慶應義塾大学学術情報リポジトリ
Keio Associated Repository of Academic resouces

Title	THE EMPYRIAN : vision files for a virtual reality music platform
Sub Title	
Author	Leonardi, Cristiano(Sugiura, Kazunori) 杉浦, 一徳
Publisher	慶應義塾大学大学院メディアデザイン研究科
Publication year	2016
Jtitle	
JaLC DOI	
Abstract	
Notes	修士学位論文. 2016年度メディアデザイン学 第498号
Genre	Thesis or Dissertation
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO40001001-00002016-0498

慶應義塾大学学術情報リポジトリ(KOARA)に掲載されているコンテンツの著作権は、それぞれの著作者、学会または出版社/発行者に帰属し、その権利は著作権法によって保護されています。引用にあたっては、著作権法を遵守してご利用ください。

The copyrights of content available on the KeiO Associated Repository of Academic resources (KOARA) belong to the respective authors, academic societies, or publishers/issuers, and these rights are protected by the Japanese Copyright Act. When quoting the content, please follow the Japanese copyright act.

Master's Thesis

Academic Year 2016

THE EMPYRIAN
Vision Files for a Virtual Reality Music Platform

Graduate School of Media Design,
Keio University

Cristiano Leonardi

A Master's Thesis

submitted to Graduate School of Media Design, Keio University

in partial fulfillment of the requirements for the degree of

MASTER of Media Design

Cristiano Leonardi

Thesis Committee:

Professor Kazunori Sugiura	(Supervisor)
Professor Naohisa Ohta	(Co-Supervisor)
Professor Susumu Furukawa	(Co-Supervisor)

Abstract of Master's Thesis of Academic Year 2016

THE EMPYRIAN:
Vision Files for a Virtual Reality Music Platform

Category: Design

Summary

This thesis presents a new type of media called “Vision” that uses Virtual reality and modern game engines to perform and create music. This study analyses how Vision files can be preferred over Music files and Music Videos. This new media is meant to be used on a platform called “The Empyrian”: we will explore Vision files and The Empyrian from several points of views and understand the reasons why through it players (“Visionaries”) will have the possibility to enrich their music experience by using and creating Vision files. The principles, design concept and challenges of the development of this new media are descripted and discussed in this study, and users’ response to Vision files is evaluated by being compared to both Music files and Music Videos. The results will show that users in the test prefer Vision files over the other two media.

Keywords:

Virtual Reality, Music design, Synesthesia, Visual music, Entertainment

Graduate School of Media Design, Keio University

Cristiano Leonardi

Contents

1. Introduction 9
1.2. Motivation and Objectives 10
1.3. Thesis Overview 10
1.4. Roles and Responsibilities 11
2. Virtual Reality and Visual Music 12
2.1. Virtual Reality: An Old Brand-new World 12
2.2. History and Trends of Visual Music 21
2.2.1 Thomas Wilfred 22
2.2.2 Oskar Fischinger 24
2.2.3 Charles Dockum 25
2.3 From Abstract Films to the Music Video 27
Notes 33
3. Related Works Review 34
3.1. Björk Digital and her VR Single 34
3.2 Other Music Applications Using VR 36
Notes 38
4. Concept Design 39
4.1. The Idea of a Music Tunnel 39
4.2. Avatar, Particles, Kinect and Heaven 42
4.3 Harder, Better, Faster, Stronger 46
4.4 The First Prototype and Transition to a Platform 51
Notes 54
5. Discussion on Vision files and their Business Model 56
5.1. Platform Design, Value Proposition and USPs 56
5.2. Business Plan and Target Audience 59

5.3 Gameplay and Other Aspects to Cover....63
5.4 Monetization, Ads and Scalability....65
Notes....66
6. Evaluation....67
6.1. Evaluation Aim....67
6.2. Evaluation Method....67
6.3. Result and Feedbacks....69
6.4. Summary of Findings....73
7. Conclusions....75
7.1. Conclusions....75
7.1.1 Advantages....75
7.1.2 Limitations....77
7.2. Future Improvements....78
7.3. Summary of Contributions....81
Acknowledgements....83
References....84
Appendix....88

List of Figures

Figure 0: The Stereoscope [2].
Figure 1: The Plastigram [3].
Figure 2: The Sensorama [4].
Figure 3: The prototype of the Telesphere, resembling modern VR HMD [5].
Figure 4: The Ultimate Display [6].
Figure 5: The first VR based arcade coin-ops [10].
Figure 6: The Oculus Rift internals, Consumer Version 1 [13].
Figure 7: The latest Magic Leap commercial on YouTube [16].
Figure 8: The colors of musical notes according to various personalities [19].
Figure 9: The Clavilux controlled by Wilfred [25].
Figure 10: Fischinger's Lumigraph [28].
Figure 11: Dockum and the Mobile Color Projector [30].
Figure 12: Mute abstract visuals of the Mobile Color Projector [30].
Figure 13: Fischinger's Color Rythm and Modernism in Visual Music [34].
Figure 14: Viking Eggeling's reception [35].
Figure 15: Len Lye's Photograms [36].
Figure 16: The first "Screen Song" [44].
Figure 17: The Cinebox, father of the modern Music video marketing [45].
Figure 18: The Beatles in "Strawberry Fields Forever" [47].
Figure 19: Queen's "Bohemian Rhapsody" [48].
Figure 20: Björk's "Stonemilker" [49].
Figure 21: Intone's "Sing" [50].
Figure 22: an example of iTunes' Visualizer function [51].
Figure 23: The first sketch of the tunnel.
Figure 24: The platform and pivotal center placed at the chest of the player [55].
Figure 25: The character design and bones necessary to link it to Kinect [56].
Figure 26: The tunnel with a cloud texture, remembering a path to heaven.
Figure 27: The TECHTILE Toolkit used to create gloves for one of the prototypes [57].
Figure 28: Daft Punk's "Harder, Better, Faster, Stronger" made into a Vision.
Figure 29: The platform prototype design.
Figure 30: The elements that make a Vision file.
Figure 31: Vision presentation as new media.
Figure 32: Oculus platform uses direct sales of VR apps and games [64].
Figure 33: Example of users' Vision interpretation after Lady Gaga's song.
Figure 34: Example of interpretation of song with Creep [65].
Figure 35: How Oculus categories its VR apps [67] .
Figure 36: Average age of participants.
Figure 37: Linear Regression results.
Figure 38: Chart of Linear Regression results and best-fit line.
Figure 39: Would you buy it? Question result chart.
Figure 40: Vergence and eyes focus example.

Chapter 1

1. Introduction

1.1. Background

At the core of human desire there has always been evasion: break the shackles of the terrain life to embrace escapism, metaphysical transportation, a life that is *other* than ours. This is the core of concepts like meditation, art, cinema and music. And is also what Virtual Reality[1] and Visual Music[2] want to achieve: surpass what is strictly sensorial to embrace a different dimension.
In the case of Visual Music, the wish to leverage senses other than vision, the will to unite image and sound date back centuries and had various names and developers. Visual Music is less known in its history and did never settle as a stable art [1]. Virtual Reality shares with Visual Music this desire of evasion. Similarly to Visual Music, Virtual Reality has an old history that dates back to the fifties and has several attempts at commercialization.
This study presents a prototype of a new media called “Vision”, that touches both the aforementioned disciplines and borrows from other media to create a new one. We will see how Vision files differs from the actual way of enjoying music done by listening to music files or watching music videos. An introduction to the little known histories of Visual Music and Virtual Reality will lead to the development of the project in stages. After the prototype development part, a business analysis of the platform called “The Empyrian”, where Vision file would be used, and an analysis of the realizability of the project and its statistical data review will follow. History of the two main disciplines (Virtual Reality and Visual Music) involved in the project played an important role in it and constitutes its background, as looking back at the various iteration of music

and visual throughout the media created in history was a great source of inspiration to conceptualize what was needed to enrich the music experience.

1.2. Motivation and Objectives

How can Virtual Reality and Music blend together? The hypothesis of this thesis is that Virtual Reality can enrich the music experience and become a more suitable media for music than the choices available today: music files or music videos. This thesis propose “The Empyrian” and its “Vision” files as the new media to do so. The Empyrian uses Virtual Reality and Music and wants to make possible for people to enjoy music in a virtual environment and for artists to achieve a new way of creative expression. The author’s focus will be on the design, conceptualization and aspects of practical development of this new media called “Vision” that borrows concepts from several media to become files usable with VR from an online platform called The Empyrian. This study will explore in depth what are the characteristics of a Vision and what it borrows from existing media and ultimately what does people want when entertained in VR and Music. The objectives of this study are: A) to present the actual state of VR and Visual Music in order to B) to illustrate how The Empyrian could enrich the music experience and to C) to illustrate how the project is realizable and can be a new way to create a new media for developers from a design and business standpoint.

1.3. Thesis Overview

This study is structured in seven chapters. The first describes the project background and motivations behind it, while the second introduces the concepts of Virtual Reality and Visual Music by analyzing a brief story of both to understand better and conceptualize what have been the needs of people in time for Visual Music and Virtual Reality. The third part describes also how Visual Music will eventually verge into what became the modern Music Video, and how this eventually became Virtual Reality Music Video with several artists and ideas developed. It also describes how Visual Music has been used in other ways precedent to the advent of Virtual Reality itself in the modern era of the computer world. The fourth chapter describes the project’s approach to Virtual Reality and Music in depth by analyzing the development of the project

in its four main iterations, each with different approaches and logics, and how these iterations helped in achieving the final form of the project, described as a last fourth step. This part involves a product conceptual part that analyzes customers tastes and tackles how customer uses various media. The fifth part of this study analyzes how the project could pass from the concept of the prototype to the one of online VR Music platform called “The Empyrian”, and introduces a gameplay analysis of the project for future eventual commercialization of it from several points of views. The sixth part of this study addresses the evaluation of the project: as the project was showcased at different venues, this part reviews the resulting statistical data and responses received during those events, in order to frame what are the limitations and the parts of the project that could be improved. The seventh and last part draws the conclusions by underlining what are the strengths, weaknesses and necessary steps for future development and improvement of the project

1.4. Roles and Responsibilities

This thesis is a result of the development of a project done during a class held at KMD in 2013. It is an original project and the author of this study was the project leader, character designer, programmer, 3D modeler, stage modeler and director and sole responsible for it.

Notes

1 According to Oxford’s definition, “The computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.”

2 According to the Centerforvisualmusic.org, “A visualization of music which is the translation of a specific musical composition (or sound) into a visual language, with the original syntax being emulated in the new visual rendition. This can be done with or without a computer. This can also be defined as intermedia.”

Chapter 2

2. Virtual Reality and Visual Music

2.1. Virtual Reality: An Old Brand-new World

The concept of Virtual reality had various waves of research and has been marketed in different eras to consumers. In the past century several artists and technicians tried to figure a way of optically deceive the mind into thinking about being in a different place. Metaphysical transportation and a different state of mind played as a very attractive promise on the mind of people, but the limits of technology precluded the development of what was, years ago, too cumbersome and ahead of its time. The latest technology, however, today can help us achieve this dream. This brief section of history of VR will introduce the key platforms of the development of what today is called Virtual Reality. Reviewing history (and especially its undeveloped side) helped me in understanding what kind of features of VR to consider when designing The Empyrian, and what characteristics can use to achieve a richer experience in music.

Historically, the first step into the creation of a system to deceived the brain into 3D thinking was with the “Stereoscope” [2] by Charles Wheatstone in 1838. His idea used slightly different images to the two eyes by using a mirror stereoscope that created what can be called “stereo photography”. The system combines two images to create the illusion of depth perception[1].

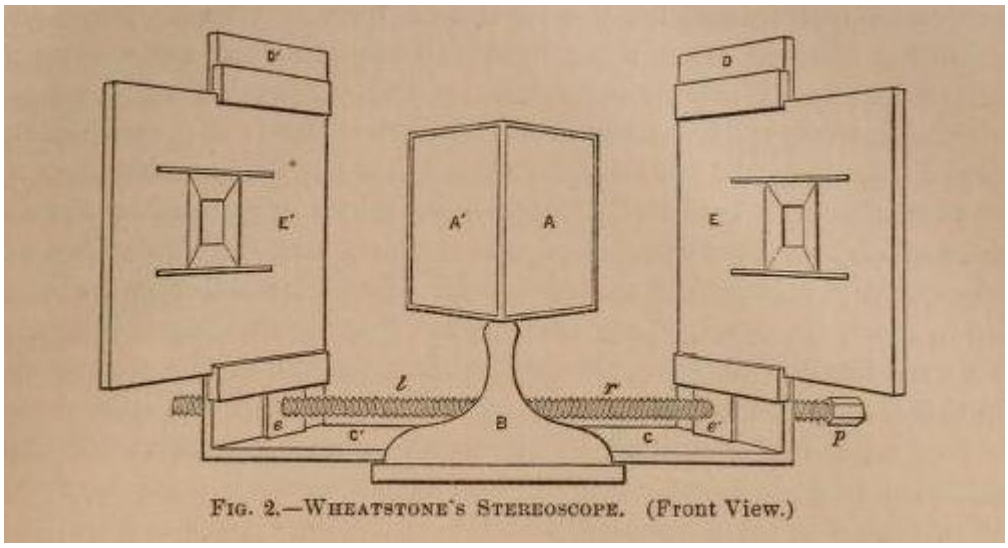


FIG. 2.—WHEATSTONE'S STEREOSCOPE. (Front View.)

Figure 0: The Stereoscope [2].

The Stereoscope stimulated the development of stereo photography during the end of the century until the beginning of the next one, when it was replaced in the mind of fans by the invention of movies. It was with movies that three-dimensional images became popular thanks to William Friese-Green who created the first anaglyph 3D² films in 1889 [3]. These movies were called “Plastigrams” and had a film with the green image emulsion on one side and the red one on the other side and were to be watched by using special glasses in the theater. Some of these movies provided also customers with different endings.

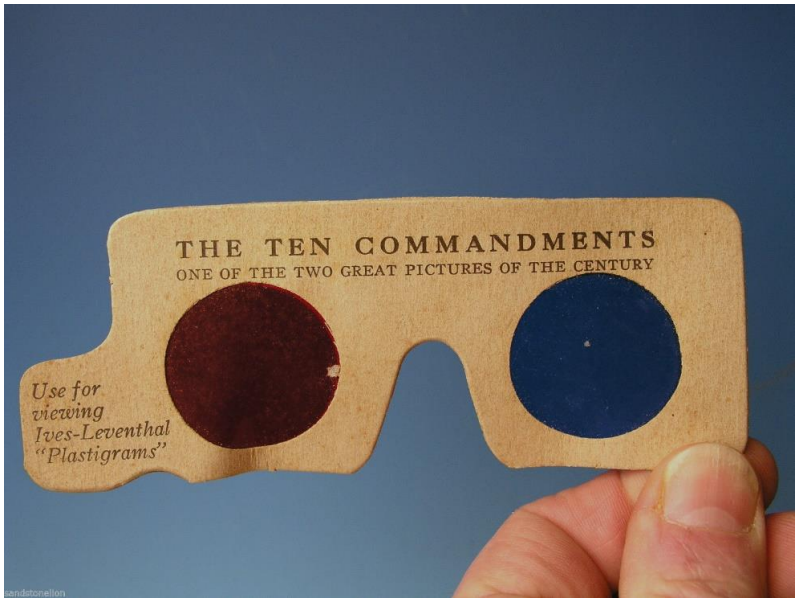


Figure 1: The Plastigram [3].

The development of what is the father of modern VR started with the “Sensorama” by Morton Heilig in 1960 [4].Heilig created a mechanical device that would create a theatrical experience and at the same time stimulate all senses of its users. The Sensorama included a stereoscopic display with wide peripheral vision, fans to emulate the wind and odor emitters to tackle the sense of smell. Also, the chair had vibration and the system had stereo speakers for sound. Heilig was, in this sense, the father of passive 3D films, he produced five short films for his system but its price point at 1.5million $ made it too steep of a sale for customers at that time. Part of its creation has been studied for this project, specifically what senses to involve in the creation of a VR experience and what degree of immersion they provide each (for more on the development of the sense of touch for this project refer to the “Harder, Better, Faster, Stronger chapter).

Figure 2: The Sensorama pamphlet [4].

Morton Heilig was also the father of modern VR HMD. He patented in 1960 the Telesphere Mask [5], that can be considered the first example of a head-mounted display (HMD)[3]. Many models nowadays follow this design. The Telesphere had stereoscopic 3D, stereo sound and wide peripheral vision

(adjustable) like the Sensorama but it excluded the other three senses and targeted mainly movie fans.

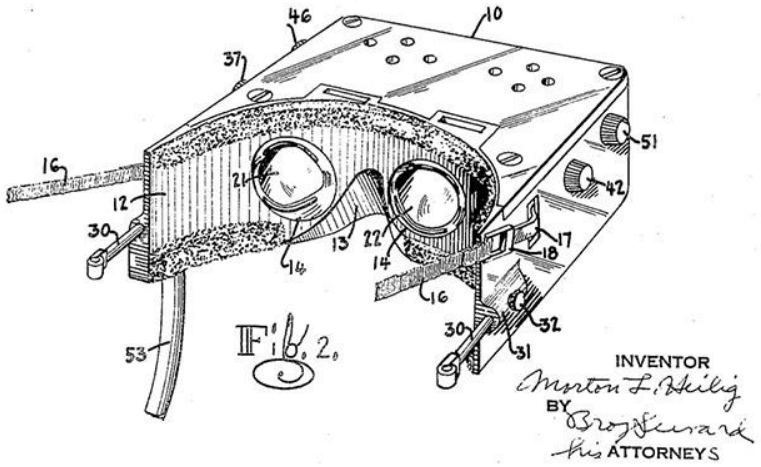


Figure 3: The prototype of the Telesphere, resembling modern VR HMD [5].

The first official HMD was developed by Philco Corporation in 1961 and called the “Headsight”. The HMD this time included a tracking system that was connected to a camera system and let use the HMD for watching remote places and turn the remote camera by turning the head. A similar system was used by Bell Laboratories for helicopter pilots in order for them to use infrared cameras on the bottom of the helicopter and have clear night vision.

