time in line with the flow in order to keep the game challenging with respect to the player's improving skills. For *Causality*, a tutorial level is intentionally omitted mainly in order to maximize the time that the audience interacts meaningfully with the piece. However, as the amount of information in the visuals is decreased, it might be necessary to have an optional tutorial level for those who are not involved with audio.

The interface was a success but some details can be improved with focus groups and additional testing. The tablet-based remote control allowed a clean installation as

well as ease of use for anybody who has used a touchscreen device such as a smartphone.

Even though I have used a sound-emotion mapping study as the basis of the sound design process, it must be noted that the sound design was done with a subjective view. This created a certain bias in the sound-emotion mapping process. I do not believe that my approach is wrong; however, those, who want to have a more objective design, should employ proper test methods. I still believe it is a strong method in creating complex emotions with sound based on happiness-sadness and high activation-low activation bipolar scales.

Finally, *Causality* lacked an error reporting mechanism. In the (rare) cases, where the system could not establish the connection between the controller and the game, the system had no way sending a message to me about the error. Implementation of such a system would decrease the down time of the installation.

CHAPTER 6. CONCLUSIONS AND FUTURE WORK

Artists and musicians have been experimenting with music to expand the expressive capabilities. Some of these experimentations were done in areas related to narration, timbre, generative systems, space and interactivity. All these processes can be united under gaming, which is an interactive creative medium that is widely available and accessible.

Using game technologies and ideas enhances music through technological sonic possibilities, interaction, narrative and virtual spaces. Moreover, a game-as-a-musical-instrument also increases the immersion of the performance and the flow of the performer. In return, games, a medium driven by a highly commercial industry, can benefit from being exposed to artists and musicians.

However, neither game audio studies nor NIME provide much information related to such an approach and, other than a minority of games such as *Rez* or *Electroplankton,* not too many games focus on sound. Thus, a model is presented as a reference point for people who want to create games-as-musical-instruments. The model, based on the ideas of intermedia theories, systems approach and game sound, proved helpful in designing the test case, *Causality. Causality*, a non-generative game-as-a-musical-instrument, proved to be immersive, accessible and expressive. However, it

also had trouble in balancing the amount of information in the visual and audio components. The next chapters of the game are waiting to be implemented and further iterations of *Causality* will provide further insight into the idea and the model.

A parallel step to improving *Causality* would be to evaluate the music recorded with the installation. Listening tests will be conducted with people who are familiar with the discussions about the thesis but not *Causality* itself. The tests will aim to evaluate the narrative and the musical value of the audio when it is removed from the visuals and gameplay. The results of these tests will provide insight about the artistic direction of the music as well as the narrative structure for future works.

Prior to designing and developing the next test case, the study will focus on improving the sonic capabilities of the game engine. By adding the capabilities of dynamic sound generation and musical composition to the system, the game can be identified as an open episteme following Herber's definition. Due to my previous experience in combining Max/MSP/Jitter with Unity3D, I am inclined to use a combination of these tools as the next game engine.

Another point that needs further investigation is the performance of the idea/model without an installation case. The standard gaming environment today is a regular houseroom that is not designed for one specific game. In addition, the game would require more standard controlling scheme such as a keyboard and mouse. In such a case, where the game is being played on a computer or a console, the ideas of immersion, performance and audience can change.

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APPENDICES

Appendix A Works in Music and Sound Arts

In Section 2.2, the works of artists and musicians are divided into five categories with respect to the element they added to the traditional music and sound. Here those works are investigated in more detail.

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- Narrative Works
    - 4’33’’ by John Cage

John Cage says that *4’33’’* is his best piece.[127] *4’33’’* composed in 1952 is a piece that is not written for a specific instrument and it has no notes. The piece only has a definite length. Even though the piece seems to focus on silence in fact, it shows that the absolute silence cannot be achieved and noise prevails. In his own words, Cage describes *4’33’’* as follows:

> to compose a piece of uninterrupted silence and sell it to Muzak Co. It will be three or four-and-a-half minutes long—those being the standard lengths of “canned” music and its title will be Silent Prayer. It will open with a single idea, which I will attempt to make as seductive as the color and shape and fragrance of a flower. The ending will approach imperceptibility.[128]

For Cage, there is no absolute silence. There is background noise, which includes the sounds of our internal organs. Cage uses music, the organization of sounds that should overcome noise, to show that there is no silence. Interestingly, the noise is changing, if we look at record companies we see that in order to make their music more recognizable companies have been increasing the overall volume of music, or our physical environment is getting louder with the same reason, everybody wants to be heard. In that sense, *4’33’’* opens many discussions rather than simply stimulating new emotions by presenting silence in a condition, where the listener expects to hear music.

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[127] Dan Gilgoff, “Fifty Years Ago, John Cage Played the Sound of Silence,” *U.S. News & World Report* 133 (2002): 34.

[128] James Pritchett, *The Music of John Cage*, (New York: The Press Syndicate of the University of Cambridge, 1993), 59.