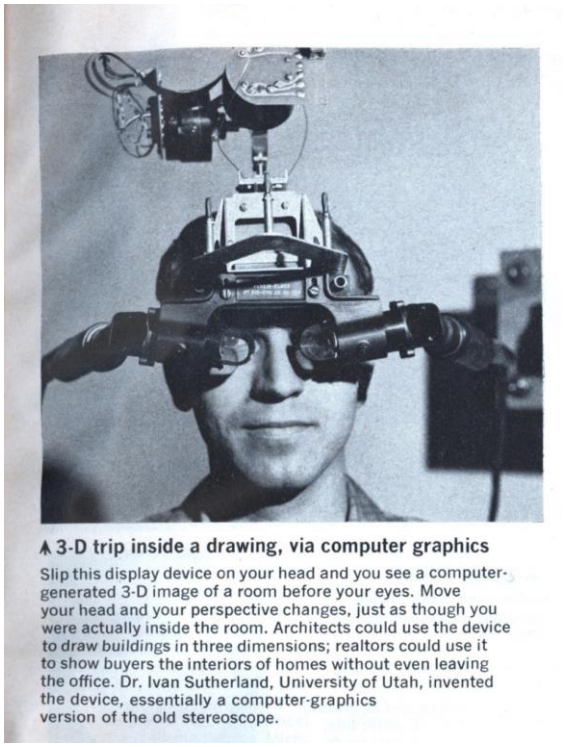
Although all these projects were connected either to movies or real cameras, the idea of a virtual world started to be conceived in 1965 by Ivan Sutherland and its “Ultimate display”. Sutherland states, in his paper that “A display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world. It is a looking glass into a mathematical wonderland” [6].

The system was bulky and barely usable by customers, but the ideas it led to were very similar to today’s VR application most common pitches: real estate, architects, etc.

Sutherland projects were funded by the Department of Defense and the National Science Foundation together with NASA. The CIA contributed $80,000 to Sutherland, and military and simulation were the categories that those research projects tackled. Used mainly for exercise for pilots, it has been said that the discrepancy between reality and VR of that time needed NASA pilots to take a day of break to between a simulated flight and a real flight to

get used to them each time and avoid performance loss. In this sense, VR remained a secret of the government until the eighties.

The eighties are the period when VR hit films, but not because of its use in movies, but because some movies tried to describe an alternative, virtual reality or alternative life from the real one. A famous example is “Tron” (1980), and later on “The Lawnmover man” (1992) and also “The Matrix” (1999) [7]. The Lawnmower Man introduced the concept of virtual reality to the masses, by telling the story (inspired by the real life of Jaron Lanier, in the movie a scientist who uses virtual reality as a therapy for mentally disabled patients). Movies played a big part in creating the concept of a computerized world. The first movie in which VR officially appears will be “Star Trek: Next Generation” (1987). During the eighties also the name “Virtual Reality”, allegedly coined by the above mentioned Jaron Lanier [8], founder of the visual programming lab (“VPL”). VPL developed several VR related gadgets, like the Dataglove and the EyePhone (a HMD that they sold for $9,400) [9]. The Dataglove let users enjoy haptics and was the first pair of gloves related to VR to sport such a feature.



3-D trip inside a drawing, via computer graphics

Slip this display device on your head and you see a computer-generated 3-D image of a room before your eyes. Move your head and your perspective changes, just as though you were actually inside the room. Architects could use the device to draw buildings in three dimensions; realtors could use it to show buyers the interiors of homes without even leaving the office. Dr. Ivan Sutherland, University of Utah, invented the device, essentially a computer-graphics version of the old stereoscope.

Figure 4: The Ultimate Display [6].

The nineties see VR invading the video games scene. In 1991 the “Virtuality Group” adds VR to famous videogames classics like Pac-man in their arcade cabinets [10]. Some units were also networked together in car games. Later on Sega announced its VR headset, called “Sega VR” [11] at CES 1993. Its design sported an all-around-the-head black visor containing a LCD screen and stereo headphones plus a head tracking system. Sega fully intended to release the product at a price point of about $200, but the product never left the prototype stage and became a flop.

Figure 5: The first VR based arcade coin-ops [10].

The Sega VR was followed by Nintendo’s Virtual Boy in 1995 [12], that used red and black hues in a 3D visor. The Virtual Boy, although developed by one of Nintendo’s veterans, Gunpei Yokoi (the inventor of the directional pad among other things) was a failure because it caused eye strain after several hours of play and was immediately retired from the market by Nintendo.
After the seventies, the end of the nineties see again the interest for VR die. This is one of the lowest spikes of VR that would last for at least two decades, until the first years of the twenty-first century. This is also one of the major reasons why some people are still skeptical about VR nowadays. The technology has now been around for many years and still people does not see a valid use for it to become mass marketed. For this reason game companies refrained to invest in it until 2012, year in which the Oculus Rift was funded by

a campaign on Kickstarter[4]. Oculus as a company focused primarily on games [13]. They created during three years three different prototypes called Development Kit, with the latest one having a head tracking system (called the “Constellation) that allows for a deeper immersion. Oculus created a product that was substantially different from any VR headset present at that moment on the market. According to Palmer himself: ” I was like, "Well okay, consumer VR isn’t that good, but the military uses this for training, so surely the military gear is the real sweet stuff. And then as I got my hands on some of that stuff, I realized that even that wasn’t very good. So I decided that I was going to try to do something myself.” [14]. In terms of business Oculus aimed at a niche market and would not have survived if not because it was later on bought by Facebook in 2014. Palmer himself stated that if they sold on Kickstarter 300 Oculus Developer Kit that would have been a success [14]. The move that Facebook did ignited again the market and created the new, latest wave in VR: by 2015 big companies like Sony (PlayStation VR) and HTC (with Vive) announced their VR HMD. Other companies like Google and Samsung took a more cautious approach by releasing Google Cardboard, Google’s take on VR made of just cardboard foldable into the shape of a VR HMD and a pair of aspheric lenses to put inside of it. Samsung similarly released Samsung VR, another HMD that does not include a screen. Users of both Cardboard and Samsung VR would slip in their smartphones and use it them as a VR display.

Figure 6: The Oculus Rift internals, Consumer Version 1 [13].

A different approach took Microsoft, who created a totally new way of intending VR and AR (Augmented Reality) called MR (Mixed Reality)[5]. Mixed Reality relies on the HoloLens, Microsoft's HMD [15]. Microsoft approach states that people are better off using visors when looking at the real environment that surround them: HoloLens, in fact, does not force the consumer to look only at a screen inside the HMD but superimposes 3D models on the real world using AR. The latest approach to VR using AR is also what a company called Magic Leap [16] is promising to do. Magic Leap is one of the most secretive start-ups in the industry, and it hyped the marked by showing a video of the company when employees where playing a game using AR that would involve the room dynamically, with great effects and the possibility of interacting with holograms with bare hands. Magic Leap further on showed a video in which kids in a room watch a real whale coming up and diving into the floor. This hype allowed them to rake about 1.4 billion dollars in investment from companies like Google and Alibaba [17].

Figure 7: The latest Magic Leap commercial on YouTube [16].

According to the latest news (December 9th 2016), though, in an interview with "The Information", the CEO of Magic Leap Roy Abovitz revealed that he lied about their project and that they are way behind HoloLens and that their video was produced entirely by a visual effect studio called Weta Workshop [18] and were used to recruit employees to work at its South Florida Headquarters. This move could likely impact the future of AR and its development, leaving to

Microsoft the lead on the matter. Still, both AR and VR still have years in development and will most likely be ready for mainstream consumers in the following years. This situation still leaves open many fields of development to VR. The one this project will cover is the field of Music. We will see in the following chapter who started its conception and what direction we will give to VR in this field with The Empyrian to achieve a richer music experience.

2.2. History and Trends of Visual Music

The concept of “Visual Music” dates way back in time, and according to the approach that one takes, several famous personalities can be taken into account. The table below shows the various interpretations of colors/musical notes according to the historical personality and the method of analysis chosen [19].

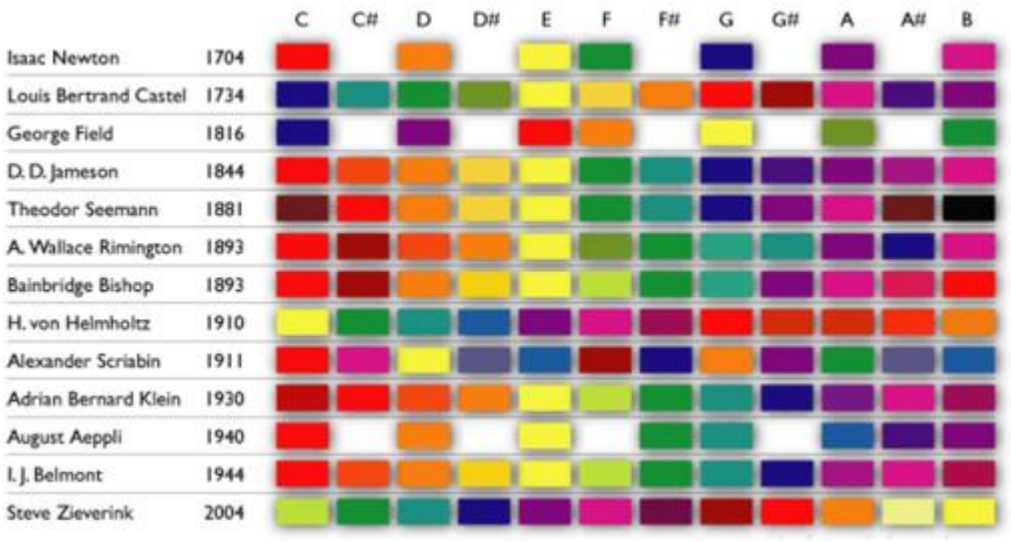


Figure 8: The colors of musical notes according to various personalities [19].

The aim of this chapter is to provide a reference for the main two types of Visual Music found in history, the analogic and the digital one that came with the advent of personal computers as music generators. The analogic production divided itself into creation of tools that let artists generate music analogically and generation of tools to create visual music to be enjoyed by the public (the latter often connected with film). This analysis was important into understanding how and to what people reacted in Visual Music.

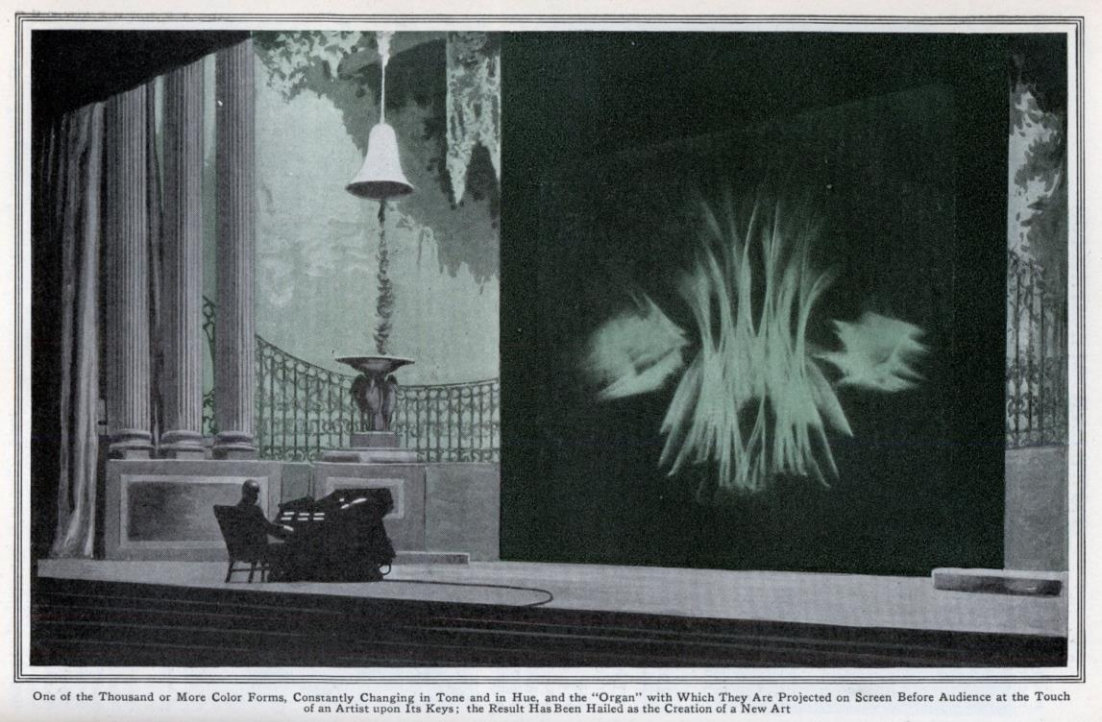
Generally speaking, analogic visual music starts with the concept of music connected to colors. In this regard personalities like Giuseppe Arcimboldi (a famous Italian painter) and his study of the Pythagorean harmonic of tones and semitones are often quoted [19]. Arcimboldi’s idea was to create a relationship between musical (in this scale, the musical scale) and the colors. This would start by considering white as a start and by adding gradually more black, and use this black to indicate a rise in semitones in the musical notes. In this design white would represent a deeper note while black a high note.

Later on Isaac Newton discovered that by increasing the frequency of light in the spectrum of colors from red to violet, a resultant increase in the frequency of sound in the diatonic major scale was found [20].
Another major step for visual music was the *Clavecin Oculaire* (1734) by Louis Bertrand Castel [21]. With this machine Castel realized in real life the bond between colors and notes in a musical instrument that had a color appearing above it at each different note pressed. This was done by connecting twelve colors and the relative semitones.
This period of history had a fervent activity around the creation of instruments related to visual music, each of them very often using very different technologies. Many of these creations adapted Castel's ocular harpsichord as a reference for some parts. For example for the keyboard, post-Castel creations include Frederic Kastner's Pyrophone (1869) [22], made of tubes in which gas enters and creates sound and abstract images. In 1895 William Schooling created an instrument that functioned by piloting tubes by using a keyboard [23]. Other examples of post-Castel instruments include George Hall's Musichrome (1930) and Morgan Russell and Stanton Macdonald-Wright's Kinetic Light Machine (1931) [24].

The twenties and thirties see an incredible advancement in visual music. Aided also by the invention of cinema, which boosted optics/electronics and the art connection. In this period in few years we assist at the creation of several visual music systems. The creators who deserve mention for their impact on the development of visual music are Thomas Wilfred with his Clavilux, Oskar Fischinger and the Lumigraph, and Charles Dockum with his Mobil Color Projector.

2.2.1 Thomas Wilfred

Thomas Wilfred invented the Clavilux in 1922, and it is still considered the first device designed specifically for audio-visual shows [25].



One of the Thousand or More Color Forms, Constantly Changing in Tone and in Hue, and the "Organ" with Which They Are Projected on Screen Before Audience at the Touch of an Artist upon Its Keys; the Result Has Been Hailed as the Creation of a New Art

Figure 9: The Clavilux controlled by Wilfred [25].

Differently from his predecessors, who focus their work on the dichotomy of color and music, Wilfred did not believe that there was an absolute correspondence between color and sound. With the Clavilux he turned his attention to “light”. The Clavilux was, according to the sources [26], designed as a large organ with a large keyboard in bank of sliders in five rows that could have been coupled to produce colors, and six projectors and several reflectors (prisms) to create the visuals by mixing the intensity of color along with a selection of geometric patterns reflected.
The Clavilux produced what Wilfred called “Lumia”, a silent art of its own according to the creator, made of complex light forms, which mix together to create a polymorphic image that uses the depth of light.

Wilfred’s definition of his art, and his deviation from the predecessors are important because they also underline that according to Wilfred visual music, with his Lumia, differ deeply with music. He thinks that the two arts are so different that “attempts to design Lumia instruments in imitation of musical ones will prove as futile as attempts to write Lumia compositions by following the conventional rules laid down for music. [27]

2.2.2 Oskar Fischinger

Although other personalities may have tried before him, Oskar Fischinger can be considered the key figure for visual music to reach the world of film [28]. He both invented instruments to create visual music and edited movies that involved it, making a complete dive into this art with an analogic approach.
Fischinger started to experiment after watching, in 1921, the Opus 1 by Walter Ruttmann, where abstract shapes moved on the screen synchronized with the music. Ruttmann achieved this by drawing colored pictures in the musical score. Musicians would be able to synchronize their playing with the film by looking at the colored pictures.
Fischinger's early movies where made using a color organ controlled by projectors with different filter.
In the late forties he then created a color organ called the Lumigraph, that allowed to play with light. Made of a large frame and rubber skin from which only a thin slit emits light, it allowed to play with several objects moving on the thin sheet of rubber. For example, moving a finger-tip around it would trace the finger's movement with light (and light colors according to the filter and light used). For this practice any object could have been used.

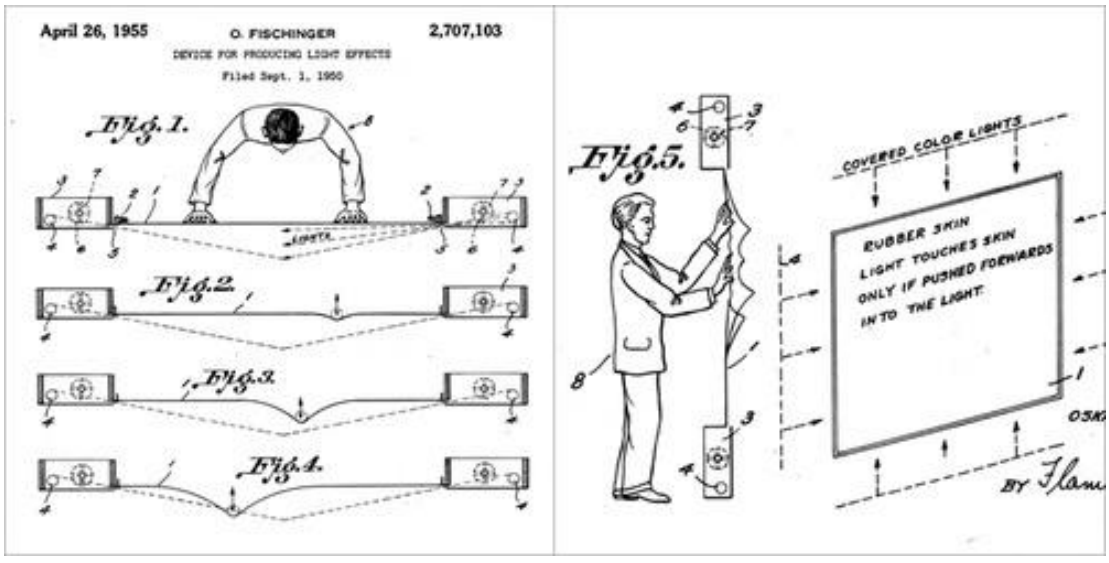


Figure 10: Fischinger's Lumigraph [28].

The Lumigraph was licensed for use in movies ("The time travelers" – 1960) and was shown at several events. It shows the different approach that Fischinger had towards music and image compared to Wilfred. Fischinger used image and sound as an opportunity for designing something else. In this regard,

he could be thought as one of the founding fathers of the modern approach to visual music. After moving to the U.S.A. Fischinger also created film works such as “An Optical Poem” [29], that used famous music scores like “Hungarian Rhapsody no.2” with stop motion film technique.

2.2.3 Charles Dockum

Charles Dockum was an inventor and experimental filmmaker from Texas who develop his experiments with light and color at the Guggenheim Foundation [30]. There he created the Mobile Color Projector (or Mobicolor Projector) since 1942.

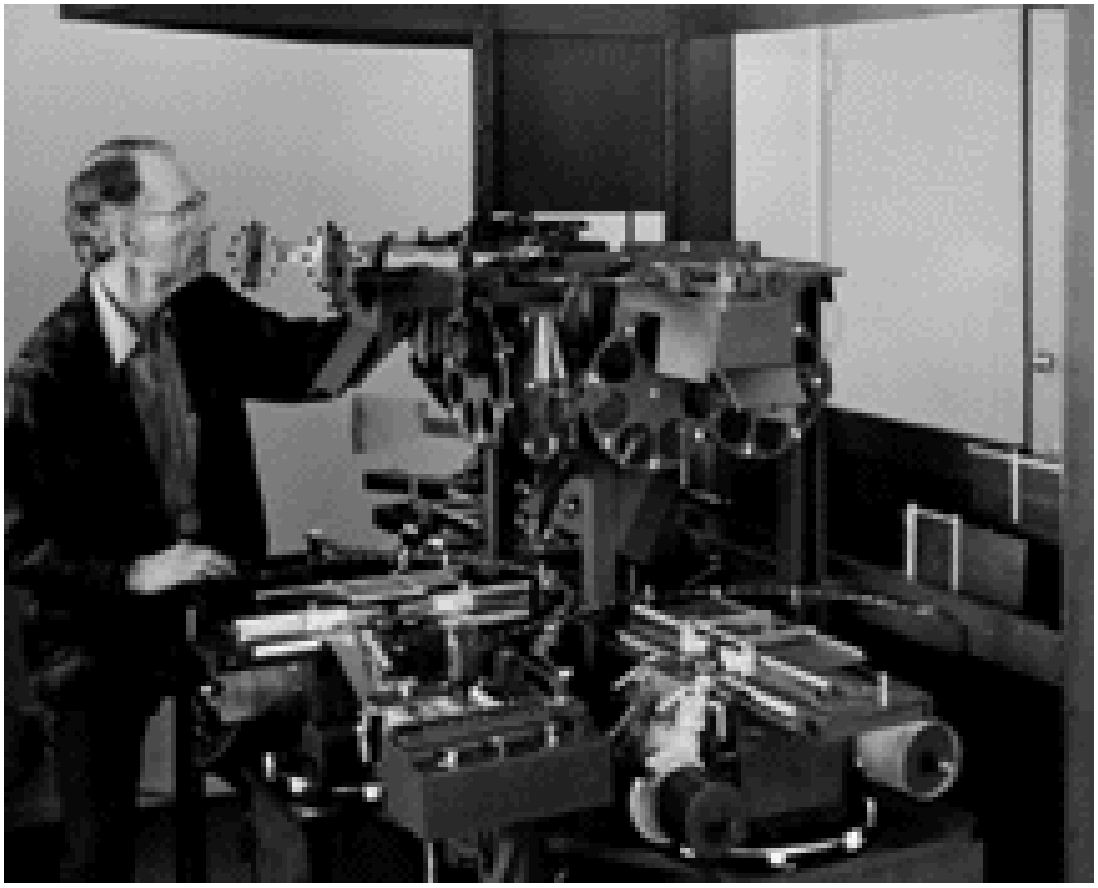


Figure 11: Dockum and the Mobile Color Projector [30].

The Mobile Color projector allowed its performer to create temporal patterns of moving, colored shapes. According to Moritz, Dockum had respiratory problems and had an out of body experience in his twenties. After that

experience it is said that he wanted to demonstrate the lights he saw by creating the Mobile Color projector.
The projector worked by using visual patterns which were moved through a mechanical programming system, using cams shaped in different ways.
What was projected by the Mobile Color projector was silent, but in Dockum's definition of it what he created was a new form of art. This was done, according to his definition, to "the harmonic movement the abstract forms have, comparable to music" [31].
The projector produced hard-edged and soft-edged images by using prepared image sources. The images onscreen rotate, change color and use focus to create the harmony above mentioned. According to the brochure of Dockum's Research Lab, "the sensitive and accurate control of these mobile forms of light toward the production of a logical and moving thematic development are analogous to the manner in which musical themes are composed into structural forms known as sonatas" [32]. There were three kinds of images: geometric forms, dot patterns and dotted or continuous lines and trails.

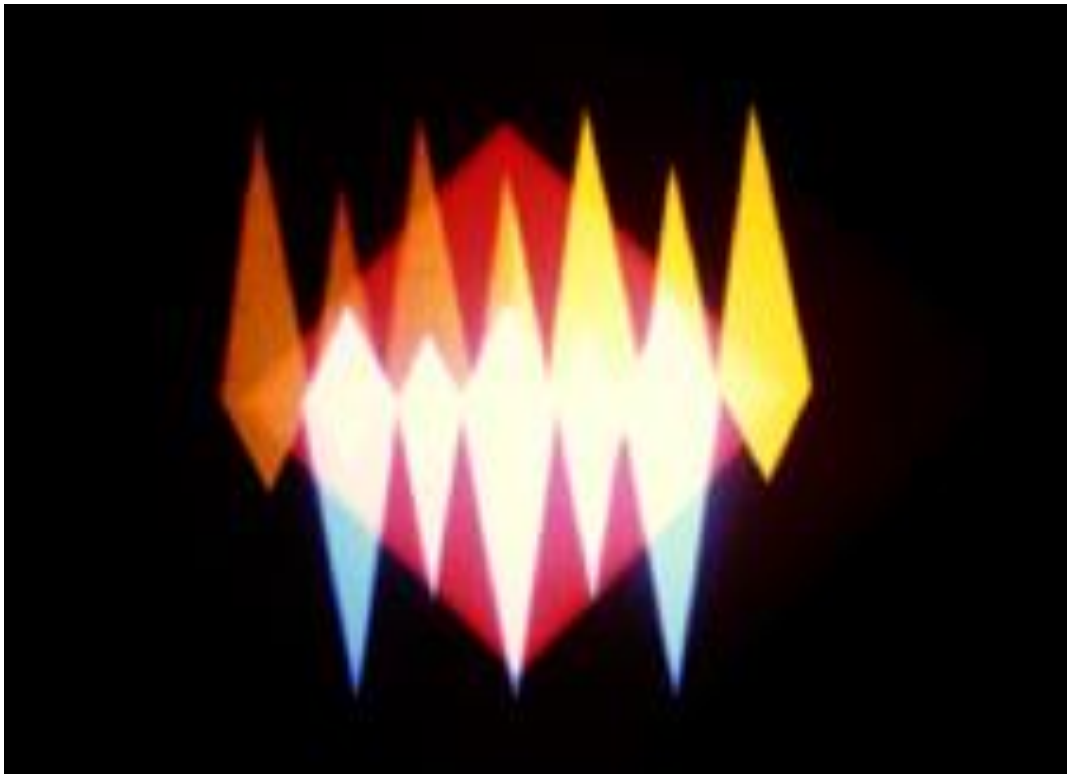


Figure 12: Mute abstract visuals of the Mobile Color Projector [30].

For Dockum, the abstract interplay of light and color produced by his machine had effects on human brain similar to those of the awe created by musical

composition, and this was especially true for him if the images were projected on big screens. According to Moritz the images had a “living’ glow more real than any image projected through cinema” [33].

2.3 From Abstract Films to the Music Video

As seen with Fischinger, after the invention of cinema some artists used film to create and show their visual music performances. This fundamental step brought visual music from interaction, with machines controlled by one (like Wilfred’s) or two people (like Dockum’s and Fischinger’s inventions) to passive vision. This step is important in defining what these authors were searching: abstract film wants to define a visual analogy to music. Of course abstract cinema is a wide argument and this study will not dwell into it entirely here, but will mention the major personalities that developed the concept that will eventually, in the sixties, change into what today is called a Music Video but has the same underlying principle.

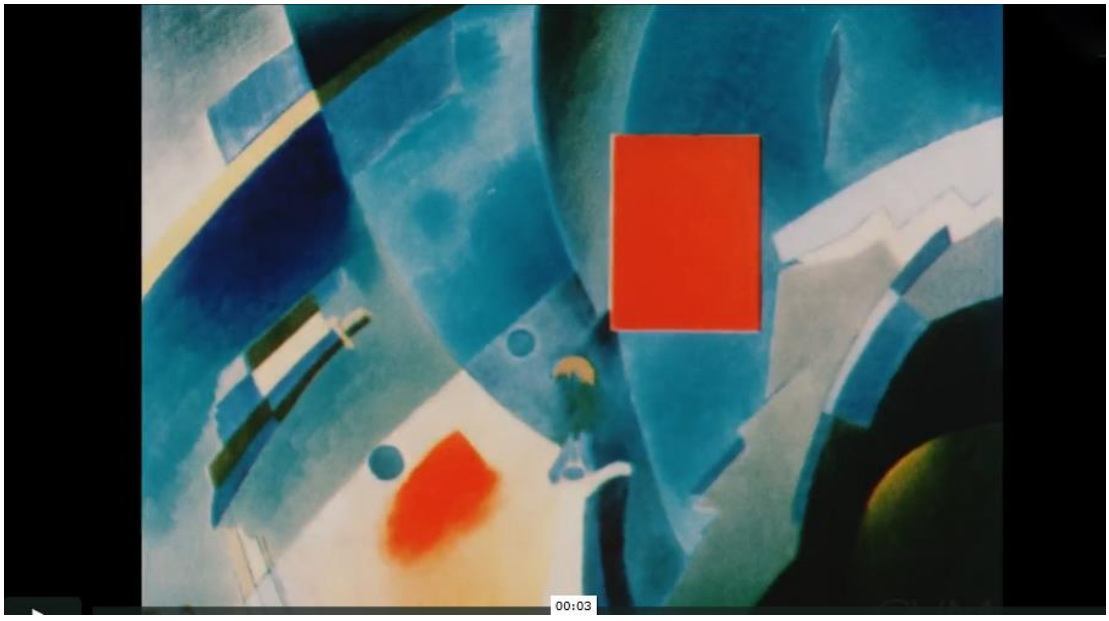


Figure 13: Fischinger’s Color Rythm and Modernism in Visual Music [34].

During the twenties to the forties Modernism was roaring and several authors began to study abstract temporal composition (like the already mentioned

Fischinger [34]). This concept is visible in the first entire abstract movie from Viking Eggeling, “Diagonal Symphony” [35].

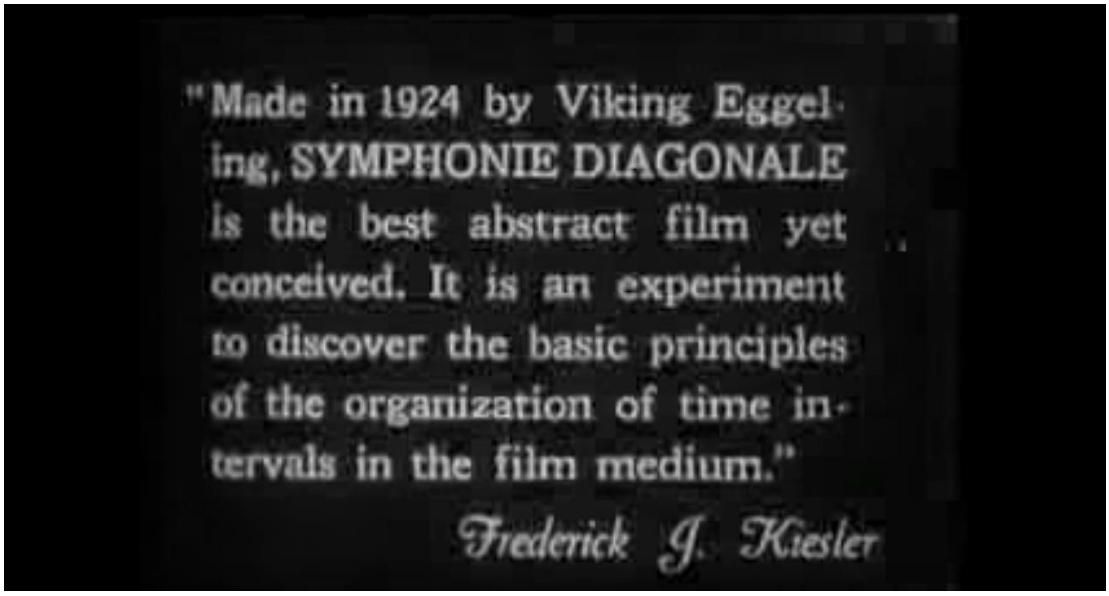


Figure 14: Viking Eggeling’s reception [35].

Diagonal Symphony was entirely silent: in Viking Eggeling’s idea, movement only could create, by organizing time intervals in the film, the suggestion of music.

Another famous technique is the one developed by the New Zealand artist Len Lye, who reinvented visual music by creating “camera-less animations” inspired by the work of Man Ray, whose results were known as “Rayograms” or “Photograms” [36]. The new technique included drawing/painting directly on film. His first creation of this genre is for an advertisement called “A Color Box”. This ad was produced without using a camera for anything except the title scores. A meticulous work to produce, this technique implied improvisation and craftsmanship.

The already aforementioned Oskar Fischinger also contributed massively to field of visual music and film, having invented several techniques in the field.

Fischinger was hired from Fritz Lang to make special effects in “Woman in the Moon” (1929) [37] and while doing this he developed a study for a series of film experiments with drawn synthetic sound called “Ornament Sound Experiments” [38]. These studies had a close synchronization with music and originally begun as advertisements and can be considered the direct precursors of the modern music video.

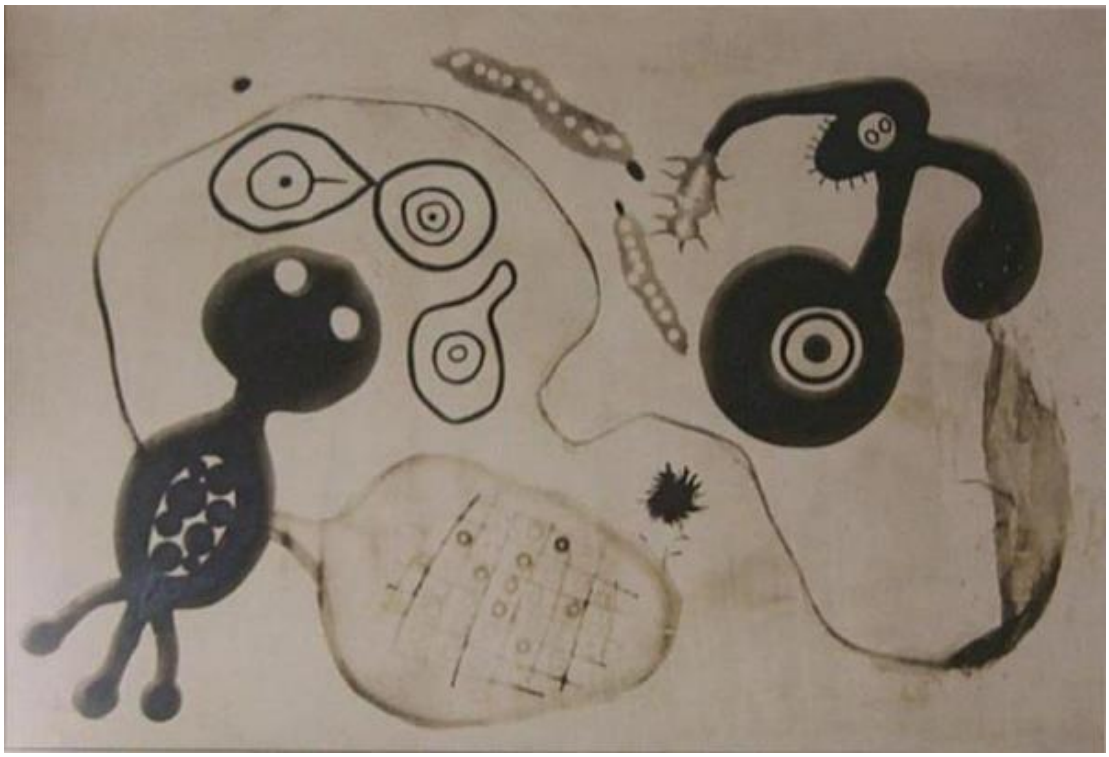


Figure 15: Len Lye's Photograms [36].

The influence of color film, and specifically of GasparColor (the rival of Technicolor in Europe) [39] created new opportunities of artistic development for visual music and Fishinger's works were adopted in commercial advertisement and labeled at the end with the advertised product name. Representing the category is "Kreise", that was basically an abstract film with the ad text only appearing in the last frames.

Fischinger's animated music ads received great praise from Hollywood (especially the one called "Composition in Blue") [40], leading him to work for the movie industry.

The entrance in the world of Hollywood started for Fischinger from Paramount, who commissioned him to create the opening number for a feature called Big Broadcast (1937) [41]. Fischinger then produced what will be called "Allegretto" [42] a short film that he was forced to buy back when he realizes that Paramount would not pay for his creation. In Allegretto Fischinger used a cell-layering technique to animate formal visual equivalents of the musical concepts of rhythm, harmony and counterpoint. By dividing each frame with different colors he achieved flashy and contrasted tones that could not be produced by the photography of that time. Was with Disney that in 1939 Fischinger had the chance of becoming very popular. He created for the movie "Fantasia" [43] the sequence of Bach "Toccata and Fugue". Disney used to modify artists' creation

to meet their own requirement and for this reason Fischinger quit. Animation had a major role in the advancement of what will be called “Music video” already in the end of the twenties, when series like “Screen songs” [44] were published by the Flescher Studios.