- Plunderphonics by John Oswald

Like Marclay, Oswald also uses recordings as the medium and source for his project *Plunderphonics (1985)*. Oswald intentionally takes the songs from recordings and modifies them before releasing his creation as an album not to be sold but to be distributed to places with the ability for public display such as radio stations and libraries.[129] With *Plunderphonics,* Oswald not only criticizes the popular music culture but also raises discussions about piracy, plagiarism and copyright. There have been lawsuits that resulted in Oswald destroying all of the undistributed copies of his works. In his paper, *Plunderphonics, or Audio Piracy as a Compositional Prerogative*, Oswald explains as follows:

> The precarious commodity in music today is no longer the tune. A fan can recognize a hit from a ten millisecond burst, 9 faster than a Fairlight can whistle Dixie. Notes with their rhythm and pitch values are trivial components in the corporate harmonization of cacophony. Few pop musicians can read music with any facility. The Art of Noise, a studio based, mass market targeted recording firm, strings atonal arrays of timbres on the line of an ubiquitous beat. The Emulator fills the bill. Singers with original material aren't studying Bruce Springsteen's melodic contours, they're trying to sound just like him. And sonic impersonation is quite legal. While performing rights organizations continue to farm for proceeds for tunesters and poetricians, those who are shaping the way the buck says the music should be, rhythmatists, timbralists and mixologists under various monikers, have rarely been given compositional credit.[130]

One of the lawsuits that *Plunderphonics* has faced was about the album cover, which featured an image of Michael Jackson with a nude female body. The aims of the

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[129] Chris Cutler, "Plunderphonia," in Audio Culture: Readings in Modern Music, ed. Chris Cox and Daniel Warner (New York: The Continuum International Publishing Group Inc., 2006). 138-156.

[130] John Oswald, "Plunderphonics, or Audio Piracy as a Compositional Prerogative," Plunderphonics. accessed April 6, 2011, http://www.plunderphonics.com/xhtml/xplunder.html

album covers are to attract attention, give information, promote the artist and make the product sell more. Even though the visual of the cover is in line with the idea behind the sound of *Plunderphonics*, I still believe that it is too apparent and in your face. Thus, it shadows the audio content. Yet, with *Plunderphonics* Oswald manages to raise questions about new musical styles as well as discussions about piracy and copyright issues. Here Oswald walks on a line between abstract sound and symbolic sounds. By using music, he uses abstract sound but since the sounds are from original music created by other people, they carry a certain meaning. However, the meaning that Oswald puts in his works is different from the narrative of the original parts. In that perspective, Oswald manages to create abstract sounds with meaning. Games provide similar opportunities in mixing different kinds of media as well putting them out of their original context for added meaning.

- Guitar Drag by Christian Marclay

Christian Marclay is an American artist that has mainly worked with analog recordings such as tape and vinyl in a process-based way. *Guitar Drag*, dated 2000, is not only a sound piece; in fact, it is a video piece, where the camera records an electric guitar being dragged behind a pickup truck. The guitar is plugged to an amplifier and one can hear the screams coming from the guitar while seeing the landscape of Texas in the background. The work has multiple references with the apparent one is to the murder of James Byrd Jr.[131] and the other one to Nam June Paik's *Violin with String*[132],

[131] More information about James Byrd Jr. can be found at http://www.cnn.com/US/9807/06/dragging.death.02/index.html.

dated 1962 as well as other instruments destroyed either by Fluxus or rock musicians. A detailed reading of the video can be found in Carlos Kase's article**.**[133] Here using the guitar, which Marclay defines as a phallic object with a female body, introduces a number of references. [134] However, after watching the video and reading a number of articles and reviews one cannot avoid seeing the Fender brand. Marclay explains *Guitar Drag* with the following sentences:

> All these references are there, and I think it really depends on the viewer's interest, knowledge, and state of mind. People will have different readings of this video, and I want all these to be legitimate. Ultimately, I made the video because of what happened to James Byrd, but all these other references allowed me to think of the guitar as this very anthropomorphic instrument that was already associated with violence, and with rebellion, and crazy youth. I think it's fine when people walk out of there disgusted. I think it's also fine when they walk out of there exhilarated.[135]

As Marclay says, the aim is not about showmanship but it is to tell a certain event in a different way. He takes ideas and procedures from music and performance and applies them to a contemporary social content. Here in addition to the sound, the way sound is created plays into the narrative. This is important as one can design a game, where the player can create sound in any way programmable. In addition, the

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[132] More information about Nam June Paik can be found at http://artnews.org/gallery.php ?i=667&exi=15154&MUMOK&Nam_June_Paik.

[133] Carlos Kase, "'This Guitar Has Seconds to Live': *Guitar Drag's* Archaeology of Indeterminacy and Violence," *Discourse: Journal for Theoretical Studies in Media and Culture*: Vol. 30: Iss. 3, Article 7 (2008): 422.

[134] Georgia Dehn, "Christian Marclay: Playing with Rock and Roll," *The Telegraph*, last modified March 1, 2008, http://www.telegraph.co.uk/culture/art/3671499/Christian-Marclay-Playing-with-rock-and-roll.html.

[135] Carlos Kase, "This Guitar Has Seconds to Live"., 422

actions that the player took, also known as gameplay, adds to the narrative similar to Marclay.

- New Sounds and Timbre
    - Intonarumori by Luigi Russolo

Even though originally a painter, Russolo is mainly known for his essay *The Art of Noises: Futurist Manifesto* in 1913. In his writings, he proposes people to embrace the new sounds and noises rather than rejecting them. With this idea, he introduces new families of sounds and a new instrument for music. *Intonarumori*, meaning noise instruments, are mechanical devices that can create sound with varying pitch and timbre. Unfortunately, the instrument and the recordings are lost and/or destroyed during World War II. Yet, some have been recreated from original plans and photos. Russolo's first conclusion in the manifesto is:

> We must enlarge and enrich more and more the domain of musical sounds. Our sensibility requires it. In fact, it can be noticed that all contemporary composers of genius tend to stress the most complex dissonances. Moving away from pure sound, they nearly reach noise-sound. This need and this tendency can be totally realized only through the joining and substituting of noises to and for musical sounds. [136]

Intonarumori is an instrument but it cannot be discussed independent of the *Futurist Manifesto.* This separates Russolo from other people who came up with new instruments. *Intonarumori* is a reflection of the manifesto on sound. Russolo worked with mechanical contraptions to create unique instruments; today his practice is

[136] Luigi Russolo, "The Art of Noises: Futurist Manifesto," in *Audio Culture: Readings in Modern Music*, ed. Chris Cox and Daniel Warner (New York: The Continuum International Publishing Group Inc, 2006), 10-15.

furthered by using electrical or software-based instruments. Within a game, one can also create instruments using programming.