Figure 16: The first “Screen Song” [44].

Basically animated movies that contained a video of the musicians singing, the Screen songs used a method to involve the spectator in singing along the song by using a bouncing ball that would highlight the songs’ tempo by bouncing on the word that was sang. A predecessor of the modern karaoke, the Screen Songs were advertisement for live theatrical appearances of famous artist and were done by Paramount as marketing.

Big impact on the modern Music Video concept came from the “Cinebox” [45], invented in Italy in 1958 by Pietro Granelli and followed by a french version called “Scopitone”. The Cinebox had 16mm tape and optic track (versus magnetic track used in film), and this allowed for a cheaper price and at the same time for films to easily have a soundtrack attached without printing film twice [46]. The Cinebox will feature songs by famous Italian artists like Domenico Modugno, also featured in this study’s VR prototype. At that time discographic companies used Cinebox as an alternative to promote their artists in Italy in shops where rooms were specifically created to host a Cinebox. A pool of discographic companies paid for the movies shown on Cinebox (price for a movie was one million lira) and they rented the Cinebox for around 1.5 million lira of that time. Jukebox and TV where not as popular as they became

later and Cinebox introduced short clips (already made in black and white Italy since 1930) made specifically for it. Cinebox introduced the first color made promotion video in 1959 with the song “Altagracia” by Don Marino Barreto Junior, a cuban singer at that time popular in Italy.

Figure 17: The Cinebox, father of the modern Music video marketing [45].

In 1964, the Beatles with “A Hard day’s night” shot a feature film in black and white that became instantly famous worldwide [47].
This video constituted (worldwide) a first shape of the Music Video that every artist after that will create. This kind of media was called at that time “Film insert”, and the Beatles produced in 1967 several famous promotion clips (between the most famous ones “Strawberry fields forever” and “Penny Lane”) in order to promote their record releases without having to appear at worldwide international venues personally.

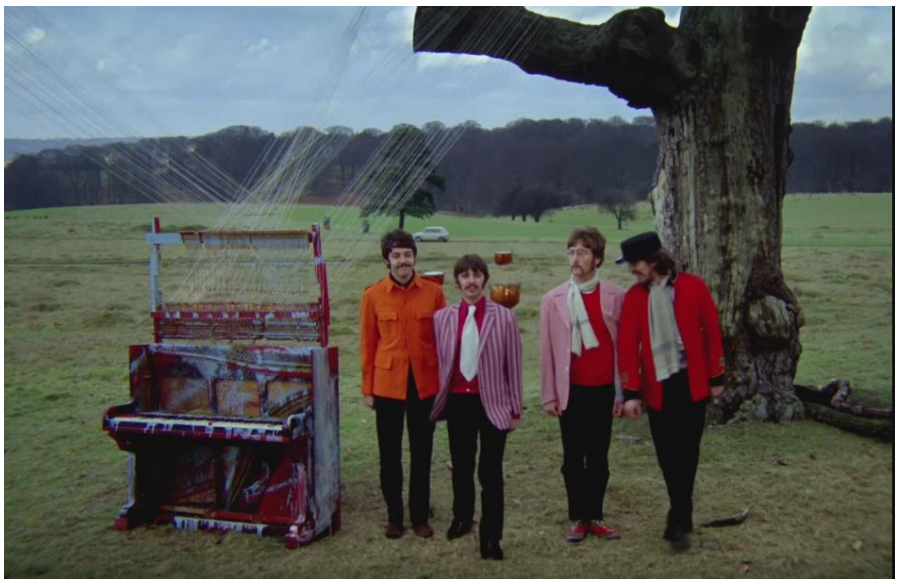


Figure 18: The Beatles in “Strawberry Fields Forever” [47].

Last but not least in this list are Queen, fathers of what is considered by many the first official video clip in history: “Bohemian Rhapsody” [48]. Created in 1975 and directed by Bruce Gowers, the video was meant to promote Queen’s new single on the BBC music series “Top of the pops”. Bohemian Rhapsody preceded the advent of MTV in 1981, where Music Videos became mainstream and had the shape and form that we all know today.

Figure 19: Queen’s “Bohemian Rhapsody” [48].

Notes

1. Depth perception is the visual ability to perceive the world in three dimensions.
2. Anaglyph 3D is an effect achieved by using different color filters on each eye.
3. Headset used for Virtual Reality, usually shaped as a pair of goggles or a full helmet.
4. World famous crowdfunding web portal for creative projects.
5. A mix of reality and Virtual Reality, using both Augmented Reality and Virtual Reality

Chapter 3

3. Related Works Review

It was not an easy task to find projects who can relate to The Empyrian as its nature is original and goes across existing media to create a new one and a consequent platform for artists. VR Music per se has been explored in other shapes and the presented works inspired also this project. One of the works considered is the VR single music video produced by Björk, while the other chapter covers other applications and past iterations in VR and Music that influenced and motivated The Empyrian. Reviewing these application will make it easier to understand the differences from this project and introduce two similar subjects: 1) VR Music Video done by using VR Cameras 2) VR Music dynamically generated by using algorithms. We will see how both of these development systems differ from the prototype of Vision file.

3.1. Björk Digital and her VR Single

VR cameras and Music Videos sporting 360 degrees material are already a reality for some artists. Bjork, the experimental Icelandic artist, already released some VR singles and an exhibition called “Björk Digital”. This exhibition is held in Sidney and structured like a museum of her more recent works. The museum features her most recent collaborations and 360 videos. Björk Digital is indeed unique as it pioneered into the realm of Video and VR, containing the premiere of “Stonemilker” [49], a music video using VR, featuring the artist singing on a desert landscape in Iceland, the place where she came up with the idea of the song. “Stonemilker” was entirely shot in 360 degrees and published on YouTube in 2015. Björk describes using VR as

“more immersive than reality”. The use of VR in this video differs from this study as it employs VR videos and not 3D graphics[1]. This detail gives to the experience a very different degree of immersion. This particular video gave me the idea of expanding more the experience of VR using 3D models and a game engine to overcome the limits of video technology. 360 degrees video material, as the 360 camera grabs videos by flattening the 3D world into a plan, does not deliver the sense of immersion that 3D graphics do. This video was also very useful in noting that most of the artists and VR creators at the moment do not have a VR Music platform to release their creations. In doing so, artists are not stimulated in exploring the media and believing in it, but most of them just releases VR singles demos (to understand more about the choice of a platform refer to chapter 5.

Figure 20: Björk’s “Stonemilker” [49].

3.2 Other Music Applications Using VR

Many other music applications use VR to have a different approach to music. A famous example is the one offered by Intone with their demo called “Sing” [50]. Sing features movement and generation of music elements (in this case represented by cubes and other particles) according to user’s voice. This kind of visual generation is dynamic and not pre-calculated as this study’s prototype. Dynamic generation mean that object appearing in the scene are connected to frequencies using an algorithm and spawn according to the frequency captured by the input device. In the case of “Sing” the input device is the microphone. The user finds himself/herself floating in space with a group of blocks (cubes) in him/her, select the cubes and inputs his voice in the microphone by singing. The cubes will react by changing colors and move depending on the sound made.

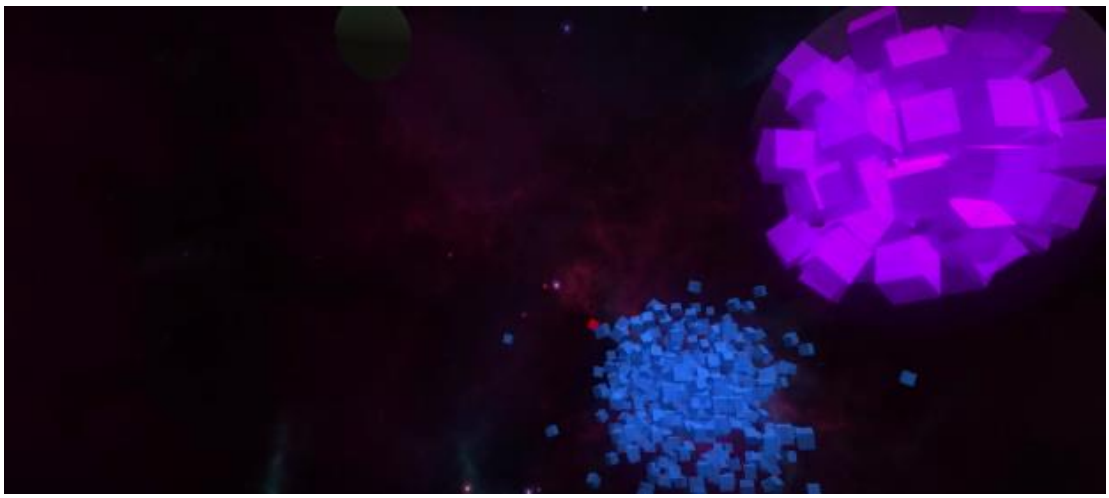


Figure 21: Intone’s “Sing” [50].

Dynamic content generation is something that also other many applications use (although usually relegated to screen savers or “visualizers function”[2] and not sold/shown as Music Video). One of them is the iTunes Visualizer [51]. This development system main problem is connected to meaning in content creation. Music videos, in fact, contain a meaning in the visual part shown. The content shown onscreen often either reflects the lyrics or give another layer of interpretation to it, and this is valid for all Music Videos (even those that do not follow the lyrics) because in that case the visual part adds visual information processed by the user brain as either a storyline or the song/band identity. Dynamically generated effects, on the contrary, do not contain a meaning. This impacts greatly the time users watch these effects and ultimately separate them from what a Music Video, and this project, want to convey.

Figure 22: an example of iTunes’ Visualizer function [51].

Notes

1. Most 3D videos shot with 3D cameras are mono-scopic as they are viewed as a flat image on a singular surface.
2. A software implementation of mapping diagrams, with the added feature of animation.

Chapter 4

4. Concept Design

4.1. The Idea of a Music Tunnel

The Empyrian, as the name suggests, is connected to the concept of a higher dimension. In ancient times the Empyrean, the higher of the skies, used to be believed as the higher achievable state of the human mind in the afterlife, where Dante places angels who look at God [52]. This part of this study will dwell into the different stages the project has been through before assuming its final form. This will help us understand which values stood out in each step and were finally considered to be strong assets in giving shape to the project. The first sketches of The Empyrian involved the idea of a gamified music experience, similar to an arcade cabinet (coin-op) in which players would stand on a platform, ala Dance Dance Revolution [53], and wear the VR HMD while facing a screen that would cover their whole height. The screen, although the player was wearing VR HMD, would project to others what the player sees inside the HMD, to ensure a more involving experience for those who were watching the player play the arcade. The main idea behind the display involved the usage of a tunnel shape screen. This is how the project started, by drawing in a 3D space a tunnel and a player in front of it, mimicking a giant void in which the player would interact with objects.

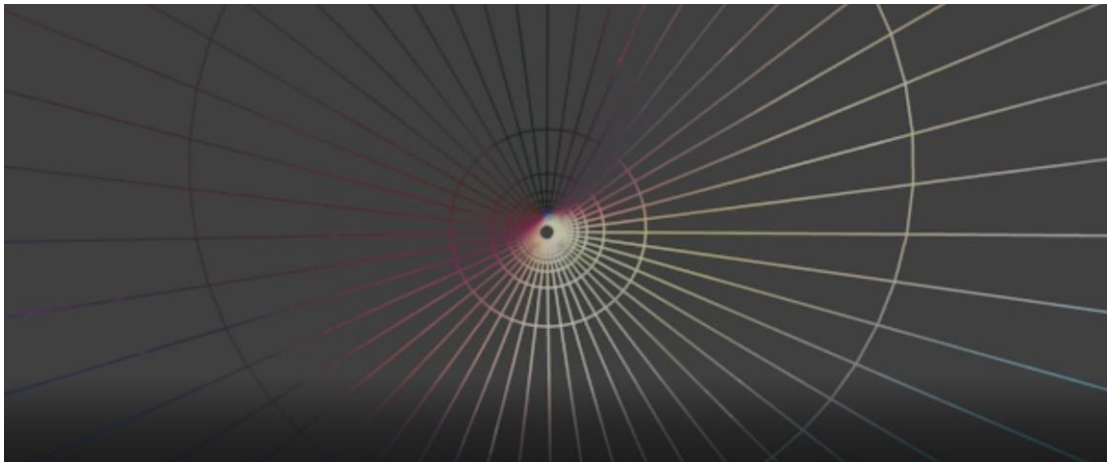


Figure 23: The first sketch of the tunnel.

In the initial layout of the project the player stood in the middle of the platform and had to stretch his/her arms in order to reach the tunnel's internal walls. This would allow the player to touch flying objects on the inner walls coming from mid-air from the tunnel ahead. The tunnel's incoming objects design resembles videogames from the Super Famicom era, specifically F-Zero and the boost pads that gave the player extra speed [54]. Speed and the concept of power-ups and touching objects played a major role at this stage of development of the project, as the arcade nature of it still seemed the major selling point of such a design. The power-ups collected by the player would have decided the speed of the tunnel, and ultimately the smoothness of completion of the stage: as soon as the player would collect all the power-ups perfectly, the stage/tunnel would proceed smoothly, in the opposite case the stage would incur in slow-downs and hiccups according to the degree of mistake in collecting objects. The development started initially by designing the tunnel. This created the initial challenge: would the tunnel need to be circular or oval? Will the platform fly with the player, and if this was the case, should the tunnel rotate using a gyroscope or not? If rotating, would this create an even more disruptive effect of dizziness in the players?

The initial crafting of the tunnel was held in Blender3D. This procedure helped in understanding the immediate limits of the design: specifically, creating a tunnel in which players had to jump for to reach walls would not be practical. The walls had to be close to reach and the movement limited to minimum for three main reasons:

1) The player would need time to go to one extreme of the wall to the other
2) The wires of the VR HMD, namely power plug and HDMI cable, would constitute an impairment to actions like jumps from one extreme to another and eventually cross.
3) Lower and higher extremes of the wall would be precluded in height to players not within the height of the design.

Even though the last point could have been created to be adaptive, by adjusting proportions of the tunnel to the players' height, the other above three points deemed an oval internal wall touch design as complex and invited for simplicity. This lead to the second stage of the first design, the player and camera placement. This was also done in Blender3D, which allowed to build a path along where the camera would move, and consequentially the player view. This was important to understand what kind of movements the head of the player would do in game. It was decided to keep the axis of the camera fixed while only rotating the tunnel to avoid increasing furthermore motion sickness (for more info on motion sickness in VR refer to Chapter 7).
After the tunnel and the camera were created, the author needed to create a path where the camera would move. This path position was, as said above, central on the tunnel, with the player's center (midpoint place at the belly button) corresponding with it. The camera was placed right were the head is, similarly to what First Person Shooter game do. The idea allows the players' hand to reach the tunnel's walls easily and can be easily understood if we think that any human figure can be inscribed in a circle, as the Vitruvian man of Leonardo da Vinci [55] placed on the platform below shows.

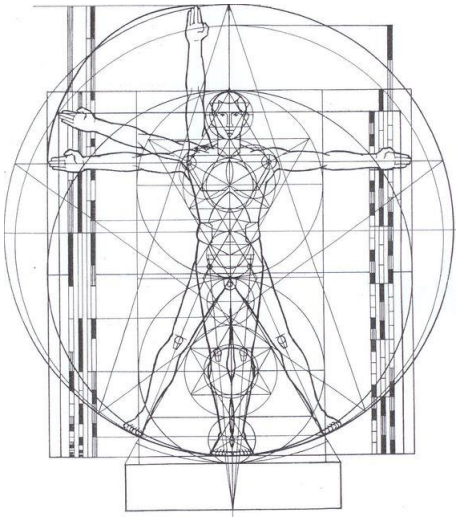


Figure 24: The platform and pivotal center placed at the chest of a Vitruvian man [55].

The circular tunnel would have its limits/walls where the players' hands fully stretched where, and made the player easily interact with incoming objects. The next step to consider was what kind of object the player would interact with and why.

4.2. Avatar, Particles, Kinect and Heaven

This step was the decisive one who steered the project into the realm of music. As the tunnel was done, the next steps would include the production of the following:

1) Tunnel texture
2) Avatar
3) Platform
4) VR Camera
5) In-game objects

At this stage the shape of the tunnel was only a wireframe, and the camera needed a texture in Blender3D for the tunnel to be visible. It has been tried to produce different images that could have given an identity to the tunnel/stage, and during this step I tried more digital-looking, Tron-alike textures in it. The step that steered the project towards music was the idea that tunnel with a beginning and an end pretty much resembled a song's timeline, where the objects incoming could have been easily words from the lyrics. This conclusion made all the other components in the project adapt to it. Using Blender3D was still fundamental to create the above items, but as more complex instances (camera, animations, music, interactions) would have become soon part of the prototype, it was decided to move everything to a game engine, in this case Unity3D. The second step after creating textures for the tunnel was thinking about the player's interaction with the virtual world. This introduced a number of smaller problems in the project, the first one being how would the player move and touch the objects. The first approach to this involved using a 3D avatar inside the prototype. The author designed a model in T-Pose first [56] and tried to connect it to the player movements.

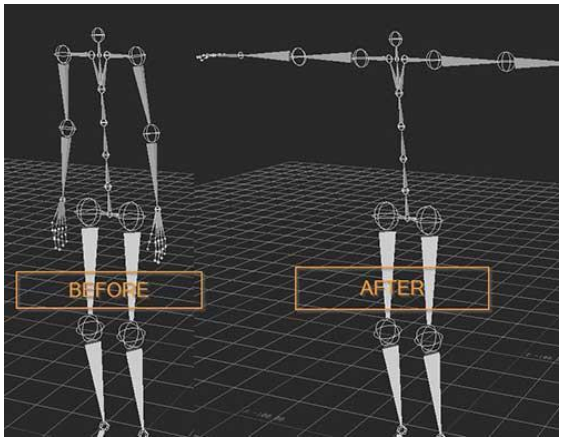


Figure 25: T-Pose character design and bones necessary to link it to Kinect [56].

The avatar's head would have the camera in its place, and stand on the platform. The avatar bones would resemble the one's in our body by using characters already rigged from Unity3D's library to start with.
Finally, for the connection between avatar and player this study opted for the Microsoft Kinect[1]. Unity3D at that time had very primitive libraries for Kinect but the Kinect unity package contained a simple player - character mirror demo. As the name suggests, this allows players to move in front of the Kinect Camera, have their movements coordinates sent to Unity3D and then translated one to one to the avatar in the game engine. It has been used that to connect the players' movement with the avatar and then translate that into gameplay by giving the players a task.