- With Hidden Noise by Marcel Duchamp

With Hidden Noise is not the only sound project that Marcel Duchamp worked on. Done in 1916 in collaboration with Walter Arensberg, *With Hidden Noise* is a small object that has a concealed space through strings. Inside the space is an object that creates noise when shaken. The object is not known, since the secret was lost with Arensberg and Duchamp never wanted to learn it.[137] Duchamp describes the object as follows: “Before I finished it Arensberg put something inside the ball of twine, and never told me what it was, and I didn't want to know. It was a sort of secret between us, and it makes noise, so we called this a Ready-made with a hidden noise. Listen to it. I don't know; I will never know whether it is a diamond or a coin”.[138]

Here, the title of the piece is interesting. Why it is not With Hidden Sound? Duchamp uses the more specific word noise instead of sound and that is related to the object’s being anonymous. A direct answer would be: The sound creates curiosity yet does not give information so it just takes room in the neural system without being resolved or ended. Moreover, does it matter if the object is a coin or a diamond? However, we know that there is an object and its proof is the sound it creates. This relates to many things in our daily life, whose existence we only perceive through our

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[137] “With Hidden Noise,” *Philadelphia Museum of Art.* accessed April 19, 2011, http://www.philamuseum.org/collections/permanent/51541.html.

[138] Marcel Duchamp, *The Writings of Marcel Duchamp,* ed. Michel Sanouillet and Elmer Peterson (New York: Da Capo Press, 1989), 135.

hearing. However, in the world of games this works takes an interesting turn: In the virtual world, no object comes with a sound unless it is the sound itself, thus sound needs to be attached to a virtual object through programming. The relationship between object and sound is determined by the designer, artist or musician but not physics.

- Music Concrète by Pierre Schaeffer

In 1948, Pierre Schaeffer played a "Concert of Noises" over the radio. The piece was composed of the sounds of the life and the city including a range of sounds from train whistles to piano keys. [139] Schaeffer defined this type of music as *musique concrète*, which means music of concrete objects as opposed to abstract objects. With *musique concrète,* Schaeffer was able to put daily sounds into music and this was possible through advancements in broadcasting possibilities.

In virtual works, the concept *musique concrete* is hypothetical since objects are free of sound. Most of the sound designers create sounds that satisfy expectation, however it is also easily possible to create a world with unexpected sounds. Thus, the concreteness of a sound is design choice. *Musique concrète* will be discussed again with the works that incorporate location.

- Kontakte by Karlheinz Stockhausen

The idea behind *Gesang der Jünglinge, Kontakte, Telemusik* and *Hymnen* is to free music from the limits of the sound of the traditional western instruments. For this

[139] Pierre Schaeffer, "Acousmetics," in *Audio Culture: Readings in Modern Music*, ed. Chris Cox and Daniel Warner (New York: The Continuum International Publishing Group Inc., 2006), 76-81.

purpose, Karlheinz Stockhausen created his own instruments from circuitry.[140] Stockhausen describes *Kontakte* in his article as follows: "In the preparatory work for my composition Kontakte, I found, for the first time, ways to bring all properties [i.e., timbre, pitch, intensity and duration] under a single control." [141]

However, Daniel Pemberton offers a critique of *Kontakte*. He argues that *Kontakte* solely focuses on sound and the composition with the aim of being different, falls short of being different as it lacks a creative approach and only tries to be opposite of regular compositions.[142] The aim of Stockhausen as stated above was to invent new sounds for musical sonic expression. Even though, not everybody may appreciate the way he employed those sounds, his work provides an impetus for today's appreciation of different sounds in art, music, cinema and games.

- Merzbow by Masami Akita

Masami Akita is a Japanese noise-musician influenced by Dadaism, Surrealism, Futurism and Japanese sado-masochism. Unlike Russolo's approach, Akita uses the structures of rhythm, melody and pitch in the compositional structure, yet his sound is defined by feedback, distortion and other sound effects. His recording name is *Merzbow*,

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[140] Karlheinz Stockhausen, "Electronic and Instrumental Music," in *Audio Culture: Readings in Modern Music*, ed. Chris Cox and Daniel Warner (New York: The Continuum International Publishing Group Inc., 2006), 370-380.

[141] Karlheinz Stockhausen and Elaine Barkin, "The Concept of Unity in Electronic Music," *Perspectives of New Music* 1 (1962): 39-48, accessed March 25, 2011, http://www.jstor.org/stable/832178.

[142] Karlheinz Stockhausen, Aphex Twin, Scanner and Daniel Pemberton, "Stockhausen vs. the "Technorcrats"," in *Audio Culture: Readings in Modern Music*, ed. Chris Cox and Daniel Warner (New York: The Continuum International Publishing Group Inc., 2006), 381-385.

which is a reference to Kurt Schwitters' installation, *the Merzbau*. About *Merzbow*, Akita explains as follows:

> I am using a more physically rooted Noise Music not as conceptually anti-instrument and anti-body as before. If music was sex, Merzbow would be pornography. […] I mean that pornography is the unconsciousness of sex. So, Noise is the unconsciousness of music. It's completely misunderstood if Merzbow is music for men. Merzbow is not male or female. Merzbow is erotic like a car crash can be related to genital intercourse.[143]

Merzbow provides an example where the timbre values are abandoned and a flow of heavy sound effects are accepted as the color of the audio. The setup is an interesting system, which creates extreme aesthetics that fit with the fast, action-based games.