The third step to develop, the platform idea, changed from its original sketch because of the new music video identity of the project, and now adopted a music video embedded into it. What was this for? Two main functions: 1) the video of the song played could be visible at any time by players because it was playing on the platform they were standing on 2) the video embedded in the platform would be a video file containing both the song's original video and audio, which would constitute the music of the prototype.
The virtual camera in Unity3D records by default the sounds emitted by any source in game. In this case, the nearness of the player's head (virtual camera position) to the platform in the 3D space would allow the sound to be received by the player from the camera's virtual microphones. This would simplify things for videos with spatial left/right sounds. A virtual distance for the camera's microphones is also selectable in Unity3D. Zeroing this value guaranteed that the volume would not decrease due to spatial reasons.

The third step led naturally to the fourth, the introduction of a VR camera in the game engine. Unity3D at that time had a very basic SDK for Oculus HMDs. The Oculus' library had one single prefab with two cameras merged into one with a FOV (Field of view)[2] adopted in its degrees to mimic human sight.
This would be in place of the camera that was already created in Blender3D first and in Unity3D later. The introduction of the VR Camera has to be thought well before time and cannot be postponed for a number of reasons. 1) The view range of the player has to be calibrated and it is part of the gameplay 2) The camera FOV and distance by default will alter the view of the tunnel. VR uses particular angles and these have to be calibrated in order for the player not to see the tunnel walls too far or mismatching with our sense of closeness. 3) The camera itself is an object and can be penetrated and surpassed by incoming in-game objects. A trigger[3] has to be given to the camera where objects cannot go, penetrate or bounce, in order to avoid to destroy the suspension of disbelief created by VR. A VR camera, in fact, temporarily fools our senses into believing that the environment we are interacting in is real. In order to properly create this effect, any interaction that undermines this has to be eliminated from the experience.

The last step was about the incoming objects. A number of questions arise around the creation of these. How would the objects destroy? Would there be a score for it, and if yes, how? What objects, exactly? Would they be created procedurally or done as prefabs inside the engine?
This led to the idea of using a particle source. Any modern game engine handles procedural object creation using particles[4] for a number of different reasons, one being the inferior number of draw calls[5] necessary and therefore memory usage compared to spawning different objects singularly by code. Particles are used to create stars, waterfalls, lightning effects like sparkles etc. In this case the idea to keep the draw calls low was to use the particle system to spawn the lyrics of the song by having a common base particle with different textures (the lyrics) every time. At that time Unity3D had only its legacy particle generation system. But also with that was possible to associate prefabs that were previously created in game and make the generator spawn them at a given time. The type of particle chosen was a cube, for practical reasons: choosing a mesh[6] would make the touching interaction more difficult than a cube, that has a flat plane on six sides easier for the players to touch and reach in-game than a word-shaped mesh that could also be very short.
After choosing a font for the lyrics the author created invisible cubes with the same word on each side that would fly towards the player.

After this it was needed to think about gameplay and how to resolve other basic problems: would the player be able to see the avatar's hand like his/her own? What would be the effect of touching the inbound objects created from the particle generator? But first of all, what kind of music video should have been used?
Experimenting with this last part created a shift of ideas and made the project than steer towards a more multi-sensorial experience. It was tried different types of music inside the game, and by combining that with changing the texture of the tunnel made the author think of a more complex, interesting experience for the players. The decisive step was trying a cloud texture as in the image shown below.

Figure 26: The tunnel with a cloud texture, remembering a path to heaven.

As the prototype had to be shown to a class at Keio University's KMD, and the teacher responsible at that time was Mr. Minamizawa, after that pictures of Mr. Minamizawa's Facebook feed (him and his family) were gathered and arranged as follows:

For the music video – Pietro Mascagni's Cavalleria Rusticana – Intermezzo
For the particles – 1) Stars 2) Sun 3) Mr. Minamizawa's life pictures

The aim for this was to create a post-life tunnel towards Heaven where the player would see picture of his memories go past him as particles, while ascending to a better life. This was achieved by placing on one of the sides of the cube-shaped particles (the one facing the player) the pictures of the teacher's life and make them fly straight pass the player. The player could then follow the particle slowly move past him until they disappear behind. A sun light was also created at the end of the tunnel, resembling God over watching on

the player while he is being transported to heaven. The gameplay didn't need touch yet (this resolved the problem of the visible hands) and had to just look while standing on the platform. This step of creating a tunnel to heaven gave the name to the project, and the impact that it had emotionally on the people who tried it made the author think about the fact that this system was quite adaptable to the needs of the creator to convey emotional messages. The idea of a deeper, synesthesia-like multi-sensorial experience connected to the user was interesting and brought the author to think how it could be possible to adapt different songs to the prototype just created. This was the step when The Empyrian reached the line between art and technology: visual music was not a gimmick anymore and created real emotions, and the project was enriching the music experience.

4.3 Harder, Better, Faster, Stronger

This step of the project was fundamental in preparing the theory around it. As the function of touch was tightly connected to the gameplay, it was needed to create a system that was compelling and fun enough to play for the player in order to have a proper prototype. The questions regarding the particles still stood:

1) How would the player touch the particle?
2) What will be of them after being touched?

As the heaven stage would not allow for much more development in the gameplay area (it was intended to be more a passive experience), the need for another song to be used in the prototype arise. The song had to allow for a pure gameplay-based experience and would be added with the thought of "touch" in mind and the two above questions.
The first question was then answered by developing a touch system in the game. This was achieved by using a system that combined triggers together. Prefabs (in this case the lyrics coming towards the player as cubes) can have a trigger around them that is triggered when it enters in contact with other objects. Giving each particle a trigger, and also providing the avatar with one itself solved partially the issue as Unity3D at that time had a bug that made the objects compenetrate with each other before their trigger was active. Polygonal

compenetration[7] is an issue in several games of the past and was fixed by using hard surfaces for triggers. Triggers by default tend to use soft surfaces and this makes them compenetrate more easily. So this part answered the first question in the virtual environment. But what about real life?
The second question, what would happen after the prefabs touch the player, was a hard one to answer. There is a number of reactions that game developers use to make an effect look real. Blur, camera shake and sound are the first examples that come to mind. Vibration is another one. As during lessons at KMD it was used the TECHTILE Toolkit from Tachilab [57], the author thought about it as a very good way of channeling haptic feedback[8] into the real world from the virtual one.

Figure 27: The TECHTILE Toolkit used to create gloves for one of the prototypes [57]

Haptic feedback, in this case in the form of vibration, with the TECHTILE Toolkit uses sound from a microphone to move a speaker that gives, when hold, the sense of vibration using sound waves. The author used it to develop a pair of gloves that the player would wear with one TECHTILE Toolkit speaker connected to each hand. As the TECHTILE Toolkit would grab all the sound frequencies and vibrate at each sound in game, included the music from the video, a solution was needed. The idea to solve this was to create two

additional cameras, place them on the hands of the player and reduce their virtual microphone range to a minimum distance. Each camera had:

- A trigger
- Acted as a microphone
- Would reproduce a sound for each time the trigger was activated

Assigning to the prefab a sound each time the particle would hit a hand would:

1) Make the microphone of each camera on each hand grab that sound
2) Make the TECHTILE Toolkit in each hand reproduce it on the speaker in each hand, generating vibration

This method was efficient for immediate results. After this part of the experience was set, another aspect had to be covered, and that was the gameplay itself. Fundamentally, a game is made of repetitions. In a game, a player learns throughout the game what to do naturally and this give him/her satisfaction and keeps him/her entertained. As the aim at this point was to create a rhythm based arcade game, a further analysis was necessary before starting to choose what song to apply to the system. Music and games share a fundamental principle: repetition and novelty. As in a game old routines are repeated and new ones are learned, in a song the chorus keeps the base and the bridge brings the novelty. This principle of small, incremental growth is part of the human nature. Following this logic makes songs with many repetitions in them more likely to be suitable for games. In this case, the routine of game and its musical aspect where connected by using a song from Daft Punk called “Harder, Better, Faster, Stronger” [58].
In this song, the tunnel was made all black and the particles were represented only but flat, minimalistic squares with words written on them. Each word was a prefab that was specifically created beforehand. Each prefab square had a color, and as the song would repeat its chorus “Harder, Better, Faster, Stronger”, the player would experience a three-folded stimulus:

1) Musical repetition
2) Color repetition

3) Muscle memory repetition

The first point is obvious because of the song used. This particular song uses the chorus for almost the whole song, decomposing it with alternations in voice and tone. A song with a lot of chorus with the same lines lead to a stronger second and third point. Color repetition, in fact, was due to the fact that the prefabs created, for example the words:

“Harder” in red
“Better” in green
“Faster” in yellow
“Stronger” in blue

would repeat themselves spawning in the same order. The song chorus would therefore change from words to colors in the mind of the player that was watching it, becoming “Red, Green, Yellow, Blue” after their memory was impressed. This was combined with the third point, muscle memory.

Figure 28: Daft Punk’s “Harder, Better, Faster, Stronger” made into a Vision.

The repetition of a motor skill or movement through a small amount of time consolidates that specific motor task into memory [59]. This allows the player to perform the motor task without being conscious about it. In this case, by the middle of the song the player could repeat easily the chorus of the song by touching particles in the same order in the air even by not closing his/her eyes: his/her body would remember where to touch and would just move consequently. This part is very important for two main aspects:

1) The player, stimulated from three different sensorial repetitions, starts seeing the game using different senses at the same time
2) The player attention lowers due to muscular memory and his/her actions are enjoyed

The first point, as stated already, is what makes the experience multi-sensorial. The second point is what creates consciousness while having fun. After having learned the movements the player feels something close to what a dancer feels while dancing to a song that he/she knows well: her body movements are not a problem anymore and ultimately the brain focuses on enjoying the experience.

4.4 The First Prototype and Transition to a Platform

The last step of the project and its most final form was achieved as a natural step of development after considering aspects and learnings achieved during the other steps. In particular, this last part of the project considered the learnings during the whole process to develop the final prototype. The project itself benefited from major discoverings during the development, last but not least the idea that people could enjoy music with multiple of their senses engaged. This aspect of multi-sensorially enriched music and is the hypothesis of this study and had to be dwelled more deeply, and this phase began by doing so. On the other hand, this step brought the final balance and identity to the project. The development showed that the idea could have had several shapes and possibilities, and could be molded in different types of experiences. Which one was the right one? It all started by questioning the essence of VR itself. The questions that arose were:

1) What do people want to see when using VR?
2) Do people enjoy music while being active? If yes, how?
3) What are the part of this projects to value and give more importance to?

The answer to the first answer could be quite subjective. To have a more objective approach it was concluded that different people may want to see different type of content. The author needed to keep this in mind and address it for the project to be successful and leave the prototype stage. By this stage different songs were done with different purposes, one was a famous aria and another one included touch and was electronic music. Which one of the two was the right direction was to be decided by leveraging the second and third questions. The aria had more emotional involvement. The electronic music prototype was more active and game-alike. Was that active part the fundamental part of the experience? The answer to this question was yes and no. People engage actively in VR experiences but not for a long amount of time if physical interaction is involved. This due to several reasons like eye-strain and a constant level of engagement. This would relegate the prototype to a stage of pure demo without any possible scalability in sight. Finally, the third

question brought us the aspects to underline in this project to make it a more consistent experience that enriched music like the study hypothesis declares.
During the various stages and prototypes the author remained positively impressed by:

A) The multi-sensorial approach
B) The emotionality of the audience trying the opera's aria prototype
C) The passivity while watching the opera's aria prototype
D) The adaptability of the idea to target different target groups

Another factor that was to consider to create a final shape was the target audience. This project was to be shown at KMD Forum [60] and the vast majority of people there would have been Japanese (refer to chapter 6 for more information) Considering the Japanese nature as a more passive one compared to foreigners, and that the emotionality and media-alike nature of the project was more important to the author, it was decided to take off the project the touch part altogether and give it an even more clear passive direction: it was decided that enjoying the prototype in a standing position in case of no action was not the most suitable one for a Japanese audience, and seating down would have probably been the best form to enjoy The Empyrian. This was the most important step during development and left a clear direction to the project.
This would also give a clear view on what had to be done. Seating down would make people less alert and more prone to look at things while actively listening to music. It was a form of entertainment that steered more towards music than game.
As people would seat back and enjoy the ride, to create the new prototype was needed a relaxed in game location and a song to start with. As music, it was decided to use, instead of one song, a remix of three different songs to show the potential of the project. As the idea was now completely focused on music and not on game mechanics, the author's intention was to use the prototype on a platform to listen to music in a different way.
As songs it was therefore used:

1) Volare – Domenico Modugno

2) Sukiyaki – Kyu Sakamoto
3) Rocket Man – Elton John

The idea would be that music would change in game, and with that the location. As locations, it was decided to create three different environments connected to each other in the game engine. Each song above connects to the locations and numbers below.

1) The starting point was partially taken from the “Tuscany” villa demo in Unity3D. In it was placed a sofa right in the middle of its garden and statues to simulate an Italian villa on the coast of Naples. The sofa in the virtual world would have a real equivalent in the sofa used during the KMD Forum: people would seat on the sofa and enjoy music, therefore something they were sitting on was also in game, creating a seamless effect of transition into the virtual reality. Furthermore, the sofa would have an old, small jukebox on one of its arms that the player would notice immediately. Music would come from the small jukebox and the title of the song would change on its display.
2) A tunnel made of clouds created with particles that have reflecting textures. The sofa would start to fly from the villa to the sky above it and above the sea. This part had the “Volare” famous chorus line matching with it as soon as the sofa enters the clouds and the player understand that he’s flying with no return. The sun light would reflect in the clouds and the player would feel a 3D effects when penetrating the clouds. Here the real prototype would start and people would enjoy flying on the sea while listening to music inside a tunnel of clouds. The song will change, right in the middle of the tunnel, to “Sukiyaki”, a Japanese old classic that would bring memories in the minds of the target customers. The song says, in Japanese, to “look up and go further”, meaning to try to overcome difficulties, but in this case could have been interpreted literally with the meaning of looking up.
3) The last location was a spherical dome simulating the solar system that contained earth and other planets including the sun. Finally, the weather would change during flight, and with that the song that the player would hear. Fake statics were created (simulating a radio interference) together with a transition between day and night, and then complete darkness. At the end of the tunnel of clouds it would get dark, with

nothing to see for few instants. The player would then find him/herself suddenly in space. The earth is visible from where the player is, and a rocket passes by their head while the sun shines, far in space. The song from Elton John, Rocket Man, starts saying “I miss the earth so much I miss my wife, its lonely out in space”, and the player looks around space while sitting on a sofa. The sofa moves around the earth when the song enters the chorus, “I’m a rocket man..”

In this final shape the prototype let the player enjoy music in a different way from the other forms chosen in the previous iterations. The Empyrian had a good success among users when shown at KMD Forum, arriving as third booth most voted in KDM Forum 2014. This success, combined with the analysis of all the iterations led the author into thinking about shaping the project in a different, wider way so that this way of creating VR Music could have been explored better by artists and the project could scale. Although this study’s hypothesis is limited to the creation of Vision files and their comparison with Music files and Music Videos, during the preliminary tests several questions were asked and to answer them would help to understand their essence and main difference in usage, creation and shape when compared to Music files and Music Videos. For this reason the next chapter will discuss what would be the business model for Vision files and their platform, “The Empyrian”.

Notes

1. Motion sensor who uses a webcam and voice commands to create interaction without the need of a game controller. It is often used as motion capture device in VR projects.
2. Observable solid angle of a Virtual Camera/VR HMD at any given moment. It does not change with eye movement.
3. Space defined by a 3D object in the 3D world that detects collisions and activates when entered.
4. Particle emitters are 3D objects used to simulate fluids, flames, sparkles and entities difficult to represent by using 3D object and meshes.
5. Number of objects in the scene drawn on screen per frame.
6. Polyhedral object in 3D computer graphics.

7. When two or more 3D objects compenetrate each other’s space without collision.

8. The use of the sense of touch in a user interface design to provide information, usually by using vibration.

Chapter 5

5. Discussion on Vision files and their Business Model

5.1. Platform Design, Value Proposition and USPs

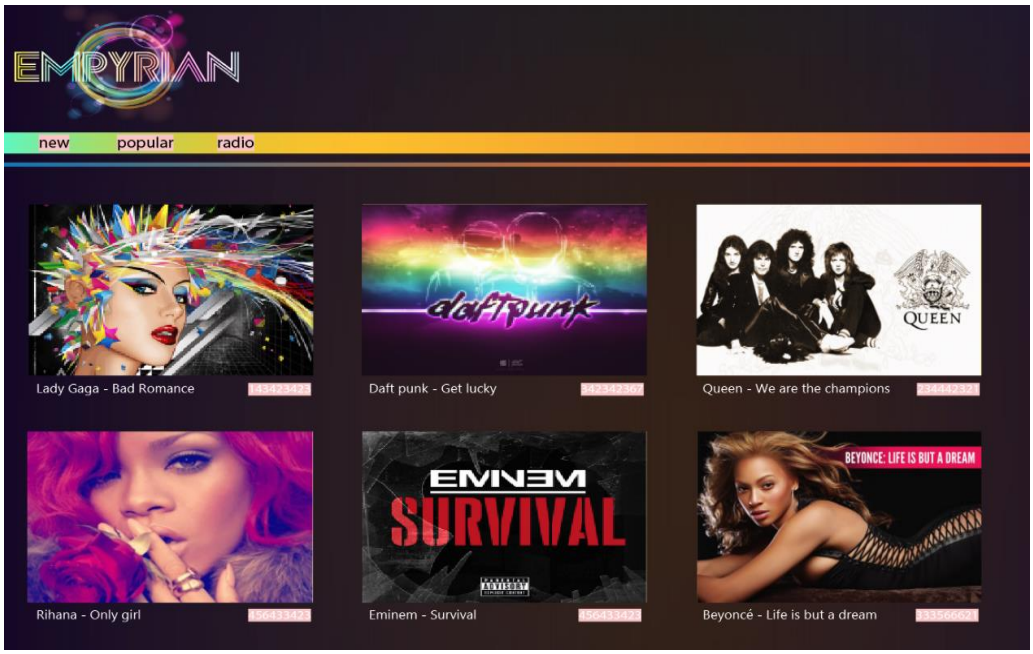


Figure 29: The platform prototype design.

To go beyond the prototype stage, any product has to be defined following a certain number of criteria that will help it create an image in the mind of the consumer. In the case of The Empyrian, when presented to people various

questions received from users were covering aspects like customers segment, type of service, price point and uniqueness and so on. This chapter will present the service and also approach those questions, giving a definition to the project and introducing the platform it is associated with. First of all, defining the essence of the project is necessary. The Empyrian has proved itself as a very adaptable system but needed a clearer shape to be considered as a viable product. In essence, questions to address where the project's:

1) Value proposition
2) USPs[1]
3) Business Plan

Everything started from addressing the value proposition of the product.
According Businessdictionary.com, the definition of Value Proposition is "An analysis or statement of the combination of goods and services offered by a company to its customers in exchange for payment" [61]. In simpler words, a sum of the reasons people should buy your product. To sum up the value proposition for this project:

"A VR Music Platform that let users watching and sharing different visual intepretations of a song with one click. Songs interpretations could also be created by users who could upload them and have a profit using different marketing channels"

Figure 30: The elements that make a Vision file.

The point to address to further clarify this value proposition was the word “interpretation of a song”. This was addressed by introducing the concept of “Vision”. What is a Vision? A Vision was essentially a new way of enjoying music, its new identity that involves more senses at the same time. Made by using music, programming and direction, a Vision could be original or an interpretation of already released music, as it was done with the Daft Punk prototype. A Vision is a Music Video made with 3D graphics in a game engine and is uploaded to the Empyrian. A Vision in the Empyrian borrows from Youtube [62] the ease of use, from Games the sense of immersion, from Music its immediateness of use and from Visual Music its multisensorial impact. A Vision can be visualized by using VR HMD and will be extended to other VR hardware in the future. Visions could be watched and collected or be shared in playlists like for simple music. Visions could be also watched with other people by being inside the same Vision at the same time for those that allowed that function. No other media can make you feel inside a song and at the same time have a playlist. These were the USPs (unique selling points) of the project.

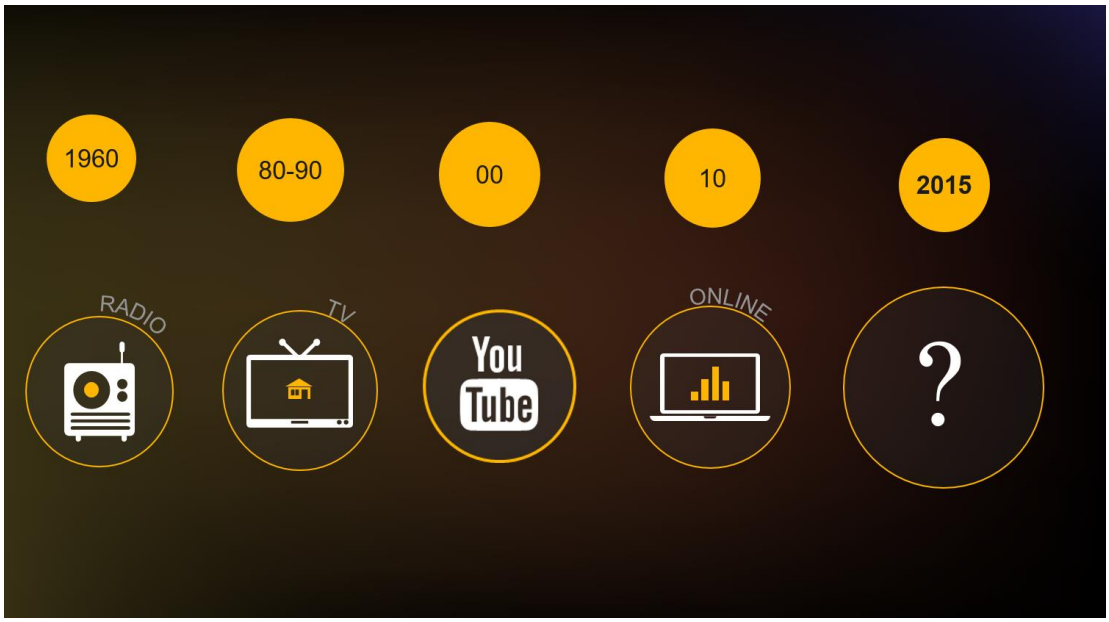


Figure 31: Vision presentation as new media.

5.2. Business Plan and Target Audience

After defining the value proposition of the project, the Business plan and therefore the following points needed to be addressed:

1) How would people use it.
2) Who was the Target audience.
3) How Visionaries will create Visions
4) What services would the project offer and how to create revenue from it.

The first part leads to dividing the users in two groups:

- Normal Users
- Visionaries

As you could both create a Vision or just enjoy it, The Empyrian allows for both an active and a passive experience. Active users (called Visionaries) are the contributors. Like Youtubers, they post their own creation to the portal. Passive users are those who will only watch Visions. They would essential just connect

their Head Mounted Display and click on the Visions, select the desired options (see the gameplay chapter of this study) and watch them by using a VR HMD. They could also comment/subscribe channels. But how will the webportal work? The webportal would use a service model that mixes various already present platform models into a hybrid system.

- Similarly to Spotify [63], users could select pre-made playlists, search and add Visions to playlists, play a preview of it and share it with friends. As a Vision is an interpretation of a song, “Mood”[2] based Visions will also be present.
- Similarly to Youtube, people can comment and rate Visions, and also upload their own one.

Having a model more similar to Youtube than the one that Oculus is using (direct sales of games or VR based apps without any connection between them [64]) will greatly benefit creators in terms of visibility of their products. This because the two business models are very different (free with ads vs pay per view), and the pay per view generally generates resistance in casual users.

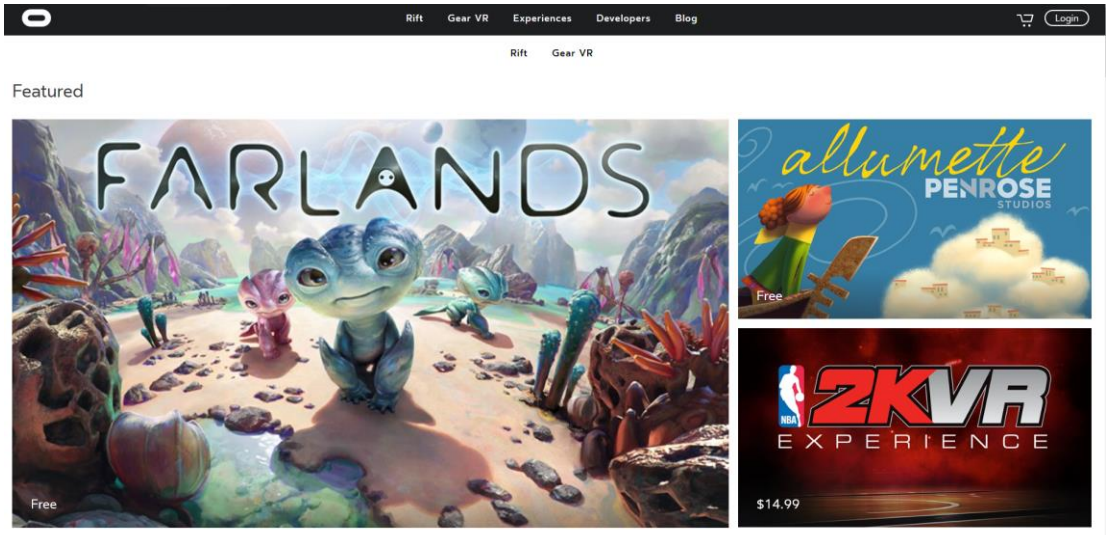


Figure 32: Oculus platform uses direct sales of VR apps and games [64].

In terms of production, artists with bigger capital would create their Visions, upload them onto the platform but also have other minor artists do the same after them, like shown in the picture below. This already happens on Youtube and it is a phenomenon that generated famous cover bands like the Penthatonix.

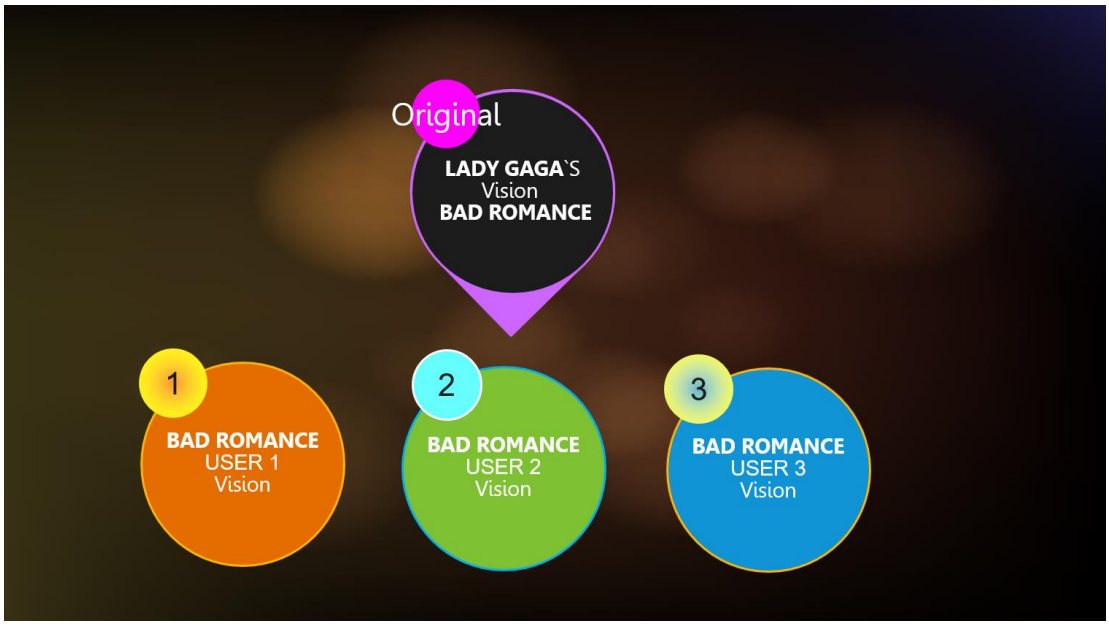


Figure 33: Example of users' Vision interpretation after Lady Gaga's song.

The "minor", indie Visions will be visible as suggestion on the side of the webplayer when the famous artist's one is reproduced.

Regarding the style, Visionaries could create Visions based on different approches and this is entirely up to the taste of the creator, and it could be a Vision based on lyrics or with its own visual interpretation. This diversity in interpretation for famous songs has been done few times in some videos on youtube and vimeo. The image on the other page shows a version of the music video of "Creep" by Radiohead done with animation. The normal Creep song shows the singer of Radiohead singing, this one instead showed an animated story of a blue collar character [65].

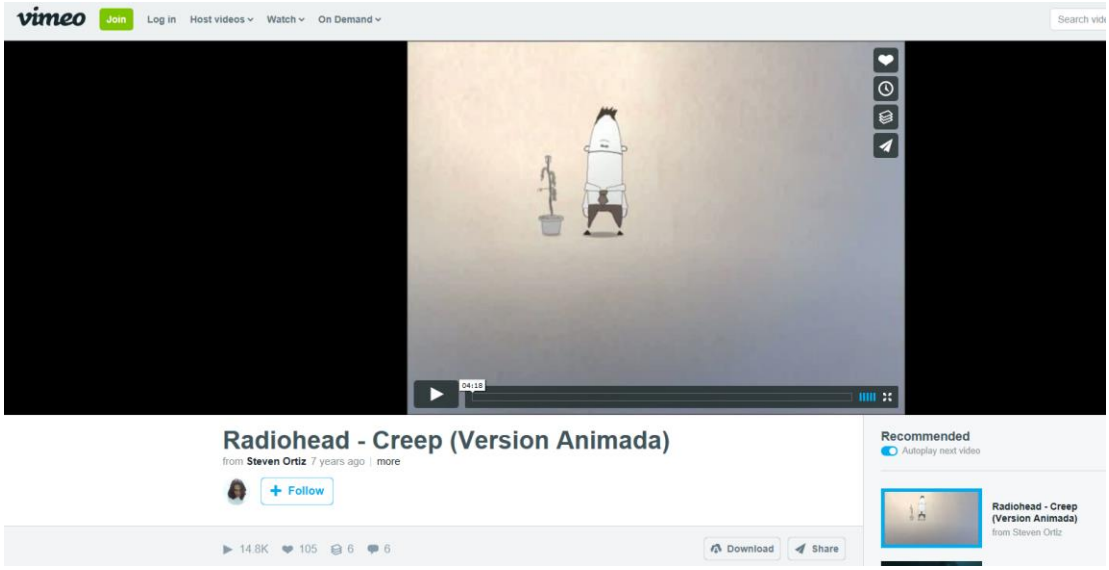


Figure 34: Example of interpretation of song with Creep [65].

The webplayer will also feature an autoplay function to increase visibility.
As platforms chosen for the webportal, PC and Ps4 would constitute the best experience as for now are the only ones that support VR HMD with sufficient power. This constitute a limit for the project at the moment and will be discussed in the respective section of this study. As software for the creation of Vision, game enginese like Unity3D or Unreal Engine would costitute a solid option for Visionaries to start developing their creation.
Regarding the target, The Empyrian in its final form has a specific business model that had both Business to Business and Business to Consumer in mind.

1) Business to Business: companies could create and sell their Visions to other companies or artists
2) Business to Consumers: users with a VR HMD will watch the Vision and artists could create their Visions and share them online with revenue coming from ads

Regarding the second point, the interesting part of this model is that a Vision is not made of only music, but is also not as challenging as programming an application or a videogame from scratches. The process of creating a Vision is fundamental to understand the strenghts of its model. A valid platform in fact, needs not only to be easily accessed and visible by being marketed for customers who use it, but also has to have a way for users to create content to

be uploaded. A famous case for this was the early Playstation 3: the new hardware (the CELL CPU) [66] had good specs on the paper but its architecture made programmers struggle and this had a bad influence in involving third parties into developing for it. In this regard, The Empyrian uses game engines and tools already present and well used from developers.

The immediate overall target audience would then be:

- VR HMD owners
- PC and PS4 owners

Of course, the project can be scaled up to mobile platforms as soon as VR extends will reach mobile platform and HMDs will become more portable.

5.3 Gameplay and Other Aspects to Cover

Points left in the analysis regard how will Visions be created and how will revenue be made. One of the question received more often during the demo of the project was, in fact, about the creation of Visions. How are Visions different between them? Are all Visions created following the same pattern? The answer to this is obviously no, but the creation of a Vision could be standardized in some aspects, to better distinguish them. As it has already been said, Vision will be created using game engines and could be done in a very original way. Standardizing a Vision though, could start from some points that have to be decided before creating it to simplify the process.

1) Procedural vs pre-made content
2) Single vs Group Visions
3) Other functions depending on each Vision

The first point will be decided by Visionaries and will most likely impact the production time. The final prototype of the Vision file was entirely pre-made content, and this strategy takes a longer time but allows for finer crafting of the experience. The procedural approach helps in terms of speed but could also create a less original experience. With procedural content, prefabs and objects

inside a Vision are generated under certain conditions. An example could be a Vision that generates situations in 3d by reading the lyrics of the song and spawning objects in the virtual world. This approach can be used for certain mechanics but by most likely generates boring or repetitive Visions, similar to how the sound waves or certain visual music generators of the past were created.
The second point is instead connected to the network aspect of the project. If the Visionary decided to create a Vision for more than one person, he/she also will have to take into account that the networking part, as there is no tool created at the time of this study, will have to be created separately per-vision. Tools from the Unity3D and other game engines' marketplaces could help with this. The networking part highly incentives consumers but on the other hand VR HMDs are still not mainstream, and this aspect has to be considered when producing a Vision that needs to be shared to be enjoyed.
The third aspect refers to the way a Vision will be defined in its other functions. This will help when filtering a Vision in the search engine. An example of this is how Oculus classifies its VR apps in its online store [67].

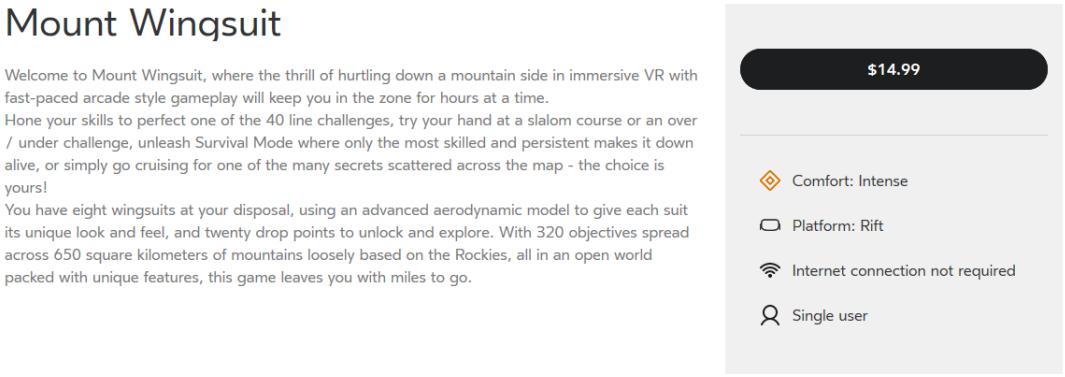


Figure 35: How Oculus categories its VR apps [67].

Similarly to Oculus, the characteristics relevant to the experience of a Vision will be divided considering aspects like the following:

- Number of players
- Genre
- Requiring internet or not
- Level of activity required/Standing or sitting
- Length/Upload date/other factors

5.4 Monetization, Ads and Scalability

An aspect that needs a separate section in the creation of a Vision is the monetization and scalability of the project and the ads system. What can Visionaries do after their Vision is liked and their channel subscribed? How can a Vision be profitable? There are several factors who will vastly improve the scalability of the project:

- Advertisement system
- After Vision-creation plan

The way the portal will create revenue for Visionaries is also an interesting part of the project, as direct sales (ala Steam) are not involved but a model rather similar to YouTube will take place instead. Ads, instead of being inserted during a video, will be part of a Vision inside the 3D space. Ads will go, as for example in Second Life [68], in spaces predefined by the Visionaries. Wallpapers, boards and much more can be created in-game and used as real estate to accommodate advertisement. As it goes for YouTube, the more popular the video is, the more companies will see, through subscriptions and visits, that the Vision is a source of visibility for their product and therefore contact Visionaries to find interesting ways of putting their ads inside their Visions. Artists will have to find compelling ways to make their Vision stand out and be watched.
Also, many YouTubers nowadays suddenly stop their vlogs due to the fact that they would like search for other possibilities to leverage their production. An after Vision-creation strategy will retain creators avoiding them to stop producing Visions. This can be done by leveraging their content and make it more visible with a model that resembles the highlighted applications on the Apple App Store [69]. Selected Visions will be showcased in the most visible part of the home page and this will grant popularity beyond subscribers to Visionaries.