- Algorithmic Composition and Generative Systems
    - UPIC by Iannis Xenakis

Iannis Xenakis works in an interdisciplinary fashion having studied architecture and engineering. His music was based on mathematical expressions and engineering. Xenakis designed the music-composing tool called *Unité Polyagogique Informatique du CeMAMu* (UPIC) in 1976 at the Centre d'Études de Mathématique et Automatique. The system allows users to compose music via drawing. Metastasis is one of Xenakis' major works; it is an orchestral piece that has a visual notation like the blueprints of a structure. Xenakis describes *UPIC* as follows:

> "[…] the UPIC did not come from architecture, but it came from music itself. Because when I wrote for orchestras, some of the things were too complicated

[143] Chad Hensley, "The Beauty of Noise: An Interview with Masami Akita of Merzbow," in *Audio Culture: Readings in Modern Music*, ed. Chris Cox and Daniel Warner (New York: The Continuum International Publishing Group Inc., 2006), 381-385.

> to be specified in stave notation. So I had to introduce a graphic notation which, by the way, is also more universal… UPIC certainly wasn't made to simulate existing instruments.[144]

Xenakis used a computer for the first time in actively creating music. It opened a door to the field of computer music, where many people investigated and experimented with the creation of music by programs looking at human machine interaction, artificial intelligence to mention some of the related studies. With today's computational power, systems such as this can be a part of a game.

- Space-Related Works
    - Music Concrète by Pierre Schaeffer

As mentioned above, with *music concrète*, Schaeffer used sounds of everyday objects within music. However, in addition to timbre, space was also an important element in his work. Taking sounds of everyday objects and putting them into another location introduced the concept of acousmatic sound, which is the sound that one hears without seeing the source. The idea of acousmatic sound changes the way one approaches sound from the source of the sound to the perception of sound. This is an important concept in creating virtual spaces and to me as it affects the dynamics between the player and the game in two ways. With acousmatic sound, you can create sonic spaces that are more than the visible space also by conflicting visual and audible stimuli; one can encourage the player to pay more attention to listening.

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[144] Henning Lohner and Iannis Xenakis, Interview with Iannis Xenakis, *Computer Music Journal* 10 (1986): 50-55.

- World Soundscape Project by R. Murray Schafer

Like acoustic ecology, soundscape is a term introduced by Schafer. *The World Soundscape Project* was a research-based project, where the aim was to counter the regression of the soundscapes from hi-fi environments to low-fi environments in Vancouver initially and measure the changes in locations over time and to compare hi-fi and low-fi in environments.[145] An acoustic environment, where all the frequency bands are available for communication is called hi-fi. On the other hand, the acoustics of a city shows that some frequency bands become too noisy to communicate properly. These ecologies are called low-fi.[146] *The World Soundscape Project* aims to look for spaces where the acoustic ecology allows humans and nature to coexist healthily with every member having minimal interference in the frequency spectrum. The results have both artistic and scientific value. The recreation of an environment or a place sonically will play an important part in my future works. Games feature artificial environments and one can apply the ideas of acoustic ecology to design better virtual soundscapes for artistic and aesthetic purposes.

- Drift by Teri Rueb

Drift is an installation by Teri Rueb. It is a sound-based locative artwork, which allows the audience to listen to the recordings of speech and footsteps in water as they wander in the Wadden Sea area. The installation gives a feeling of discovering the

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[145] Barry Truax, B., The World Soundscape Project, retrieved April 25, 2011, http://www.sfu.ca/~truax/wsp.html.

[146] Wrightson, A*n Introduction to Acoustic Ecology*, 10-13.

Wadden Sea as the hearing depends on the walks. The piece creates a soundscape enhanced by a physical environment via a virtual link. Rueb defines her project as follows:

> The ubiquity of GPS (global positioning satellite) and other tracking technologies suggests that "being lost" may itself be an experience that is being lost. However, simply knowing one's geographical location as expressed in longitude and latitude coordinates has little bearing on one's personal sense of place or direction. "Drift" poses the age-old question "Where am I and where am I going?" in a contemporary moment in which spatial positioning and tracking technologies provide evermore precise, yet limited, answers to this question.[147]

With *Drift*, Rueb combines multiple ideas: Space-wise, the audience is following the water streams and waves; the movement is mapped to the virtual net of sounds. It creates a soundscape with an alternate physicality and space. Interactors can no longer wander with the rules of the space that they hear and they can no longer hear the space that they wander in. This superposition results in an alternate space that the mind can discover and the same idea can be translated to games to create sound-focused experiences.

- Listening Post by Ben Rubin and Mark Hansen

Listening Post is an installation by Ben Rubin and Mark Hansen. The installation sniffs texts from chat rooms and reads them via a text-to-speech module while displaying the text in hundreds of small screens. Ben Rubin describes *Listening Post* with the following sentences: "Dissociating the communication from its conventional on-

[147] Teri Rueb, "Drift," *Teri Rueb,* accessed March 20, 2011, http://www.terirueb.net/drift/index.html.

screen presence, Listening Post is a visual and sonic response to the content, magnitude, and immediacy of virtual communication." [148]

The project brings the sounds and/or noises of the vast virtual chat spaces into a comparably small physical environment. With *The World Soundscape Project*, the investigated space is a physical one. In Rueb's *Drift,* the space is a combination of virtual and physical space. *Listening Post* is interesting as it goes back and forth between virtual and real spaces. The initial space is a physical one spread all over the world by the people chatting online. The resulting chat rooms, the virtual space, are the focus point of the piece. Yet the resulting space is again a physical one.

Looking from Schafer's view, one can ask about the acoustic ecology of virtual environments: Players, NPCs, actions and objects making sound. One thing that might be interesting would be listening to the soundscapes of most played games. Will they provide a soothing experience or will the soundscapes be more distracting than a metropolitan downtown?