Notes

1. Unique Selling Points are factors that make a business unique, different or better than others already present in the market.
2. Playlists selectable according to our mood of the moment.

Chapter 6

6. Evaluation

6.1. Evaluation Aim

The evaluation of the project was held at two different KMD Forums in 2014. This evaluation wants to examine the effective possibility of realization of this project in real life. The objective is to understand if, in case The Empyrian platform would be published, users would buy Vision files and preferring them over Music files or Music videos.
The overall aim in brief was:

-Understand if people would buy Vision files over Music files or Music Videos given the same song.

For this purpose, two tests were conducted during two different KMD Forums. A KMD Forum is an event from Keio University's Keio Media Design Department held twice a year in which student's projects are shown to the public and press.

6.2. Evaluation Method

In terms of the evaluation method used, users who came at the KMD Forum would sit on a sofa in a prototype evaluation space, wear a pair of headphones and the Oculus Rift and see the prototype of the Vision file. After that the author would ask them to compare the Vision prototype to both a Music file and a Music video of the same song and give feedback. As the hypothesis of this study is that Vision files enriches the music experience compared to Music files

and Music videos, to have a more objective result this study compared the same song in three different variants: as Music file, Music Video and as Vision file. As song it was chosen the Italian classic “Volare” (by Domenico Modugno) that this study used in the prototype of the Vision.
Therefore, three versions of the same song (“Volare”) where presented to users as follows:

A) “Only Music”
B) “Music Video”
C) “VR Version”

“Only Music” (A) consisted in the song in MP3 form played through a pair of headphones.
“Music Video” (B) consisted in the song’s official music video played on YouTube.
“VR Version” (C) was the prototype of the Vision.
To simplify the final equation for this study the author called these versions “OM”, “MV” and “VR”. The author let each user listen to OM, MV, and VR in a random order and asked them the following questions:

1) Assuming the same price, would you buy a Vision file over the same song’s Music file or Music Video?
2) If no, why?
3) What is your age?
4) Are you currently subscribing any Music service?
5) Do you listen to music by yourself?

To avoid multicollinearity**,** it were used independent variables that the author thought are not related with each other but only directly influence the dependent variable one at the time. These independent variables were represented by questions 3-4-5 of the questionnaire. Question 1 represent the dependent variable (hypothesis of this study).
Multicollinearity is one of the pitfalls of applying a linear regression. If using variables with a high level of correlation this would lead to decreased precision of the results. To verify the strength of each variable the author tried to visualize their single relationships using scatterplots on excel, and the results showed that the independent variables (3-4-5) are not related and multicollinearity is

not an issue per se: the questions of the questionnaire proposed to users were not influencing each other. As variables it were then used the following:

Dependent variable:

"Would buy a Vision" (Agreement percentage (%)

Independent Variables:
"Age" (*Age*) 19-60yo
"Streaming Music plan subscription" *(Subscri)* 0=no 1=yes
"Listening Music by yourself" *(MusicAlo)* 0=no 1=yes

The regression model used is: $\mathbf{y = \beta_1 + \beta_2 x \ldots\ldots + u}$

The dependent variables are the result after asking customers questions 1), if they would buy "Vision" files on this study's platform after comparing it with the Music file and Music video of the same song. The independent variables are, "Age" and "Streaming Music plan subscription" and "Listening Music by yourself" respectively question 3) and 4), concerning how old is the user and if the user has subscription to a Music service. The last independent variable is question 5), concerning if the user listens to Music by him/herself or with others. These variables are all related to our independent variable result with the aim of understanding our best-fit and predict an outcome.
The number of people considered for this test was 206 spread across two KMD Forums in Spring/Winter 2014. During KMD Forums one can leave a vote for each application he/she is impressed from to make that application reach the status of top voted in the KMD Forum. Although The Empyrian was voted the third application in 2014's KMD Forum, in this study the author considered not only the people who left us a positive vote during the forums but all the people who tried the Vision prototype to have a more objective outcome.

6.3. Result and Feedbacks

The main result was a success and verified this study's hypothesis. Results showed that under the "Would you buy Vision Files over Music files and Music Videos", on a sample of 206 people the average answer in percentage was 77.9 percent. The participants who answered 100 percent were 92 (almost 50

percent), and participants who answered positively (considered from 50 to 100 percent) were 172 on 206. Customers who answered 40 percent and lower were 34. Of those customers, around 80% were women and their main reason (Question 2) was “it is too bulky” or “hair gets tangled”. Of these 34 participants, two suffered from motion sickness visibly and added it as a main reason for not liking it. The rest of the participants added no reason to not liking the service. These results will be further analyzed in the conclusion part, where this study will draw the line on what has to be done to use these experience at best and to create a better overall service for the customers.

Additionally the test results showed us, in our sample of 206 people, that the average age (mean) of our users was around 39.5 years old. Of these participants, 42 were women and 1643 men. The spikes in the graphic also show us how the upper range of the age used the prototype, but also that the age range is important not only around the Millennials as one may think, but involves a great part of “Generation X” (born late 1970s to early 1980s, the main customer according to the result) and “Baby Boomers” (people born between 1945 and 1964). The youngest participants age was 19, and the oldest ones were 60 years old.

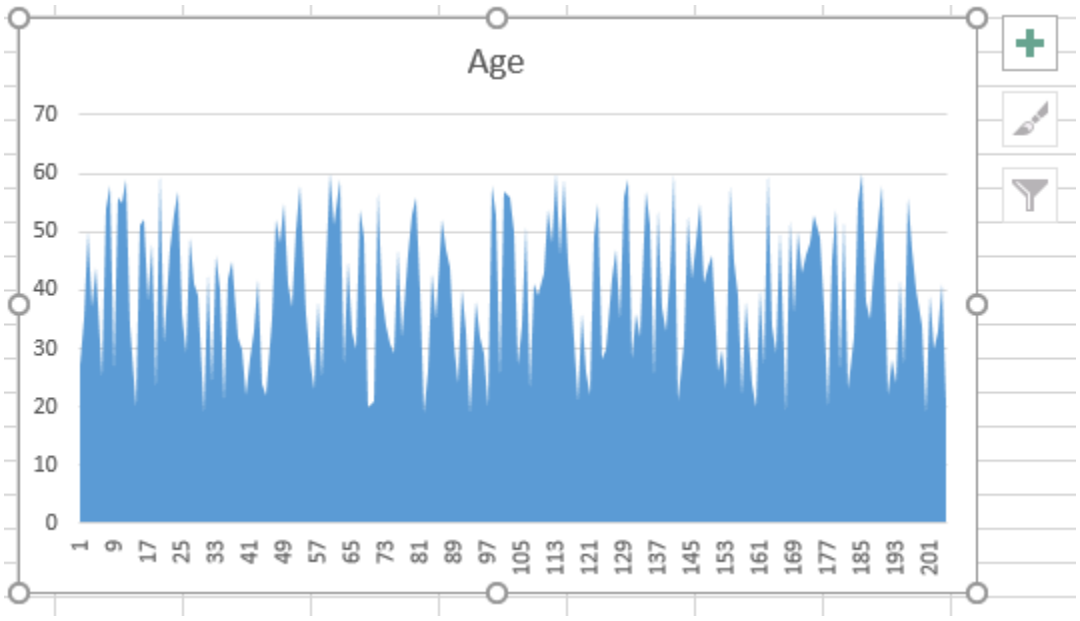


Figure 36: Average age of participants.

By applying the regression model it was discovered that the resulting formula was:

$$Y=52.9046+ (Age\ -0.3157)+Subscri\ 43.1741+\ MusicAlo8.859$$

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.893154
R Square	0.797723
Adjusted R Square	0.794704
Standard Error	12.81311
Observations	205

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	130140.2	43380.06	264.2293	1.8E-69
Residual	201	32999.34	164.1758		
Total	204	163139.5			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	52.90459	4.511023	11.72785	1.54E-24	44.00959	61.79959	44.00959	61.79959
X Variable 1	-0.31569	0.084343	-3.74288	0.000237	-0.482	-0.14938	-0.482	-0.14938
X Variable 2	43.17401	5.862935	7.36389	4.5E-12	31.61326	54.73476	31.61326	54.73476
X Variable 3	8.859366	6.01328	1.4733	0.142234	-2.99784	20.71657	-2.99784	20.71657

Figure 37: Linear Regression results

Following this table multiplying the "*age"* for the negative coefficient our result states that *10 years older* means that the value will raise of 3 points percent. That means that the predicted "potential buyer" is on the higher scale regarding age starting from 37 years old and rising as best-fit. This is observable by looking at the vales placed on a scatterplot. The best fit line (regression line) in the linear regression is the line that minimizes the sum of the squared errors of prediction.

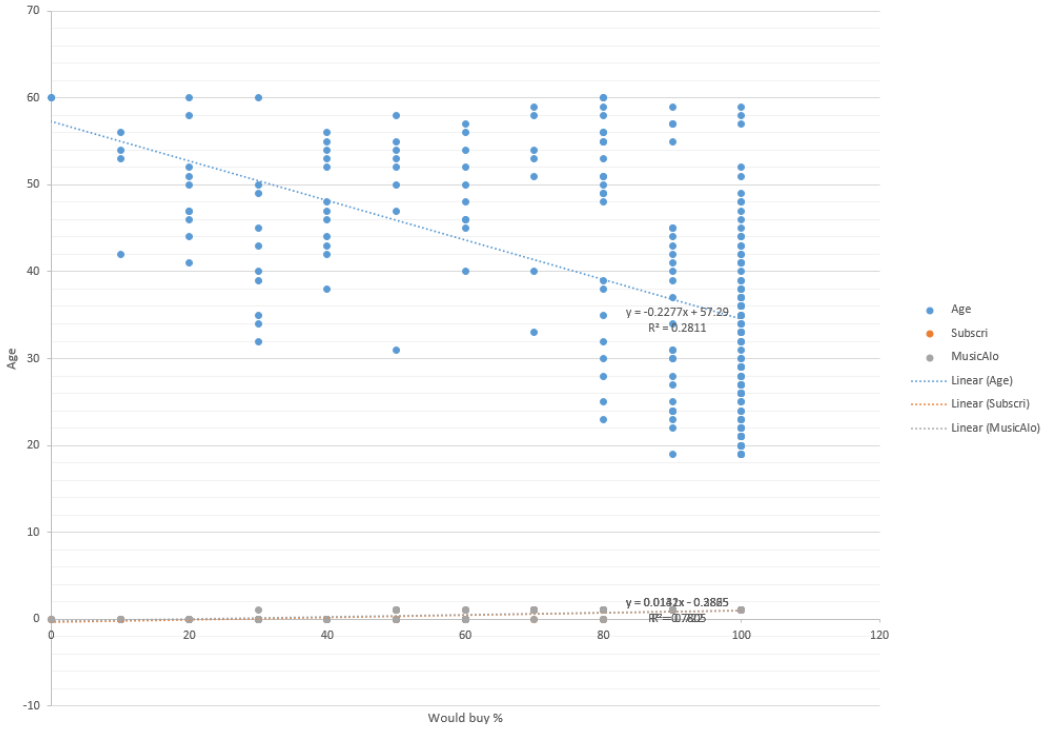


Figure 38: Chart of Linear Regression results and best-fit line.

Results also showed us that only 57 participants on 206 did not subscribe to an online Music Streaming service. Although not in the graph, the most used service subscribed was Spotify. When asked if they would listen to Music alone, most of the customers (three quarters) declared that they only listen by themselves, and the remaining quarter (53 people) declared that both alone and with others is important. This result is interesting as the first prototype unit for preliminary evaluation did not provide networking, but the author was directly asked by customers if the service would allow sharing with friends in around 20 cases on 206 and with participants from age 19 to 29. This means that to appeal to younger generations, used to share more their lives compared to Generation X participants, a networking function has to be implemented (see the Conclusion chapter for more details on this).

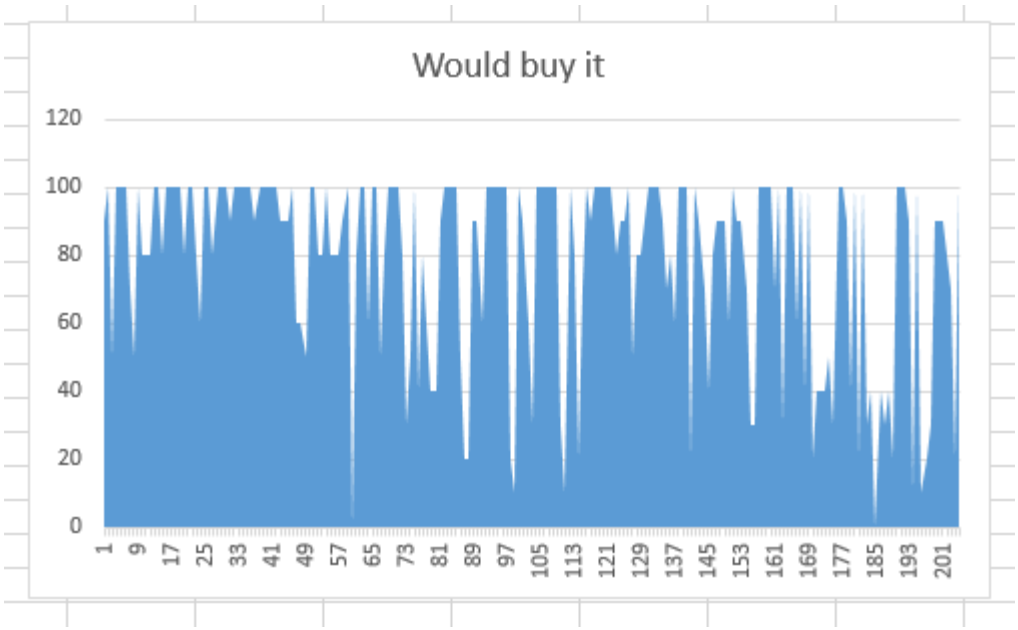


Figure 39: Would you buy it? Question result chart.

6.4. Summary of Findings

Although this study was conducted on a small group of participants, it showed that Vision files are most likely to succeed and be liked more than Music files and Music Videos: most of the users in our test would buy Vision files after comparison. Furthermore, the average of users tested is around the end of thirties and this has also been considered important from the point of view of purchasing power. HMD are still an expensive buy (a PC plus capable of VR + an HMD starts from around 1500$). This finding also help us in understanding that the female participants, around 42 in total, had a bad feedback altogether due to practical problems (27 girls answered “hair gets tangled” in the HMD headset). For this matter, the Oculus Prototype that was used in this study is still the DK1 (Developer Kit one), the oldest of the Oculus releases dating now almost three years ago which did not address the problem of usability in its design. The new HMD in these terms work better. This means that the problem could have had different outcome using the new Oculus DK or other HMD like HTC Vive [70] or Sony PlayStation VR [71]. For the motion sickness problem, although in this study’s findings there was no strong negative result about it, it is still a phenomenon difficult to describe by using a

small number of participants and would need bigger data available to have a valid statistical importance.

Chapter 7

7. Conclusions

7.1. Conclusions

The main hypothesis of this study was that “The Empyrian” could enrich the music experience by using Virtual Reality compared to already present media like music files and music video. As results showed, during the prototype preliminary evaluation a high percentage of people were favorable to the use of The Empyrian in their life, and the problems presented by users were solvable by addressing software and hardware issues in a timely fashion. Still, the project has its own advantages and disadvantages that cannot be ignored and will have to be tackled in order for it to succeed.

7.1.1 Advantages

The Empyrian has various advantages that would constitute a great leverage to both users and creators both on the short and long term.

- Consumers can see Vision Files using HMD of any kind: Music evolves into Immersive 3D, Full HD visual contents (up to 4k), FLAC lossless high quality music.
- Artist can sell Vision files: Artists from all over the world can give visual interpretation to their music or the one of other artists.
- The idea is new and can be defined as “Blue Ocean” (market with few competitors). The competition, YouTube, Pandora, Spotify offer different services based on mp3 files or videos.

- Vision sharing: Users could gift and share Visions with their friends (being inside the same Vision at the same time possible).
- Vision Radio: Users can connect to a streaming channel and see Visions played by a “Visionary”, a Vision artist.
- Highly customizable service: The service can be customized with templates for users who want to send Visions as presents (messages, photos, dedications, etc.)
- Google, Oculus, Apple, Sony, and Microsoft all have their own "walled gardens" and a platform like The Empyrian would eliminate what is the main obstacle to the diffusion to mainstream of VR now: exclusive releases.
- Facebook acquired Oculus and will probably uses VR in their SNS and this study’s project could tackle it, resulting in a huge user base to target
- Glasses will be probably smaller and more portable in the future, allowing for portability and other uses

Also, the project has other indirect advantages:

- Moving from video creation to Vision creation will educate creators in using new medias and game engines
- Blending more genres together could stimulate artists in creating art in genres different from their own one: music, or graphics etc.
- Sharing Visions created based on old music could revamp old classics to new generations.

This last point could work particularly well for the nature of the project, as often old music classics do not offer good quality in terms of music videos (some old songs of course do not even have one) but offer great quality in terms of pure music and content.

7.1.2 Limitations

The limitation of this study are those involved with the actual limits of VR as a technology, and therefore its diffusion and usability may influence the business model validity of the project. These include hardware limits, usability limits and business limits.

- Hardware limits: Motion Sickness
- Usability limits: VR Prolonged usage, Knowledge
- Business limits: Uncertain Stream of revenue
- Knowledge limits: Users

The first limit is related directly to the nature of human brain and vision and involves the difference between focus depth and what is called “vergence”. Oculus Rift and other HMD use images place on a single focal plane. This is different from the real world, where the eye focus and senses the depth of an object. With a single focal plane, the brain gets depth from the rotation of the eyes towards each other, and this last measurement is called “vergence” and there is a disparity between vergence and focus. This disparity in some individuals creates eye-strain and tiredness and creates bad focus. This problem right now is not easily fixable.