- Interactive Works
    - Very Nervous System by David Rokeby

Very Nervous System is an interactive sound installation created by David Rokeby. With the installation, Rokeby creates a system that is composed of computers, cameras, sensors and synthesizers; it is triggered with body movements to create sonic responses. Rokeby defines the installation as an instrument, where the actual details of controls are

[148] Ben Rubin," Listening Post - EAR Studio," *EAR Studio,* last modified September 29, 2010, http://earstudio.com/2010/09/29/listening-post/.

not important; however, the feedback between the movements of the user and the sonic response of the system is more crucial.[149] About *Very Nervous System,* Rokeby says:

> Each instrument is basically a behavior, an electronically constructed personality. It's watching you. It's looking out of the video camera at your body, and taking playing cues from your movement. These behaviors are just algorithmic definitions - computer subroutines. I construct them to suggest whether this instrument, for instance, tends to play on offbeats, or perhaps plays on offbeats but doubles its rhythm if you move faster. The piece you just experienced has an electric guitar, an acoustic guitar, a bass, drums, and a brass section. It's a funk piece.[150]

Interactivity is one of the main elements of games. With *Very Nervous System*, we are presented with a system that incorporates multiple cameras, image processors, computers and synthesizers to create the desired experience. By using gaming technologies for performance, we have an easier access to different interaction methods. Today game interfaces include but not limited to from the basic mouse-and-keyboard combination to accelerometers, gestural interfaces, real musical instruments, motion detection and the whole smartphone as a controller. By determining the amount of control and the method of interaction, we change the dynamics of the performance, the instrument and the produced sound significantly.

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[149] David Rokeby, "David Rokeby: Very Nervous System," *David Rokeby,* last modified November 24, 2010, http://www.davidrokeby.com/vns.html.

[150] Douglas Cooper, "Wired 3.03: Very Nervous System," *wired.com,* last modified March, 1995, http://www.wired.com/wired/archive/3.03/rokeby.html?pg=1&topic=.

Appendix B Examples of Video Games

Here, I will present some examples from recent video games. The aim of these examples is to provide a wide range of types of games that supports the definition offered in Section 2.3.1. For these reasons, I will look at games beyond the more mainstream game genres such as the shooter.

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- Fallout: New Vegas

Fallout: New Vegas is a 3D role-playing game that takes part in a post-apocalyptic Las Vegas area. The game provides an open world, where playing the role of a courier; players have the chance to be the hero or the villain. The game environment is composed of small settlements, ruins and relics from the imagined-old world in the Mojave Dessert. Players get to interact with the non-player characters of the world and

shape their world through choices, words and combat. The game follows a well-written story and utilizes nostalgia to create an immersive experience. In addition, the game provides an acoustic environment that interacts within the game and with the player. By listening to the environment, the player not only gains information but also feels and understand the setting she is in.

- Braid

Braid is a 2D platformer/puzzler that is designed by Jonathan Blow. The game's main theme is about regret and each world in the game provides a different set of challenges based on time. *Braid* uses well thought game mechanics and puzzles to support and further the story of the game. The game features consistency in all the elements of the game and this raises the overall experience. For example, the main character can rewind the time and when the time is going backwards the music of the game is also reversed. This gives the control of each element under the player's hand in a united way. *Braid* has won multiple awards including awards from Independent Games Festival and Game Developers Conference.

- The Blood Typing Game

The Blood Typing Game[151] is a Nobel Award winner educational game about blood. The game is defined to answer questions about blood types, blood transfusion, antibodies, antigens and risks of blood transfusion. In the game, the players needs to find out the blood type of the patient and needs to transfuse the patient with the

[151] Nobel Media AB, *the Blood Typing Game* (2011).

correct blood. Here the action of play is used for education purposes and the same can be applied to practicing a musical instrument.

- uDraw

uDraw[152] is not a single game instead a series of games that is based on drawing on a graphical tablet. The games within *uDraw* family range from *uDraw Pictionary*[153] to *Marvel Super Hero Squad: Comic Combat*[154]. *uDraw* games translate drawing to an action that trigger a game mechanic. The platform offers interesting opportunities for game design and interaction. Even though *uDraw* turned out to be an economic failure after initial commercial success, it is an example that presents a controlling scheme that is different from the default controls. In addition, it also provides a creative translation of the user's actions to events. This is important because different types of games requires different schemes of controls and if the aim is to create a game that is a musical instrument, the controls also needs to be thought from the inception to serve that idea.

- Just Dance

Just Dance[155] is a successful dance gaming franchise that has yearly installations. Even though, it is not the first dancing game, it has employed the wireless controlling scheme of Nintendo Wii platform to create a natural game mechanics for dancing. In the

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[152] THQ Inc., *uDraw* (Agoura Hills: THQ Inc., 2010).

[153] Pipeworks Software, *uDraw Pictionary* (Agoura Hills: THQ Inc., 2010).

[154] Griptonite Games, *Marvel Super Hero Squad: Comic Combat* (Aguora Hills: THQ Inc., 2011).

[155] Ubisoft Paris, *Just Dance* (Montreuil: Ubisoft, 2009).

game, the player needs to match the movements with the dancer on the screen to earn points and unlock more songs. The game also features workout modes. Similar to *uDraw*, *Just Dance* also provides a unique type of interaction as the controllers such as Wii Remote, Microsoft Kinect and PlayStation Move enable motion detection.

- Dear Esther

Dear Esther[156] is defined as a story that is told using the first-person-shooter technologies. The game does not focus on interactivity or game mechanics in the traditional sense. Instead, *Dear Esther's* only game mechanic is exploration. Initially started as a MOD, *Dear Esther* was developed by a small group of developers and won multiple awards. Even though, the game lacks most of the common gameplay elements and game ideas, it still is a good reference for storytelling, which can be used as a starting step for employing the narrative capabilities of games to a musical instrument game.