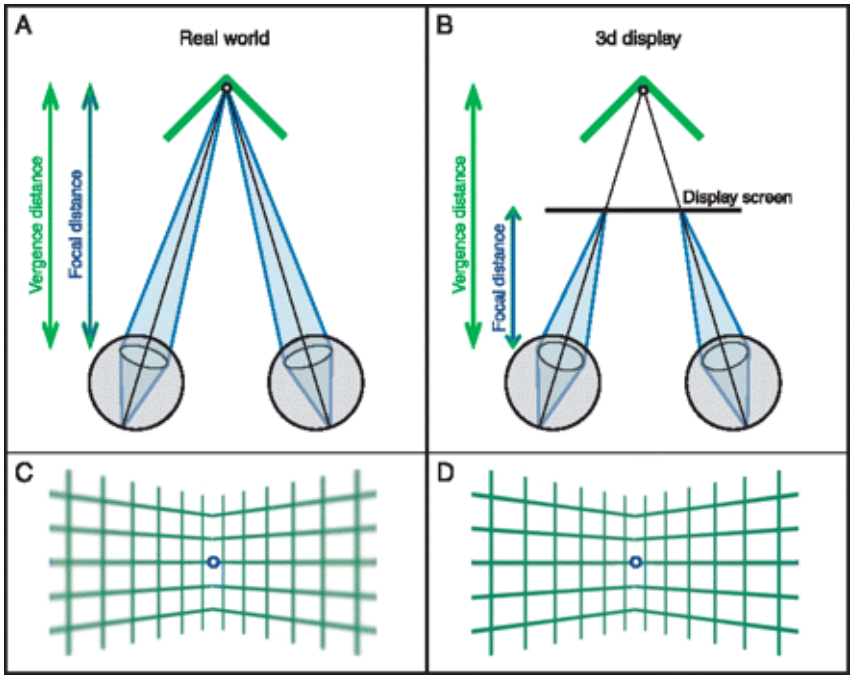


Figure 40: Vergence and eyes focus example.

Another problem is the gap between what the brain feels with eyes and ears. While using Virtual Reality the user's vestibular system tells him/her that he/she is static, although his/her eyes see images of the user moving inside the virtual world. This most commonly is the source of motion sickness related to VR and works in the opposite way of car sickness, where your eyes perceive stasis but your ears sense the car motion.
As per now, the Empyrian's platform will try to tackle this by suggesting Visionaries how to create Visions that result in less motion sickness with a practical and simplified guide to learn about the phenomenon.

The second issue is the fact that initially not many musicians/labels will know how to craft Visions. This will have to be tackled by releasing specific tools and suggesting game engines to easy the creation and expansion of the media's capabilities. Creating tutorials, and initially dividing Visions into pre-modeled samples to learn could address this (refer to the future development section for more info on this).

The third issue is directly connected to the first two as the diffusion of a media, no matter the quality of it, dictates its business success. To secure a valid stream of revenue for the creators and the company would be challenging if the work done on Visions would not be watched by a consistent number of users when released. This may impact the retaining of Visionaries (that would move to older but more solid platforms like YouTube) and acquisition of the initial market share. To cope with this, the eventual starting strategy could use a friendlier free to play model to achieve initial market share and create a leverage from where to start.

7.2. Future Improvements

The future work will have to focus on several important points:

- Create networking system
- Create tools for Visionaries
- Mixed Reality compatibility

The first point will be necessary in order to proceed to the next step in evaluation of the platform. As the results in Chapter 6 show, younger audience

and Millennials in general are used to share their life on Social Networks. At the actual state Visions are not shareable and cannot be enjoyed by several players at the same time. Creating this will likely impact the success and diffusion of the platform and can also easily be linked to preexisting services (Facebook, Spotify, etc.) by using buttons or directly make the user access using their SNS login credentials. Creating a network will also impact the user target pool, as couples, groups of friends and families will enlarge the user base to a more casual crowd. This will be possible only if the platform is easy to access. The second point, in fact, is probably the most important in terms of active user base (the so called “Visionaries who contribute to the platform by uploading their creations). At the moment two main tools are required for the Visionaries to have easier access to content creation:

- Timeline tool
- Path tool

The timeline tool is a function that allows users, like for programs like After Effects or Final Cut, to have total control on their Vision in terms of what happened in any precise time frame. The Unity3D default installation does not provide users with any basic timeline function and at this time rolling the prototype and checking its status every time is the only solution available. A package for the Unity3D marketplace done specifically to address this would solve the problem and invite more creators. The Path tool is also much needed in order for users to address the camera movements inside the vision easily. For this, already present tools like Camera Path in Unity3D could solve the problem, but creating a unique tool that comprehend both timeline and path creation would be better.
As for Mixed Reality (HoloLens and future HMD) compatibility, this is probably the definitive solution into diffusion of the Empyrian to the masses when this technology will become mainstream, and this for several reasons:

- HoloLens is less bulky and more portable than VR HMD
- Mixed Reality allows for a more prolonged experience than VR
- Mixed Reality allows user to see the surroundings and has less investment in terms of time absorbed playing
- HoloLens and Mixed Reality use the real world and this could be leveraged to have an even more interesting type of Vision files

Mixed Reality is still a bit far away to draw conclusions though, but as soon as companies like Microsoft will invest in its chances are that this study’s project

will likely have a wider audience of users if implemented with HoloLens as well. In terms of a wider compatibility, the VR platforms are also at the moment available at the moment only for PC and PlayStation 4. Spreading the system first to consoles and then the mobile systems (when power will be sufficient and resources less important) will also make the platform more scalable.

7.3. Summary of Contributions

The goal of this thesis is to develop a new medium for audiovisual self-expression to artists and creators, together with the analysis of the layout of a valid online platform for them to sell their creations. The contributions of this thesis include:

1. A History of both Virtual Reality and Visual Music to understand what man has been creating and want to achieve from multi-sensorial tools.
2. Four different prototypes of a Virtual Reality based Music video file that show the stages in development and tackle design problems related to Visual Music and Virtual Reality, done by using Unity3D and other software.
3. A new way of intending music described from the design and business standpoint.
4. An analysis of a prototype for a web portal in which to sell files connected with The Project Empyrian.
5. An analysis of the results of showings related to this study, including a deeper analysis of their successful and unsuccessful elements.
6. An outline of future directions to where to continue the research and expand the project in order to have more impact, and what tools to build in order to make it a more seamless experience for creators.

Acknowledgements

This project was developed with the help of many people who believed in it. Thanks Professor Minamizawa and Assistant Professor Charith Fernando for the advice received during the initial lesson, where this project came to life. Thanks to Professor Ohta and Sugiura for believing in me and for the constant and precious advice and help in showing the project in several venues. Last but not least, thanks also to all the members of KMD Forum, CINEGRID and Tokyo Film Festival who voted the project and considered the project interesting and let me showcase it.

References

[1] Interactive Dynamic Abstraction. Snibbe and Levin, 2000.
[2] History of Ophthalmic Photography, http://www.opsweb.org/blogpost/1033503/History-of-Ophthalmic-Photography-Blog
[3] The History of Stereo Photography, http://www.arts.rpi.edu/~ruiz/stereo_history/text/historystereog.html
[4] Theory and research in hci, http://comm6480rpi.blogspot.se/2008/09/morton-heilig-pioneer-in-virtual.html
[5] History of Virtual Reality, http://vrcherries.com/virtual-reality-history/
[6] Augmented Reality, The Ultimate Display by Ivan Sutherland 1965, https://www.wired.com/2009/09/augmented-reality-the-ultimate-display-by-ivan-sutherland-1965/
[7] Five Films that Brought VR Cinema to Life, http://www.sciencefocus.com/article/future/five-films-brought-vr-cinema-to-life
[8] From CVR to CVRO: The Past, Present, and Future of Cultural Virtual Reality, Fischer, Niccolucci, Ryan, Barcelo, 2000
[9] Then Vs Now: Virtual Reality, https://www.colocationamerica.com/blog/then-vs-now-virtual-realities
[10] Historia Virtualenej Reality, http://oculus-rift.sk/historia-virtualnej-reality/
[11] Sega Retro, http://segaretro.org/Sega_VR
[12] Nintendo Virtual Boy wikia, http://nintendo.wikia.com/wiki/Virtual_Boy
[13] Oculus, https://www.oculus.com/
[14] The Rise and Fall and Rise of Virtual Reality, The Verge, http://www.theverge.com/a/virtual-reality
[15] Microsoft HoloLens, https://www.microsoft.com/microsoft-hololens/en-us
[16] Magic Leap, https://www.magicleap.com/#/home

[17] Bloomberg, http://www.bloomberg.com/news/articles/2016-02-02/magic-leap-raises-793-5-million-from-alibaba-google-qualcomm
[18] The Reality Behind Magic Leap, The Information, https://www.theinformation.com/the-reality-behind-magic-leap
[19] Brief History of Visual Music, https://overprocessedthinking.com/brief-history-of-visual-music/
[20] Light & Sound, Color & Music, http://www.roelhollander.eu/en/tuning-frequency/sound-light-colour/
[21] Metamorfosi dei lumi, Saglietti, 2012
[22] Description of M. Kastner's New Musical Instrument, the Pyrophone, http://www.sciencedirect.com/science/article/pii/0016003275902847
[23] Rhythmic Light's Timeline, http://rhythmiclight.com/archives/timeline.html
[24] LACMA on Morgan Russell, http://collections.lacma.org/node/166763
[25] Futures Past: Watch the Clavilux, an ethereal light organ from 100 years ago, http://hplusmagazine.com/2015/08/18/futures-past-watch-the-clavilux-an-ethereal-light-organ-from-100-years-ago/
[26] Origins and Development of Kinetic Art, Popper, 1968
[27] Light and the Artist, Wilfred, 1948
[28] Sensitive Interfaces, http://s-v-m.tumblr.com/post/47711000850/sensitive-interfaces-i
[29] Optical Poems by Oskar Fischinger, the Avant-Garde Animator Hated by Hitler, Dissed by Disney, http://www.openculture.com/2014/09/optical-poems-by-oskar-fischinger.html
[30] Center for Visual Music on Charles Dockum, http://www.centerforvisualmusic.org/Dockum/
[31] The Dream of Color Music, And Machines That Made it Possible, Moritz, 1997
[32] Live and Expanded Cinema, http://livecinema.wikidot.com/charles-dockum
[33] The Dream of Color Music, Moritz, 1993
[34] Oskar Fischinger, Color Rythm, https://mubi.com/cast/oskar-fischinger
[35] Opposite Fields, Symphonie Diagonale, Viking Eggeling, http://oppositefields.com/blog/symphonie-diagonale-viking-eggeling-1924
[36] Emanations: The Art of the Cameraless Photograph, Batchen, 2016
[37] Woman on the Moon, Fritz Lang, 1929, http://www.imdb.com/title/tt0019901/
[38] Ornament Sound Experiment, Fischinger, https://vimeo.com/ondemand/26951
[39] Timeline of Historical Film Color, http://zauberklang.ch/filmcolors/timeline-entry/1264/
[40] Tate.org.uk, Where Abstraction and Comics Collide, http://www.tate.org.uk/context-comment/articles/where-abstraction-and-comics-collide

[41] The Big Broadcast of 1937, http://www.imdb.com/title/tt0027356/
[42] Allegretto, 1942, http://www.imdb.com/title/tt0027275/
[43] Bach's Toccata and Fugue: The 'Fantasia' opener that drove Disney to abstraction, http://www.classicalmpr.org/story/2015/02/27/bach-toccata-fugue-fantasia
[44] Fleischer Screen Song Dinah, 1932, https://www.youtube.com/watch?v=JcxxMjtk2lA
[45] Eventi Milleluci, Canzoni da Guardare, http://2011.eventimilleluci.it/it/progetto.html
[46] Da Carosone a Cosa Nostra. Gli antenati del videoclip, Michele Bovi, 2008
[47] The Beatles' Hard Day's Night Was a Revolution in Black and White, http://somethingelsereviews.com/2014/07/09/no-rules-just-rock-the-beatles-hard-days-night-was-a-revolution-in-black-and-white/
[48] Bohemian Rhapsody Offical Video, https://www.youtube.com/watch?v=fJ9rUzIMcZQ
[49] björk: stonemilker (360 degree virtual reality), https://www.youtube.com/watch?v=gQEyezu7G20
[50] WearVR, Intone's Sing, https://www.wearvr.com/apps/intone
[51] iTunes Visualizer Magnetosphere in 1080p, https://www.youtube.com/watch?v=X29DK0qYEcE
[52] Treccani Empireo, http://www.treccani.it/enciclopedia/empireo_(Enciclopedia-Dantesca)/
[53] Konami's Official Dance Dance Revolution's Website, https://us.konami.com/ddr/
[54] Nintendo's F-Zero, http://www.nintendo.com/games/detail/iftL2T9_tZwGrviks-n1-RfsfvVsZUyk
[55] The Geometry of The Man in the Squared Circle, http://academysacredgeometry.com/courses/mysteries-vitruvian-man
[56] T-pose biped, http://www.flipbookmarket.com/blog/transfer-animations-motionbuilder-fbx-3ds-max-biped-characte
[57] Tachi Lab, http://tachilab.org/modules/projects/techtile_toolkit.html
[58] Daft Punk's Harder, Better, Faster, Stronger, https://www.youtube.com/watch?v=GDpmVUEjagg
[59] Muscle Memory, Wikipedia, https://en.wikipedia.org/wiki/Muscle_memory
[60] KMD Factory, http://kmd-media.com/forum
[61] Business Dictionary Value Proposition's Definition, http://www.businessdictionary.com/definition/value-proposition.html
[62] YouTube, https://www.youtube.com/
[63] Spotify, https://www.spotify.com/us/
[64] Oculus' Experiences, https://www.oculus.com/experiences/rift/
[65] Radiohead's Creep, Versione Animada, https://vimeo.com/6970188

[66] Cell Architecture Explained Version 2, http://www.blachford.info/computer/Cell/Cell1_v2.html
[67] Oculus Mount Wingsuit, https://www.oculus.com/experiences/rift/903642616411015/
[68] Second Life, http://secondlife.com/
[69] Apple App Store, https://itunes.apple.com/us/genre/ios/id36?mt=8
[70] HTC Vive, https://www.vive.com/eu/
[71] PlayStation VR, https://www.playstation.com/en-us/explore/playstation-vr/

Appendix

A. Answers to Empyrian questionnaire (Excel)

Would buy it	Age	Subscri	Musicalo
90	27	1	1
100	35	1	1
50	50	0	1
100	37	1	1
100	44	1	1
100	25	1	1
70	54	1	1
50	58	0	1
100	26	1	1
80	56	1	1
80	55	1	1
80	59	1	1
100	34	1	1
100	20	1	1
80	51	1	1
100	52	1	1
100	38	1	1
100	48	1	1
100	23	1	1
80	60	1	1
100	31	1	1
100	47	1	1
80	53	1	1
60	57	0	0
100	36	1	1
100	29	1	1
80	49	1	1
100	41	1	1
100	39	1	1

100	19	1	1
90	43	1	1
100	24	1	1
100	46	1	1
100	40	1	1
100	21	1	1
100	42	1	1
90	45	1	1
100	32	1	1
100	30	1	1
100	22	1	1
100	28	1	1
100	33	1	1
90	42	1	1
90	24	1	1
90	22	1	1
100	35	1	1
60	52	0	0
60	48	0	0
50	55	1	1
100	41	1	1
100	37	1	1
80	50	0	0
80	58	1	1
100	36	1	1
80	28	1	1
80	23	1	1
80	38	1	1
90	25	1	1
100	44	1	1
0	60	0	0
80	51	0	0
100	59	1	1
100	27	1	1
60	45	0	1
100	33	1	1
100	30	1	1
50	54	0	0
80	49	0	0
100	20	1	1
100	21	1	1
100	57	1	1
80	39	1	1
30	34	0	1
50	31	0	1
100	29	1	1
40	47	0	0
80	32	1	1
60	46	1	1
40	53	0	0
40	56	0	0
90	40	1	1
100	19	1	1

100	26	1	1
100	43	1	1
100	35	1	1
50	52	0	0
20	47	0	0
20	44	0	0
90	31	1	1
90	24	1	1
60	40	0	0
100	33	1	1
100	19	1	1
100	38	1	1
100	32	1	1
100	29	1	1
100	20	1	1
20	58	0	0
10	53	0	0
100	25	1	1
90	57	1	1
60	56	0	0
30	50	0	0
100	27	1	1
100	34	1	1
100	51	1	1
100	23	1	1
100	41	1	1
100	39	1	1
30	43	0	0
10	54	0	0
100	48	1	1
80	60	1	1
20	46	0	0
70	59	0	0
100	45	1	1
90	37	1	1
100	21	1	1
100	36	1	1
100	26	1	1
100	22	1	1
100	49	1	1
80	55	1	1
90	28	1	1
90	30	1	1
100	42	1	1
50	47	0	0
80	35	1	1
80	56	1	1
90	59	1	1
100	28	1	1
100	36	1	1
100	32	1	1
90	57	1	1
70	51	1	1

80	25	1	1
60	54	0	0
100	37	1	1
100	33	1	1
100	43	1	1
20	60	0	0
100	21	1	1
90	31	1	1
70	53	1	1
40	42	0	0
80	48	1	1
90	55	1	1
90	41	1	1
90	44	1	1
60	46	0	0
100	26	1	1
90	30	1	1
90	23	1	1
70	58	1	1
30	45	0	0
30	39	0	0
100	22	1	1
100	38	1	1
100	24	1	1
100	20	1	1
70	40	1	1
100	27	1	1
30	60	0	0
100	34	1	1
100	29	1	1
60	50	0	0
100	19	1	1
40	52	0	0
100	36	1	1
20	50	0	0
40	43	0	0
40	46	0	0
40	48	0	0
50	53	0	0
30	49	0	0
100	37	1	1
100	20	1	1
90	45	1	1
40	54	0	0
100	26	1	1
20	52	0	0
100	23	1	1
30	32	0	0
40	55	0	0
0	60	0	0
40	38	0	0
30	35	0	0
40	44	0	0

20	51	0	0
100	58	1	1
100	22	1	1
100	28	1	1
90	24	1	1
10	42	0	0
100	27	1	1
10	56	0	0
20	47	0	0
30	40	0	0
90	34	1	1
90	19	1	1
90	39	1	1
80	30	1	1
70	33	1	1
20	41	0	0
100	21	1	1