- Minecraft

Minecraft[157] is a massively multiplayer game about shaping the world through mining resources. *Minecraft* presents a fully customizable world that is created procedurally. Within Minecraft, people have been creating various types architecture and projects. Even though it is dominantly in visual realm, *Minecraft* portrays the power of games to be a creative tool–a 3D CAD tool in this case–that is accessible to a large

[156] The Chinese Room, *Dear Esther* (The Chinese Room, 2012).

[157] Markus Persson, *Minecraft* (2009).

crowd. Minecraft has won multiple awards and sold 10,958,194 copies as of June 21, 2013.[158]

[158] The current value can be obtained from https://minecraft.net/stats.

Appendix C Top 100 Games in Steam

Steam is the largest online platform that is available worldwide that sells video games for Windows, Mac and Linux based computers. The below table shows the top 100 games top 100 games played in Steam as of May 31, 2013 at 12:35 GMT -6 among 4,613,901 current online users.[159] Of these 100 games, none of them is known for employing sound as an essential part of the game.

Table 2: The 100-most played games in Steam

Current Players	Peak Today	Game
303,763	308,015	Dota 2
64,614	65,033	Team Fortress 2
44,822	61,805	Football Manager 2013
30,098	35,300	Counter-Strike
25,440	30,354	Counter-Strike: Source
24,962	28,042	The Elder Scrolls V: Skyrim
23,777	33,286	Counter-Strike: Global Offensive
22,810	27,454	Sid Meier's Civilization V
20,283	23,902	Call of Duty: Black Ops II - Multiplayer
17,043	17,552	Warframe
16,607	20,886	Borderlands 2
14,762	17,689	Garry's Mod
10,903	12,442	Call of Duty: Modern Warfare 3 - Multiplayer
8,555	9,798	Left 4 Dead 2
8,394	8,394	Terraria
6,802	9,729	Football Manager 2012
6,727	7,956	Call of Duty: Modern Warfare 2 - Multiplayer
6,572	6,572	GRID 2
6,319	8,479	Crusader Kings II

[159] The current data can be obtained from http://store.steampowered.com/stats/.

Table 2 Continued.

6,206	7,187	Total War: SHOGUN 2
5,220	6,274	PlanetSide 2
5,149	6,083	Empire: Total War
4,839	6,167	Arma 2: Operation Arrowhead
4,796	4,796	Rising Storm/Red Orchestra 2 Multiplayer
4,548	6,129	Mount & Blade: Warband
4,371	5,730	Ragnarok Online 2
4,009	5,560	PAYDAY: The Heist
3,949	5,848	Star Trek Online
3,773	4,209	Stronghold Kingdoms
3,697	4,623	Fallout: New Vegas
3,479	4,926	Chivalry: Medieval Warfare
3,348	3,780	Don't Starve
3,317	3,875	Wargame: AirLand Battle
3,283	3,836	Metro: Last Light
3,108	4,043	Company of Heroes (New Steam Version)
3,009	3,284	Call of Duty: Black Ops II - Zombies
3,008	3,277	Serious Sam HD: The Second Encounter
2,921	3,653	Kerbal Space Program
2,900	2,900	Alan Wake
2,761	3,573	XCOM: Enemy Unknown
2,725	3,122	Grand Theft Auto IV
2,622	3,410	Age of Empires II: HD Edition
2,613	2,753	Saints Row: The Third
2,597	2,768	Napoleon: Total War
2,573	2,904	The Binding of Isaac
2,565	2,990	Portal 2
2,494	2,724	Tomb Raider
2,489	2,881	Call of Duty: Black Ops - Multiplayer
2,373	3,359	Awesomenauts
2,371	2,868	Dark Souls: Prepare to Die Edition
2,357	2,910	Torchlight II
2,328	3,057	Arma 3 Alpha
2,296	2,296	Primal Carnage
2,200	2,908	The War Z
2,130	2,469	Killing Floor

Table 2 Continued.

2,018	2,648	The Incredible Adventures of Van Helsing
1,999	2,445	BioShock Infinite
1,814	1,891	Call of Duty: Modern Warfare 3
1,794	1,794	The Walking Dead
1,718	4,737	APB Reloaded
1,542	1,736	Might & Magic ® Heroes ® VI
1,533	1,940	F1 2012
1,524	1,702	Blacklight: Retribution
1,488	1,994	Counter-Strike: Condition Zero
1,477	1,968	Magic: The Gathering - Duels of the Planeswalkers 2013
1,442	2,066	Day of Defeat: Source
1,442	1,939	Defiance
1,419	1,752	Call of Juarez Gunslinger
1,402	1,672	Far Cry® 3
1,356	1,537	Just Cause 2
1,347	1,525	Hitman: Absolution
1,346	1,707	DC Universe Online
1,340	1,639	Farming Simulator 2013
1,278	1,444	Dead Island Riptide
1,242	1,505	Metro 2033
1,230	1,562	Dust: An Elysian Tail
1,190	1,405	Dungeon Defenders
1,178	1,351	Spiral Knights
1,149	1,540	Deus Ex: Human Revolution
1,149	1,179	Resident Evil 6 / Biohazard 6
1,143	1,407	Age of Empires Online
1,127	1,412	X3: Albion Prelude
1,124	1,203	Call of Duty: Black Ops II
1,123	1,452	The Lord of the Rings Online™
1,109	1,333	Warhammer® 40,000™: Dawn of War® II – Retribution™
1,107	1,346	Medieval II: Total War
1,104	1,389	Sleeping Dogs™
1,087	1,324	Sniper Ghost Warrior 2
1,081	1,307	Train Simulator 2013
1,072	1,623	Little Inferno
1,067	1,332	Assassin's Creed® III

Table 2 Continued.

1,058	1,309	Resident Evil Revelations / Biohazard Revelations UE
1,057	1,433	Sins of a Solar Empire: Rebellion
1,050	1,140	Call of Duty: Black Ops
1,049	1,216	Dead Island
1,044	1,237	Borderlands 2 RU
1,033	1,336	Rome: Total War
1,009	1,476	Hotline Miami
1,009	1,244	Half-Life 2
993	1,107	Grand Theft Auto: Episodes from Liberty City

Appendix D Games with Unique Audio

In Section 4.3, I have mentioned a number of games about their usage of sound. Here, the games are introduced in more detail.

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Guitar/Band/DJ Hero p. 112

Beat Hazard p. 112

Auditorium p. 112

Fallout: New Vegas/Grand Theft Auto p. 113

Silent Hill 2 p. 113

LIMBO p. 114

- Rez

Designed by Tetsuya Mizguchi for PlayStation and Sega, Rez is a rhythm based music game like the popular game Guitar Hero. Yet in the game, the player does not try to hit a button at a certain time, instead the player flies around and fights with enemies in a science fiction environment. The actions chosen are reflected via the soundtrack, the timings of the output sound are adjusted to match with the rhythm. Rez takes the

basic approach of "Mickey Mousing" [160] as in the early computer games, yet uses it to create a more complex diegetic and nondiegetic music. The musical style of the game stems from research done on African tribal music and techno music. On the gaming side, Rez has a mode in which the character is invincible so that the player can focus on creating music. The initial success of the game resulted in a rerelease of the game with improved graphics for newer gaming consoles.[161]

- Electroplankton

Designed by Toshio Iwai for Nintendo DS, Electroplankton is descendent of Iwai's games that introduce music creating entities in the game. Electroplankton is a game that includes composing, performing via audiovisual interactivity. The game uses biological concepts as metaphors for directing the visuals and the audio. The aim of the game is allowing the players to create their own interactive audiovisual performance as a visual music instrument.[162] Even though, *Electroplankton* is a successful example of using games for audiovisual performance like the game created by the *Tacit Group*, it does not carry a narrative.

[160] Mickey Mousing is the technique, where sound reflects the animation in a cartoon one-to-one.

[161] Axel Stockburger, "Sound-Image Relations in Video and Computer Games," in in *See This Sound Audiovisuology Compendium*, ed. Dieter Daniels and Sandra Naumann (Cologne: Verlag der Buchhandlung Walther König, 2009), 129-139.

[162] Ibid.

- Guitar/Band/DJ Hero

These games try to mimic and gamify actual music performance by providing simplified instruments. They do not try to make a new instrument or a new composition but repeat what is already there and embed it with ideas of gaming. In addition, these games also do not support a narrative nor use the translational potentials of computer interfaces. However, they do succeed in bringing the action playing an instrument to an audience that may not have the skills, knowledge or the desire to learn.

- Beat Hazard

Beat Hazard is an action shoot 'em up game, where the levels are generated based on the music that you choose. In the end, it is not a sound game but an action game/visualizer that is triggered by the melody, timbres and rhythm of the soundtrack. The game does not create sound in a creative way. However, it uses sound as an input and employs translation to level design.

- Auditorium

Auditorium is a puzzle game where you have to lead light rays to certain locations on the screen with various contraptions. When the light feeds the correct places, layers of music are activated creating a sonic output. The result is in the sonic domain yet the game mechanics are not about sound as the feedback is visual and the game is based on abstract physics.

Games that are not sound games but applicable:

- Fallout: New Vegas, Grand Theft Auto

These two games are examples for a type of game that feature open worlds, complex acoustic environments and soundscapes that allow mixing and possibilities of acousmatic music. In addition, they both feature radios, which play the soundtrack of the games as well as 'radio' shows, whose content changes based on the game states. In that sense, they bring non-diegetic music into diegesis through game mechanics. These games, as they are now, try to replicate reality and they are sonically mostly bounded with the realistic expectations of how things sound like. They support various types of interaction, ideas and narrative, yet not through sound. I believe these can be converted into novel sonic experiences by employing the virtual space and creating the games with the idea of a creative sonic experience in mind.

- Silent Hill 2

The sound of Silent Hill 2 is designed and composed by Akira Yamaoka and it features in general no distinction between 'music' and 'sound effects'. This is achieved by using music that blends in with the sounds of the environment. For practical purposes, this creates smooth transitions between the songs of the game, but it also creates a more complete atmosphere, where the diegetic and the non-diegetic sounds blend in.

- LIMBO

Limbo is a platform game with music that is in a style not much seen in the game industry as it features a soundtrack that is created with the objects in the game in real time with the mechanics of the game. In the talk, titled The Environment is the Orchestra: Soundscape Composition in LIMBO[163], Martin Stig Andersen presents some of the reviews the sound of Limbo got. The reviews were varying from saying that there is no music in LIMBO to the music of LIMBO is great. These reviews show the expectation and understanding of the professionals who write game reviews and shows that most of them are only familiar with traditional or mainstream music. On the other hand, the music of *LIMBO* shows the power of games in creating an experience that integrates space with sound through *musique concrète*, where the concreteness of the sounds can be designed as desired.

[163] Martin Stig Andersen, *"The Environment is the Orchestra: Soundscape Composition in LIMBO*" (presentation, Game Developers Conference, San Francisco, CA, February 28-March 4, 2011).

Appendix E Steam Games per Genre

Steam does not feature any specific genre for audio or music games;[164] however, the breakdown of the number of games per genre can be observed in Table 3 as acquired on May 31, 2013.[165] The sum of the number of games in each genre does not give the number of total games since some games have multiple genres and are counted multiple times.

A forum discussion from October 2010 lists the 'music driven' games that people who have contributed to the thread are aware of.[166] There are eight games discussed in the thread and at least one of them cannot be considered as a 'music' game.

Table 3: The distributions of games in Steam per their genre

Genre	Number of Games
Platformer	2007
Action	793
Indie	536
Strategy	406
Adventure	347
Casual	**267**
RPG	246
Simulation	168
Racing	72

[164] Searching for 'music' or 'sound' returns games with the searched word in their titles, descriptions and reviews. Thus, it is not helpful.

[165] Current data can be obtained from http://store.steampowered.com/search/?genre=Action&category1=998#category1=998&advanced=0&sort_order=ASC&page=1.

[166] http://forums.steampowered.com/forums/showthread.php?t=1548134

Table 3 Continued.

Free-to-play	70
Massively Multiplayer	60
Sports	57
Total	5029
Unique total	2007

Appendix F Framework for Acoustic Ecology of First Person Shooter

Here is Grimshaw's framework that describes the relationship between the player and the acoustic ecology of a first person shooter.[167]

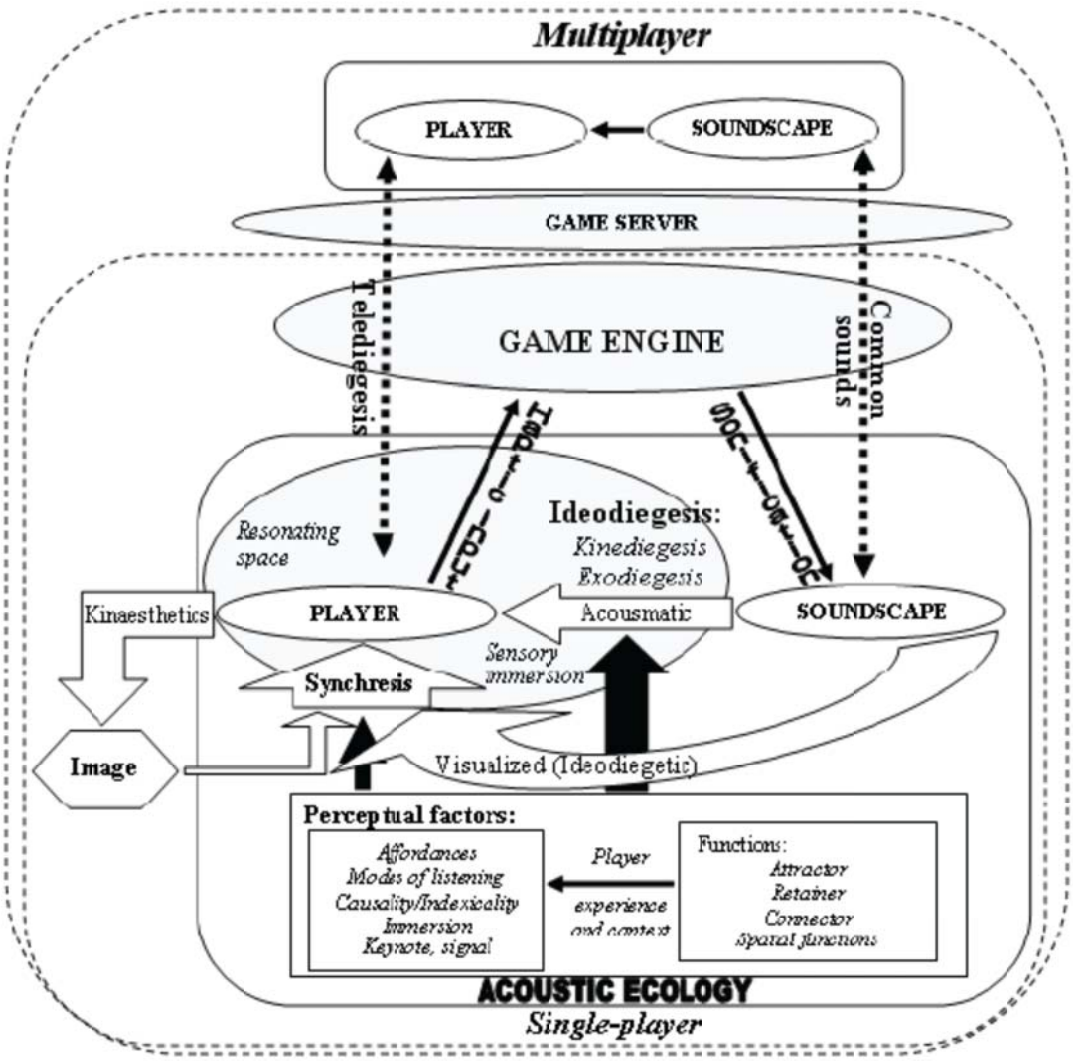

Figure 12: The framework of acoustic ecology of a multiplayer run-and-gun first person shooter

[167] Mark Grimshaw, *The Acoustic Ecology.,* 251.

Even though the complete explanation of the framework is beyond the aims of thesis, it can be explained as follows: The resonating space is defined as a space with volume and time and here represents the space that the player hears.

The player and the soundscape is part of the acoustic ecology. The functions of the sounds of the space can be defined as:

- *Attractors:* Sounds that tempt the user to do something.
- *Retainers:* Sounds that encourage the user to stay and enjoy an area.
- *Connectors:* Sounds that help the user to find out her location.

These sounds are perceived based on affordances, modes of listening, their causality and indexicality, the player's immersion.

The seen space and the sonically visualized space create synchresis.

All the inputs to the user contribute to the sensory immersion.

In a multiplayer setting the players may share soundscapes; however, each player's own acoustic ecology can be analyzed independently by modeling the other player as an interactive sound source.